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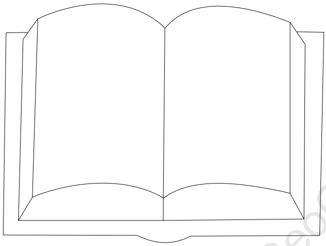

Section ECOLOGY AND ENVIRONMENTAL PROTECTION

A COMPARATIVE STUDY ON CONVENTİONAL NATURAL DYEİNG AND MACHİNE DYEİNG METHODS

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ABSTRACT

Wool yarn has been dyed with natural colourant extracted from the different natural dyes in the absence and presence of Potassium aluminium sulphate, Copper sulphate and Acetic acid mordants for producing shades of different colours, and then tested for *CIE Lab* properties. L^* value of the washed wool yarn was much higher than not washed wool yarn. Colouration of both the dyeing methods is found to be most effectively accomplished at treatment time. Dyeing on effect of treatment temperature, time and different mordants with Conventional and Machine dyeing methods have been discussed.

Keywords: Dyeing machine, Natural dyes, CEI space systems, mordants, Wool yarn

1. INTRODUCTİON

Manufacturing of synthetic dyes and pigments largely depends on petrochemical sources and some of these used in dyeing industries. Very small amount of dye in water is highly visible and can be toxic to creaatures in water, for example, these can cause allergic dermatitis, skin irritation, cancer, and mutations. The removal of colour from process or waste effluents becomes enviromentally important Therefore, the undesirable dye pollutions are required to rmove from wastewater before being discharged to the environment[1,2,3]

During the past three decades, several physical, chemical and biological decolorization methods such as aerobic and anaerobic microbial degradation, coagulation and chemical oxidation, membrane separation process, electrochemical, dilution, filtration, flotation, softeing, and reverse osmosis have been proposed. However, all of these methods suffered with one or another limitation, and none of these were succesful in removing colour from the wastewater completely [4].

Many researchers have investigated the fate of textile dyes in the adsorption process is one of teh effective techniques that have been successfully employed for colour removal from wastewater, such as activated sludge[5], chitin [6], and activated carbon[7], bentonite [8] diatomite[9].

Some of the synthetic dyes contain toxic, carcinogenic amines which are not ecofrendly, moreover, the global consumption of textile is estimated at around 30 million tonnes, which is expected to grow at the rate of 3% per annum and in spite of the beter performance of synthetic dyes recently the use of natural dyes on textile materials has been attracting more and more scientists for study on this due to the reasons, wide viability of natural dyes and their huge potential, and to protect the ancient and traditional dyeing technology generating livelihood of poor artisan/dyers, with potential employment generation facility, and to study the ancient dyeing methods, coloured museum textiles and other textiles recovered by archaeology for consevation and restoration of heritage of old textiles. Availability of scientific information on chemical characterizations of different natural colorants, including their purification and extraction [10].

The present work was aimed at applying such colourant on wool and assessing some fundamental parameters related to dyeing of conventional Natural dyeing and Machine dyeing methods, and in this study, such as natural dye that it has been used Alpinia officinarum. *Alpinia officinarum*, known as lesser galangal, is a plant in the ginger, family,cultivated in southeast Asia. It originated in China, where its name ultimately derives. It can grow several feet high, with long leaves and reddish-white flower

2. Materials and Methods

2.1 Materials

Wool yarns of 2.5Nm count were used for the study. As mordant, potasium aluminium sulphate and copper sulphate were used for the study. Laboratory model open bath beaker dyeing machine and spectrophotometer (konica minolta 3600d) were used.

2.2. Methods

2.2.1. Extraction of Alpinia officinarum

Alpinia officinarum was taken in hot water for extraction of its colour component varying condition such as material to liquor ratio of 1:50 1:100 P^H natural, time period 60-90 min and temperature 95-100 ^{0}C in order to the conditions of colour component extraction.

2.2.2. Conventional Dyeing

Dyeing of wool yarns with Alpinia officinarum at material-to- riquor ratio of 1:100. the dye bath temperature was kept at 95 ^{0}C for 1h. After dyeing is over, the wool fabric were washed cold water and then dried in air. The same procedure was performed in precence of different mordants. Soaping of all the dyed wool yarns were done employing 2g/L non- ionic detergent at 45 ^{0}C for 30 min. Finally, the wool yarns were cold washed and dried,and analyzed by spectrophotometer (konica minolta CM 3600d)

2.2.3. Dyeing Machine

Each of material-to- riquor ratio of 1:100 Alpinia officinarum was put in the twelve steel caps. Then, the dyeing temperature was slowly at 95^0C for 45 min. Finally, the wool yarns were cold washed and dried, and analyzed by spectrophotometer (konica minolta 3600d) . The same procedure was performed in precence of different mordants. Soaping of all the dyed wool yarns were done employing 2g/L non- ionic detergent at 45 ^{0}C for 30 min.

3. Results and Discussion

3.1. conventional and machine dyeing methods

Effect of different dyeing process variables have been studied to optimize the dyeing conditions for uniform colour yield. It is found that machine with dyeing process carried out in a short time and faster than conventional dyeing method. For this reason, it was make with on CIE L a^* b^* machine dyeing process in after these dyeing methods.

Table 1-3 shows observed colour of wool yarns in absence and presence of mordant and colour fastness. It is evident from table 1-3 that after washing there was slightly to change of colour and bright in all samples. Maximum colour change was not observed in absence and prensence mordant in all samples. But Washing wash fastness ratings slightly decreased. Similar resutls have also been reported by many researchers[11,12,13 and 14]

	CIE L^*	a^*	b^*	Colour Observed	Wash fastness
In absence of mordant	30.10	-1.42	- 3.45	dark green	3- 4
After washing	35.21	-1.65	-2.12	light green	3

Table 2 *CIE* L^* a^* b^*values of wool yarn samples dyed with Alpinia officinarum dye and in presence of mordant

Mordanting agent	CIE L^*	a^*	b^*	Colour Observed	Wash fastness
$KAl(SO_4)_2 12H_2O$	35.10	-2.12	4..45	mustard yellow	4
$CuSO_4 5H_2O$	40.36	-2.30	3. 85	greenish	4

Table 3 *CIE* L^* a^* b^*values and wash fastness properties of after washing wool yarn samples dyed with Alpinia officinarum dye and in presence of mordant

Mordanting agent	CIE L^*	a^*	b^*	Colour Observed	Wash fashness
$KAl(SO_4)_2 12H_2O$	35.10	1..50	3.40	light mustard yellow	3-4
$CuSO_4 5H_2O$	37.30	- 3.34	2.35	light greenish	4

Conclusion

Wool yarns dyed in presence mordant metods, Indicating its wash fastness rating is improved by using mordant. Colouration of wool yarns with Alpinia officinarum was found to be effectively accomplished within natural P^H. Colour fastness to washing of wool yarn dyed with this dye in presence and in absence of any salt appears to be 4 and 3-4 respectively. The results of present work indicate that the Alpinia officinarum can be a good resource for natural dye for wool yarns.

REFERENCES

[1] K.N. Vinod and et all, İndian J fibre Text Res. (2010). 159-163.

[2] M,S Chion. P.Y., Dyes and pigments, 69-94 .

[3] Ertaş, M. and et all, J hazmat. 183 (2010) 421-427

[4] Doğan M, et all J.hazmat (165) (2009).1142-1151

[5] M .MCKAY, H.S.Blair, J.R.Gardner. J.Colloid interface sci, 95 (1983) 108-119.

[6] Basıbuyuk, M., and C.F., Forster. Process Biochem. 38 (2003). 1311-1316.

[7] F.Rozada, et all, Bioresour. Tech. 87 (2003) 221-230.

[8] Koyuncu , M., Asian J. Chem. 21 (2009), 5458-5464.

[9] Koyuncu, M., Kul, A.R., J.Chem. Pharm. Res. 3 (2011) 297-303.

[10] Kumar, A S., and Agarwal, P., Indian J. Fibre Text.Res. (2009). 384-399.

[11] Mishra, S., Pattaniah P, mohapatra P,& Das N, Asian Text J. 9(11) (2000) 124.

[12] Koyuncu, M., Lournal og Agricultural Sci. 18 (1) (2008). 27-33.

[13] Debasish, Das, et all. Indian J. Fibre Text Res. 32 (2007). 366-372.

[14] Samanta, A.K Agarwal, P., Datta S., Indian J. Fibre Text res. 33 (6) (2008). 171.

A DISTRIBUTED CONTROL SYSTEM FOR GREENHOUSE ENVIRONMENT APPLICATIONS

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ABSTRACT

The paper speaks to an important subject in the current situation of environmental resources, such as efficient control of the process of irrigation plants in greenhouse conditions. Therefore, it is submitted a comprehensive application that aims to be a distributed control system including data acquisition and processing, both local and remote monitoring and control of the process parameters. The distributed control system is based on modern equipment: Siemens Simatic PLCs and HMI, Memsic *ēKo Pro* wireless sensors network, level sensors for irrigation tanks and actuators such as on/off valves and pumps. In terms of communication between equipments, an industrial bus and protocols were used – Profinet, MPI, AS-I and wireless communication. The software part is provided by *STEP 7*, *WinCC flexible RT* and *LOGO! Soft Comfort* for programming of the automation devices, *C* language for communication protocol development, and *HTML*, *JavaScript* and *PHP* for Web interface of the remote process control.

Keywords: distributed system, PLCs and HMI network, remote control

INTRODUCTION

During last years, in the field of monitoring and control processes a significant increase both in terms of equipment development and new communication technologies implementation was achieved. By covering a wide range of requirements such as data measurement, acquisition, management, monitoring and control, diagnosis and prediction, the growth of process complexity determined both the involvement of human operator and process computers. The process computers have become more efficient in order to obtain optimum performances in relation to one and more several performance criteria. In these conditions, a structure of distributed control system with hierarchical management levels is required. Therefore, the networked control system architecture was implemented. The components of this distributed system ensure the closing of the control loop: the sensors collect data from the process; the control devices provide the commands, the actuators apply commands and the industrial networks provide the communication between all the system's components. This control structure is illustrated in figure 1.

In the presented application the networked control system use several industrial bus and protocols such as Profinet, MPI, AS-I and wireless communication. The sensors are based on *ēKo Pro* wireless sensor system produced by Memsic that measures the parameters' values of the greenhouse environment and on/off level sensors for water tanks. The actuators are represented by three on/off valves and one pump. The control part is made with Siemens PLCs and HMI devices. This study of greenhouse microclimate is intended to complete the process of irrigation to keep plants at the appropriate level of growth.

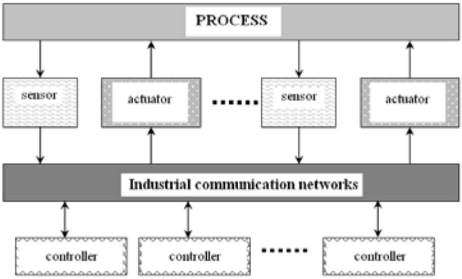

Fig. 1. The architecture of the networked control system.

THE COMPONENTS OF THE DISTRIBUTED CONTROL SYSTEM

The proposed solution for distributed control system of the irrigation process consists of three subsystems: the primary acquisition and processing of data is performed by *eKo Pro Series* wireless sensors network; the control tasks are performed by a network of programmable logic controllers and interface equipment and the final set of tasks, the irrigation process itself is performed by a third subsystem. Each subsystem is presented below in detail.

The first subsystem is represented by the sensor network with wireless data transmission. The central equipment of this subsystem is the eKo-gateway (presented in figure 2a), which collects data via a radio base (presented in figure 2b) from sensors attached to wireless nodes.

a) b)

Fig. 2. The eKo-gateway (a) and the base radio (b).

The eKo-gateway runs a visual monitoring application of the ecological phenomena. Thus, there is a graphical interface that allows the management of parameters and sensors network configuration, called *eKo-View* interface that is explained in detail in applications' part. Six wireless nodes compound this data acquisition subsystem, one node for each location with plants in the greenhouse. The eKo-node (that is illustrated in figure 3) integrates an IRIS processor/radio board and antenna that are powered by rechargeable batteries and a solar cell. The nodes themselves form a wireless mesh network that can be used to extend the range of coverage. By simply adding an additional eKo-node, it is easy to expand the coverage area. The nodes are pre-programmed and configured with *XMesh* low-power networking protocol, which provides plug-and-play network scalability for wireless sensor networks. Four ports to connect the sensors the eKo-node has. An efficient monitoring and data acquisition application from multiple locations is provided by this solution.

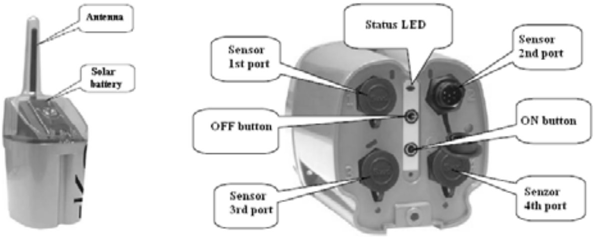

Fig. 3. The wireless eKo-node and its communication ports.

The subsystem contains a variety of sensors (figure 4) such as soil water content, soil moisture and temperature, ambient humidity and temperature, leaf wetness, and solar radiation.

Fig. 4. The sensors of the *eKo Pro* wireless subsystem.

All the three components (soil, air and plants) of greenhouse environment can be monitored using existing sensors. Thus, the ecological parameters that can be purchased are specified below in table 1, with the variation range of measured values, measurement units, and an acronym, which will be used further.

Table 1. The ecological parameters and its range values and units.

Soil	Leaf	Air
Moisture (Mo) 0 ... 240 [cbar]	*Leaf Wetness* (LeWe) 0 ... 1024 [CntS]	*Humidity* (Hu) 0 ... 100 [%]
Temperature (Te) -40 ... +65 [°C]		*Temperature* (Te) -40 ... +65 [°C]
Water Contents (WaCo) 0 ... 100 [%wfv]		*Dew Point* (DwPo) -10 ... 50 [°C]
		Solar Radiation (SoRa) 0 ... 1800 [W/m^2]

The data transfer between the base radio and eKo-gateway device is done using serial USB interface. The eKo-gateway runs the *Debian Linux* operating system and comes preloaded with sensor network management and data visualization software packages, *XServe* and *eKo-View* applications. These programs are automatically started when the gateway is turned on. The data from each sensor is sampled every 15 minutes. The software located in the eKo-gateway then computes average values for every hour, day and month for long term statistics and stores this data into a *SQLite* database that can be exported for processing by third-party applications or simply for backup.

The *eKo-View* application, presented in figure 5, offers a familiar and intuitive web browser based interface for sensor network data visualization. In this interface is easy to start monitoring and data acquisition from anywhere in the world via a computer after the sensor network was configured. Through *eKo-View* interface, it is possible to setup and configure the wireless network to display only the data that are interested. The *eKo-View* web interface allows users to make various settings [2].

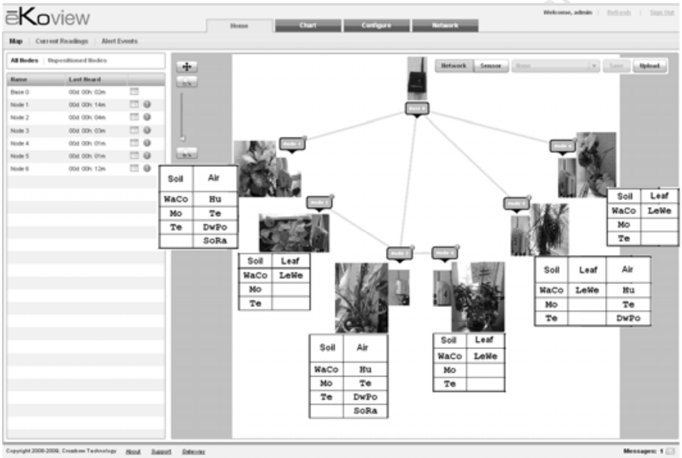

Fig. 5. The *eKo-View* web interface.

Besides the presented functionality, additional software was designed and developed to allow the system to communicate the relevant data to the automation equipment: binaries for low level communication via the MPI interface (attached to an USB port of the eKo-gateway) and high level scripts for selecting and sending the data. Therefore, at the level of eKo-gateway equipment have been implemented many applications [2] such as communication protocol to facilitate data transmission between the eKo-gateway and Simatic S7-300 PLC (the *Master* of the control subsystem), and PHP scripts that represent the development base of the eKo-Greenhouse web interface for remote monitoring and control the process parameters and systems devices.

The complete structure of the acquisition subsystem for collect and monitoring parameters' values is presented in figure 6. There three levels of transferring data are shown – the sensors' level with wire connections, the nodes' level with both wire connections and wireless transmission, and acquisition level with wireless transmission.

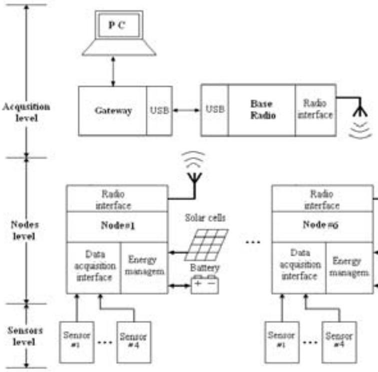

Fig. 6. The complete structure of the acquisition subsystem.

The control subsystem has a central unit CPU315F-2DP/PN of the Simatic S7-300 Programmable Logic Controller. Here all the data from the *eKo Pro* data acquisition subsystem is collected via the MPI communication bus. Other industrial communication networks used in the control subsystem are the Profinet/Industrial Ethernet communication bus and AS-I interface. The Profinet is used to accomplish two very important tasks: one is the programming of the CPU315F PLC and the other to transfer data between the CPU and the OP 177B HMI device with touch panel. An important software application, developed in *WinCC Flexible RT* software environment, is the program that runs on the OP177B HMI device. This solution represents the modality to monitoring and control at local level the irrigation process. Thus, this application allows changing important parameters locally in the system like the limits which trigger the opening of valves and the timings for the valves. The AS-I interface connects the S7-300 PLC (the *Master* device) and Simatic LOGO! PLC (the *Slave* device), which receives the instructions directly from the CPU315F. The control functions of the distributed system reside in the PLC network. An overview of this subsystem can be observed in figure 7.

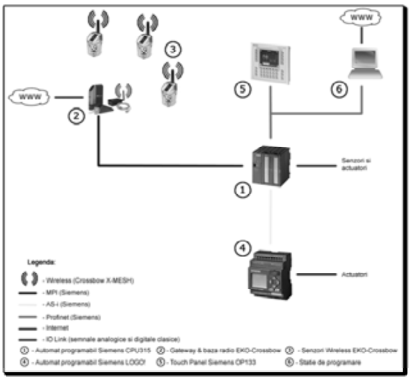

Fig. 7. The control subsystem and it communication with acquisition subsystem.

The most important piece of software in this subsystem is the control software for the CPU315F of S7-300 PLC. This program computes the average values across all the sensors and makes decisions on which of the valves to open so that the humidity values stay within preset limits. Another function of this program is to detect abnormal conditions and defects in the system and take corrective measures. The last of the tasks performed by the central PLC is to log its own actions so that problems are detected and corrected by the human operator [1]. These implemented tasks are presented in the application part of this paper, where the web interface for remote control is described.

Finally, the interactions with the third subsystem – the irrigations subsystem – are done with the help of S7-300 and LOGO! PLCs. The two PLCs interact with the irrigations subsystem with basic I/O digital signals: the water levels in the two irrigation tanks are detected by on/off float sensors – low, middle and high level for each tank – that are connected directly to the CPU315F. Actuators – the three on/off valves and the pump – are controlled by the LOGO! PLC according to the instructions received from the CPU315F on the AS-interface network.

THE CONTROL APPLICATIONS AND THE EXPERIMENTAL RESULTS

The data acquisition subsystem, control subsystem, and irrigation subsystem form together the complete structure of the proposed distributed system, illustrated in the figure 8.

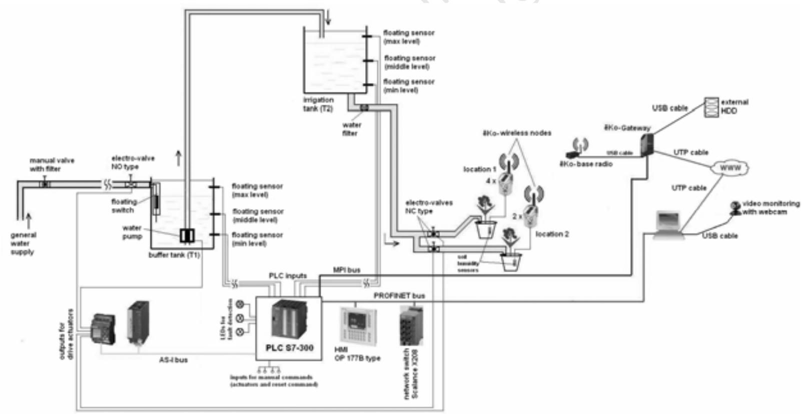

Fig. 8. The complete structure of the monitoring and control distributed system.

This architecture is based on the measurement and data acquisition, management of database, monitoring and data processing, and then the *Master* device (S7-300 PLC) take decisions to control the irrigation subsystem by sending commands to actuators via *Slave* device (LOGO! PLC). To improve system performance, at the level of the control subsystem some measures of reliability are considered. From this point of view, the causes that produce system failure are eliminated. In this architecture a webcam is used 24 hours a day for video monitoring of the process. For this task, another LOGO! PLC is used to control lighting enclosure. Thus, a lamp will be lit at night and goes off next morning.

For the irrigation process two tanks of water are used. The first tank into the water flow circuit is a buffer tank (T1), which is fed directly from the mains water supply. The second tank (T2) is used for the irrigation process of plants.

Before the first water tank, a normal-open (NO) type valve is installed to interrupt the general water supply in an emergency. Also, there is a manual tap with a mash water filter, which is used to retain impurities. The NO type valve is closed if an extreme condition determines an emergency state of the system, in order to stop the water supply and three LEDs are lit.

Inside the buffer tank are mounted some elements such as a float switch for water supply, three sensors for detecting water level in the tank (“min”, “middle” and “max” levels), and a mini-submersible pump. Also, the second tank has three floating level sensors that determine the minimum, middle and maximum levels of water. To fill the second tank with water the mini-pump is used. The irrigation process is performed because the second tank is located at a height of about 3 meters above the floor. The irrigation process begins when a normal-closed (NC) type valve receives command to open. This command is sent by the AS-Interface bus from S7-300 PLC to LOGO! PLC after the Master processes the sensors data. There are two NC type valves, one for each plant area. Water flows through the pipeline in a time set by user. At the end of the irrigation cycle, the valve switches in the closed position again (default position).

The web interface to remotely monitoring and control the automatic irrigation system was built using common web technologies: *HTML* (Hyper Text Markup Language), *JavaScript*, *AJAX* (Asynchronous JavaScript and XML), and *PHP* (PHP Hypertext Processor). This interface is protected and the access is done using a username and a password. Also, the web interface contains the image of process area provided by the webcam. Moreover, in the left side of the interface the last 10 events are precisely shown (date and hour). The remote monitoring and control web interface of the distributed system is presented in figure 9.

Fig. 9. The remote monitoring and control web interface of the distributed system.

In this web interface the control panels are organised into 4 sections, each section containing a set of commands [2]. The first section contains remote commands for S7-300 PLC such as *Start*, *Stop*, and *Refresh Data*. The second section includes remote commands for manual control of actuators in irrigation process, such as *Start* and *Stop Pump*, *Open* and *Close Valve* for plant area 1 or *Open* and *Close Valve* for plant area 2. Also, this section contains suggestive indicator elements to get the status of these commands. The third section allows user to view and set the application parameters, such as the current values of soil parameter, the irrigation threshold settings for both plant area, and the values for irrigation time period. The last section represents an easy modality to export data from the eKo-gateway in *.csv* type file. For example, the data obtained in this section is useful for prediction algorithms that are part of another paper [3], which consider data as input series.

The system had a great influence over the evolution of the relevant parameter (soil moisture), as best observed in figure 10 that shows the evolution graph for the soil moisture as captured by the sensors planted near the root of the six monitored plants.

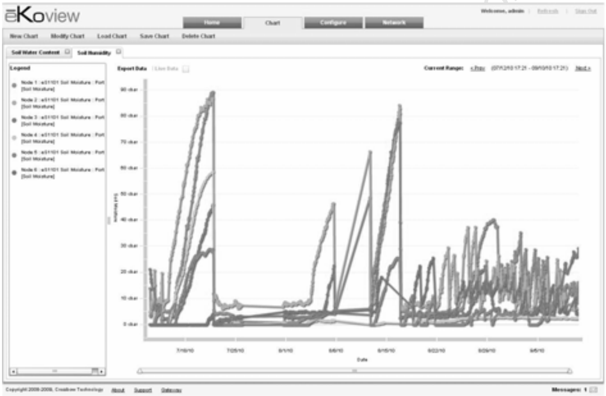

Fig. 10. The experimental results of the irrigation system.

The graph is provided by the software implemented in the eKo-gateway. The first half represents the period of time in with the irrigation system was turned off. After switching the system on, the variation limits for the soil moisture were severely reduced, translating in better health and plants comfort, which is the purpose of the system, too.

REFERENCES

[1] Nitu C., Dumitraşcu A., Vînătoru M. Automatica, vol. 1, Chapter 17th, ISBN 978-973-1883-4, pp. 849-886, Romanian Academy Press, Bucharest, 2009.

[2] Dumitraşcu A. Contributions to industrial computer networks in process control, PhD thesis, pp. 218, University Politehnica of Bucharest, 2010.

[3] Culiţă J., Ştefănoiu D., Dumitraşcu A. EcoMonFor - A System for Greenhouses Monitoring and Forecasting, Industrial Simulation Conference ISC-2011, Venice, Italy, ISBN 978-90-77381-63-2, ISI-Thomson and INSPEC referenced, pp. 262-269, 2011.

A SLOVAK ENVIRONMENTAL RATING TOOL FOR BUILDINGS

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ABSTRACT

Sustainability assessment of buildings can be defined as a specific complex of proceedings oriented towards systematic and objective evaluation of a building's performance. These processes lead to the design, construction and operation of buildings with respect to criteria for sustainable development. The integrated assessment is not only a tool for control, but also a tool of sustainable building design. The purposes of assessments from environmental, economic and social aspects and indicators are due to the determination of real building states from a safety and reliability point of view, the possibility of building comparisons, the effect of environmental buildings potential and the proposal of measures resulting in sustainable buildings. These indicators are included in building environmental assessment systems and tools used in different countries for evaluating the integrated building performance. In recent years the evaluation of building performance in terms of environmental, social and economic aspects has become a topic of discussion in the Slovak Republic, as well. This topic is often discussed by architects, designers and developers. The new building environmental assessment system (BEAS) has been developed at the Institute of Environmental Engineering, Technical University of Košice. The systems and tools used in many countries have been the foundation of the new system development applicable under Slovak conditions, mainly the SBTool. The BEAS has been developed for the preliminary stages of the life cycle, i.e. pre-design and design. This system contains six main fields and 52 indicators. The main fields and determining indicators of BEAS are based on the available information analysis from particular fields and also on one's own experimental experience. The proposed fields and indicators respect and adhere to Slovak standards, rules, studies and experiments. The fields and indicators are proposed on the base of available experience database analysis from integrated performance of buildings. The presented paper introduces the building environmental assessment system developed in Slovakia. The aim is however a weighting and analysis of significance of main fields and indicators of assessment using multi-criteria analysis and formal concept analysis to measure the quality of buildings in the Slovak republic.

Keywords: building environmental assessment, rating tool, sustainable buildings, Slovakia

INTRODUCTION

Environmental assessment of buildings has been an emerging field during the last decades involving both practitioners and academia [1, 2]. The increasing awareness of the significant contribution of the built environment to society's environmental impact as a whole has been essential for this development. To reduce the environmental impacts of new and older buildings, tools for evaluating and assessing potential impacts, performance and improvement potentials, are seen as useful [3]. In assessing the performance of buildings, the scope on environmental evaluation is widening, marking an evolution from a single criterion consideration, like the economic performance of buildings, towards a full integration of all aspects emerging during the lifetime of a building and its elements. It becomes therefore clear, that "Sustainable Buildings" is a brad, multi-criteria subject related to three basic interlinked parameters: economics, environmental issues, and social parameters [4, 5]. Environmental assessment tools vary to a great extent. A variety of different tools exist for building components, whole buildings and whole building assessment frameworks. The tools cover different phases of a building's life cycle and take different environmental issues into account. These tools are global, national and, in some cases, local. A few national tools can be used as global tools by changing the national databases. Tools are developed for different purposes, for example, research, consulting, decision making and maintenance. These issues lead to different users, such as designers, architects, researchers, consultants, owners, tenants and authorities. Different tools are used to assess new and existing buildings. Moreover, the type of the building (residential or office building) influences the choice of the environmental assessment tool [6]. Building sustainability assessments based on a life-cycle approach can produce important long-term benefits for both building owners and occupants, namely: helping to minimize environmental impacts; solving existing building problems; creating healthier, more comfortable and more productive indoor spaces, and reducing building operation and maintenance costs [7, 8]. Operation of the ventilation and air-condition units is a cost demanding matter. Designers are looking for new methods how to reduce energy consumption of this machinery, however it is necessary to take into consideration the required parameters of indoor air [9].

A SLOVAK ENVIRONMENTAL ASSESSMENT TOOL FOR BUILDINGS

In recent years the evaluation of building performance in terms of environmental, social and economic aspects has become a topic of discussion in the Slovak Republic, as well. This topic is often discussed by architects, designers and developers. The new building environmental assessment system (BEAS) has been developed at the Institute of Environmental Engineering, Technical University of Košice. The systems and tools used in many countries have been the foundation of the new system development applicable under Slovak conditions, mainly the SBTool. The BEAS has been developed for the preliminary stages of the life cycle, i.e. pre-design and design. This system contains six main fields and 52 indicators. The main fields and determining indicators of BEAS are based on the available information analysis from particular fields and also on one's own experimental experience. The proposed fields and indicators respect and adhere to Slovak standards, rules, studies and experiments. In the table (Table 1) is shown a hierarchy structure of proposed building environmental assessment system. Main fields are: A – Site Selection and Project Planning, B – Building Construction, C – Indoor Environment, D – Energy Performance, E – Water Management, F – Waste Management. Some of main fields have subfields. Fields and subfields have determining indicators [10].

Table 1. Hierarchy structure of proposed building environmental assessment system

BEAS	A	A1	A1.1	A1.2	A1.3	A1.4	A1.5	A1.6	A1.7	A1.8	A1.9	A1.10
		A2	A2.1	A2.2	A2.3	A2.4	A2.5	A2.6	A2.7			
	B	B1	B2.1	B2.2	B2.3	B2.4	B2.5					
		B2	B2.1	B2.2	B2.3							
	C	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	
	D	D1	D1.1	D1.2	D1.3	D1.4	D1.5					
		D2	D2.1	D2.2	D2.3							
		D3	D3.1	D3.2								
	E	E1	E2	E3	E4							
	F	F1	F2	F3								

Hierarchy structure allowed using Multi-criteria analysis (MCA) and Formal Concept Analysis (FCA) for weight significance determination. MCA is a tool for effective evaluation and decision support. Analytic hierarchy process (AHP) is one of the Multi-criteria analysis methods. AHP is a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales. It is scales that measure intangibles in relative terms. The comparisons are made using a scale of absolute judgments that show how much one element dominates another with respect to a given attribute [11]. The multi-criteria framework incorporates the consideration of environmental issues in a development and it will play an important role in the evaluation approach. To ensure that the indicators developed are applicable to the operations of the business it is necessary to verify and revise the indicators through fieldwork reviews and consultation with experts and stakeholders. This series of verification/modification processes is repeated until a refined set of indicators is obtained that is both necessary and sufficient to monitor the sustainability performance of the buildings [12].

METHOD OF WEIGHTING

According to Lee et al. [13, 14] credit-weighting is the heart of all assessment schemes since it will dominate the overall performance score of the building being assessed. However, there is at present neither a consensus-based approach nor a satisfactory method to guide the assignment of weightings. Cole [15] states that the main concern is the absence of an agreed theoretical and non-subjective basis for deriving weighting factors. There is not enough consideration of a weighting system attached to the existing environmental building assessment methods. The overall performance score is obtained by a simple aggregation of all the points awarded for each criterion. All criteria are assumed to be of equal importance and there is no order of importance. This demands in-depth understanding of the environmental impact of building. The relative importance of performance criteria is an important part of the decision if the stated objectives are to be achieved, for example, the public sector's opinion will definitely differ from that of the private developer. Therefore, the weighting of the criteria should be derived on a project-by-project basis and reflect the objective of a development. The absence of any readily used methodological framework has hampered existing environmental assessment methods in achieving sustainability goals [16, 17].

MEDIAN ABSOLUTE DEVIATION METHOD

One solution how to obtain a weighting of criterions that is acceptable to as large subgroup of experts as it is possible is median absolute deviation method. It is obvious that arithmetical average is not suitable solution for such set of data. Arithmetical average should largely change an opinion of larger group of experts just because of different opinion of one expert. Expert preferences were expressed by 9 to 1 point scale as it is in the Table 1. We have chosen the median absolute deviation method because the method is able to cope with above defined problem. Result of such method is in the Table 2.

Table 1. Nine point preference scale.

Intensity of Importance	Descriptor Verbal Scale
9	Most significant
7	Significant
5	Less significant
3	Less insignificant
1	Insignificant
Intensity of 2, 4, 6, and 8 can be used to express intermediate values	

Table 2. Results of expert identification of significance in system BEAS

BEAS	A	A1	A1.1	A1.2	A1.3	A1.4	A1.5	A1.6	A1.7	A1.8	A1.9	A1.10
		0.90	0,1414	0,1596	0,0940	0,0486	0,0456	0,0610	0,0477	0,1485	0,1243	0,1293
		A2	A2.1	A2.2	A2.3	A2.4	A2.5	A2.6	A2.7			
		0.09	0,1688	0,1493	0,1407	0,0285	0,1752	0,1903	0,1472			
	B	B1	B1.1	B1.2	B1.3	B1.4	B1.5					
		0,58	0,1048	0,2303	0,2216	0,1697	0,2736					
		B2	B2.1	B2.2	B2.3							
		0,41	0,3471	0,4160	0,2369							
	C		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
			0,0899	0,1189	0,1149	0,1238	0,0889	0,1398	0,0869	0,081	0,0669	0,0889
	D	D1	D1.1	D1.2	D1.3	D1.4	D1.5					
		0,51	0,2779	0,2303	0,1957	0,1307	0,1654					
		D2	D2.1	D2.2	D2.3							
		0,22	0,5124	0,1956	0,292							
		D3	D3.1	D3.2								
		0,26	0,4359	0,5641								
	E		E1	E2	E3	E4						
			0,2642	0,1719	0,3849	0,1790						
	F		F1	F2	F3							
			0,3104	0,3448	0,3448							

FUZZY FCA

Formal Concept Analysis (FCA) is a very effective tool for extracting knowledge from object/attribute table. FCA was introduced by Ganter and Wille in 1980's (Ganter and Wille 1999) as an applied Lattice Theory. Bělohlávek (2010) [18] and his research group extended the theory by using an L-fuzzy logic that became in a very useful in working with tables of many-valued graded truth items. Main notion of FCA is a formal context that is an object/attribute table with boolean (true/false) items or fuzzy (1,…,0.5,…,0) items. Formal context is a tool for describing a real situation where any row belongs to some object (to some expert in our case) and any column belongs to some attribute (to some criterion in our case). In the table in classical case there at each expert/criterion place there will be a true/false (or yes/no) answer of a question if such expert prefer each criterion or not. Our table contains more complicated answers. Every expert preference is expressed by some value of the scale {9- most significant criterion, 7- significant criterion, 5-less significant, …}. This scale should be interpreted as a structure of truth values {1-truth (9 most significant criterion), 0.75-less truth (7 less significant), 0.5-maybe (5 significant), … }. By rewriting of our table we will obtain a so called fuzzy formal context such that any criterion/expert place express how such expert prefer each criterion. Due to have such preferences expressed more in details we have enlarged the structure of membership degrees to {1, 0.875, 0.75, 0.625, 0.5, 0.375, 0.25, 0.125, 0}.

Experts preferences as fuzzy sets of criterions

Theory of fuzzy sets was introduced in 1960's by Zadeh. Main idea of the theory is that any classical set should be interpreted by its characteristic function that to any element of the set the characteristic function returns 1 (or true/yes/...) and to any element that not belong to the set returns 0 (or false/no/...). An extension from classical to fuzzy sets is based in enlarging of the structure of truth (membership) degrees of the set from classical {1,0} (or {true,false}) to more informative discrete ordered set{1,...,0.5,...,0} or whole real number interval [0,1] or more complex lattice structure. In our situation every expert gives us a fuzzy set of criterions that membership degree of any criterion is a degree of its significance from a point of view of such expert. By summarizing of all the answers we obtain a table of criterions and experts with items from the above mentioned structure of membership degrees {1 (9-most significant), 0.75 (7-significant), 0.5 (5-less significant), …}. Now a problem is how to obtain a fuzzy set of criterions that will represent all preferences of all experts in common.

Using basic operations of Fuzzy FCA

Fuzzy FCA provide a so called Galois connection of mappings between ordered sets of all fuzzy sets of objects and attributes (criterions and experts) such that their connections provide closure operators on such ordered sets. All details are in (Bělohlávek, 2010). Another main and basic notion of FCA is called a fuzzy formal concept that is a pair of fuzzy sets of objects and attributes that are closed in such closure operators and they are connected by the Galois connection. Mapping of such Galois connections are defined by using basic logical connectives extended for case of fuzzy logic. We have used so called Lukasiewicz's implication li(x,y)=min{1,1-x+y}

and Lukasiewicz's strong conjunction lc(x,y)=max{0,x+y-1}, where x,y are any two truth values from the structure of membership degrees.
By computing of all such fuzzy concepts of our context table we have obtained 368 fuzzy concepts. It is pretty much but there is another solution how to choose the right concept. As it was said any fuzzy concept is a pair of fuzzy sets of criterions and experts in our case. It is possible to create an lc-product of fuzzy sets from any concept that is a new criterions experts table such that to any criterion/expert pair is assigned a truth value of Lukasiewicz's strong conjunction of truth values from such fuzzy sets of such expert and criterion. lk-product of any concept is a full subset of our table of preferences. If we turn the inclusion from table of preferences to lk-product of such concept by using a subsethood function well known in Fuzzy Set Theory, we will obtain a truth degree that represents how much does the concept covers our table of preferences. In tables 3 and 4 there are mentioned five concepts C1, …, C5 that cover the table of preferences with a highest truth degree. In the table 3 there are criteria part of concepts and in the table 4 there are expert part of concepts.

Table 3. Fuzzy concept with degrees

	C1	C2	C3	C4	C5
A – Site Selection and Project Planning	0,625	0,625	0,75	0,75	0,875
B – Building Construction	0,5	0,5	0,625	0,625	0,75
C – Indoor Environment	0,625	0,75	0,75	0,875	0,875
D – Energy Performance	0,75	0,875	0,875	1	1
E – Water Management	0,5	0,5	0,625	0,625	0,75
F – Waste Management	0,375	0,375	0,5	0,5	0,625

Table 4. Fuzzy concept that cover the preferences

	C1	C2	C3	C4	C5
E1	1	1	0,875	0,875	0,75
E2	1	1	1	1	0,875
E3	1	1	1	0,875	0,875
E4	1	0,875	0,875	0,75	0,75
E5	1	1	1	0,875	0,875
E6	1	1	0,875	0,875	0,75
E7	1	0,875	0,875	0,75	0,75
E8	0,875	0,875	0,75	0,75	0,625
E9	875	0,875	0,75	0,75	0,625
E10	1	0,875	0,875	0,75	0,75
E11	0,875	0,75	0,75	0,625	0,625

Meaning of concepts

Any fuzzy concept is a representation of knowledge divided into two parts. First criterion part represents expert preferences and in the second expert part, there we can see an answer of how much does each expert should agree with the criterion evaluation from the first part. Concretely in concept C1 we can see the criteria evaluation such that is completely acceptable by eight from eleven experts and more or less acceptable for three experts (truth degree 0.875 is more or less truth). After such analysis we can see that the concept C1 is a most representing concept from all 368 concepts. As a complete result we can take the following fuzzy criteria evaluation A-0.625, B-0.5, C-0.625, D-0.75, E-0.5, F-0.375. By the method we have extracted most common preferences of small groups of subcriterions A1 and A2, B1 and B2 and D1, D2 and D3. We have obtained the following results (Table 5):

Table 5. Subcriterions fuzzy evaluation

	A1	A2	B1	B2	D1	D2	D3
Most common preference degree	0,5	0,375	0,75	0,5	0,875	0,625	0,625

RESULTS

On the base of intensity expression of significance has been assigned the order of fields. The identification of significance of main assessment fields has been determined by experts. The final weights have been determined in two variant using MCA and FCA. Results of determination via MAD method are: A-21.35%, B-14.54%, C-22.52%, D-27.84%, E-7.8% and F-5.97%. Results of determination via FCA have been compared with MAD method. Percentage value has been computed for each criterion's truth degree. Sum of all truth degrees is 0.625+0.5+0.625+0.75+0.5+0.375=3.375. Percentage value of each criterion truth degree of the sum we can compute by 0.625/3.375=0.1852… that is 18.5% for criterion A and so on. Similarly we have obtained percentage distribution of criterions A-18.5%, B-14.8%, C-18.5%, D-22.22%, E-14.8% and F-11.11%. Determined weights of significance were analyzed and compared with weights of significance determined in various systems used worldwide. On the basis of comparative and consistent analysis of two variants (MCA, FCA), a variant determined by Median absolute deviation method is more suitable.

CONCLUSION

This paper introduced the system BEAS developed in Slovakia. The paper also presents a comprehensive method of identifying indicators for assessment in office buildings applying feasibility, completeness, effectiveness and multi-attribute decision making rules. The percentage weights of significance were determined for proposed sub-fields and relevant indicators. For the purpose of next system verification, a statistically significant set of buildings is required to be evaluated. The outcome from the system verification will be result in the modification of indicators weighting.

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REFERENCES

[1] Cole Rj. Building environmental assessment method: redefining intentions and roles. Building Research & Information 35(5), 2005, p. 455-467.

[2] Kibert CJ. Sustainable construction. Green building design and delivery. Hoboken, New Jersey: John Wiley & Sons, Inc; 2005.

[3] Malmqvist, T. et al. A Swedish environmental rating tool for buildings. Energy 36, 2011, p. 1893-1899.

[4] Dimitris, A., Giama, E. Papadopoulos, A. An assessment tool for the energy, economic an environmental evaluation of thermal solutions, Energy and Buildings 41, 2009, p. 1165-1117.

[5] Mwasha, A., Williams RG., Iwaro, J. Modeling the performance of residential buildings envelope: The role of sustainable energy performance indicators. Energy and Buildings 42, 2011, p. 2108-2117.

[6] Haapio, A., Viitaniemi, P. A critical review of building environmental assessment tool. In: Environmental Impact Assessment Review 28, 2008, p. 469-482.

[6] Hikmat HA, SABA FN. Developing a green building assessment tool for developing coutries – case of Jorda. In: Building and Environment 44, 2009, p. 1053-1064.

[7] Mateus, R., Braqanca, L. Sustainability assessment and rating of buildings:, In: Building and Environment 46, 2011, p. 1962-1971.

[8] Vilčeková, S., Krídlová Burdová, E. Building environmental assessment. Science monograph. p. 136, 2010 [In Slovak].

[9] Kapalo, P., Pauliková, A., Muntea, C., Domnita, F.: Legislative requirements for ventilation of buildings in Slovakia and Romania. In: Instalatii pentru inceputul mileniului trei, Vol. 2, Bucuresti, 2011, p. 300-309, ISBN 978-973-755-755-1

[10] Saaty, T. L.: Decision making with the analytic hierarchy process. In: International Journal of Services Sciences, Vol. 1. No. 1 (2008), pp. 83-98.

[11] Tahir, A. Ch.; Darton, R.C.: The Process Analysis Method of selecting indicators to quantify the sustain-ability performance of a business operation. Journal of Cleaner Production 18, 2010, pp. 1598-1607.

[12] Lee, W.L., Yik, F.W.H. A framework for formulating a performance-based incentive-rebate scale for the demand side energy management scheme for commercial buildings in Hong Kong. In: Applied Energy 73, p. 139–166, 2002.

[13] Lee, W.L., Yik, F.W.H., Burnett, J. Assessing energy performance in the latest versions of Hong Kong Building Environmental Assessment Method (HK-BEAM). Energy and Buildings 39, p. 343–354, 2007.

[14] Cole R. J. Emerging trends in building environmental assessment methods. In: Building Research & Information 26 (1), p. 3–16, 1998.

[15] Ding, D.K.C. Sustainable construction – The role of environmental assessment tools. In: Journal of Environmental Management, 86, p. 451-464, 2008.

[16] Korviny, P. Teoretické základy vícekriteriálního rozhodování. http://mca7.wz.cz/soubory/teorie_mca.pdf

[17] Říha, J. Multikriteriálni hodnocení. 25. 7. 2007, s. 67

http://www.brno.cz/download/europoint/analyza2007/analyza-prilohac1.pdf

[18] Bělohlávek, R., De Baets, B., Outrata, J., Vychodil, V. 2010. Computing the latice of all fixpoints of a fuzzy closure operator. IEEE Transactions On Fuzzy Systems 18 (3)

ACCUMULATION OF TUNGSTEN IN NATIVE PLANTS OF MINING AREAS RELATED WITH THEIR MOBILITY AND BIOAVAILABILITY IN SOILS AND TAILINGS (NORTHERN PORTUGAL)

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ABSTRACT

The mechanisms relating to the mobility and bioavailability of tungsten have been explored using chemical extraction techniques. The procedure adopted in this study allows the separation of the water-soluble fraction, so the extracted chemical elements must be considered highly bioavailable because they are easily mobilized. The elements extracted from the so-called exchangeable fractions, which in this study were leached through the use of NH4 OAc, are an important part of the potentially available elements and can be considered as an estimate of bioavailability. We compared five mining areas of Northern Portugal with distinctive paragenesis for bioavailable levels of tungsten in soils and the resulting bioaccumulate levels in six species of plants (*Erica arborea* L., *Halimium umbellatum* (L.) Spach, *Pinus pinaster* Aiton, *Pteridium aquilinum* (L.) Kuhn, *Pterospartum tridentatum* (L.) Willk. and *Quercus faginea* Lam.). Tungsten appears to be relatively immobile in most studied sites, but soils of Tarouca mine show significant increases in bioavailable fraction. The soils of the Tarouca mine area stand out by their higher content of W in the bioavailable fraction. Probably as a result of easier fragmentation and dissolution of scheelite, compared to wolframite. This is reflected in the bioaccumulated concentrations in the tissues of the studied species at this site. It's in the samples of Tarouca mine that occur higher bioaccumulated levels of W than all five mines. This exemplifies the importance of soil mineralogy, controlling the biogeochemical distribution of elements.

Keywords: abandoned mine, bioaccumulation, mobility, sequential chemical extraction

INTRODUCTION

Elements in soils may be present in several different physicochemical phases that act as reservoirs or sinks of trace elements in the environment. These phases include the following broad categories: water-soluble; exchangeable; specifically adsorbed; carbonate; secondary Fe and Mn oxides; organic matter; sulphides; and silicates. All of these phases may occur in a variety of structural forms [1, 2, 3, 4]. Understanding the mode of occurrence of elements in soils is essential for the environmental assessment of contamination.

An approach to the analytical determination of the distribution of elements among these physicochemical phases has been made using phase-selective chemical extractions involving multiple extracting reagents to extract metals associated with specific fractions of the soils [2, 4, 5, 6, 7] or mine wastes [8, 9].

The study areas were selected on the basis of mineralization and environmental factors, in order to provide an overview of the most representative types of tin and tungsten mine in Portugal (Fig.1): Ervedosa mine with cassiterite and diverse sulphides; Rio de Frades mine and Regoufe mine with wolframite, scheelite, cassiterite and sulphides; Adoria mine with volframite, cassiterite and sulphides; and Tarouca mine with scheelite, cassiterite and sulphides.

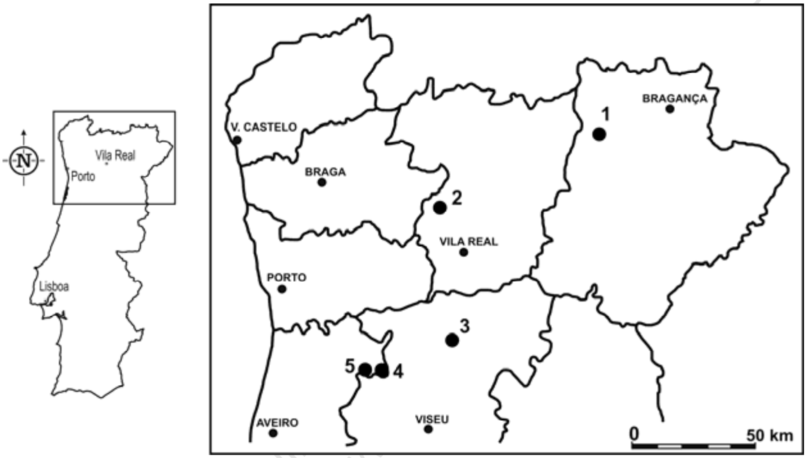

Figure 1 – Location of studied areas. 1- Ervedosa mine; 2- Adoria mine; 3- Tarouca mine; 4- Regoufe mine; 5- Rio de Frades mine.

METHODOLOGY

Field sampling and sample preparation

Samples of soils, mine tailings and plants were collected from line transects in the surrounding areas of the mines. Line transect 1 is located in an area outside the influence of mining although it intercepts mineralised veins. Line transect 2 includes mine tailings and soils. Line transects 3 are located downhill and affected by runoff from the mining area. Along these line transects, at intervals of 20 m, samples of soils, tailings and plant species present have been collected in a circle with a radius of about 2 m [10]. Each soil or tailings sample weighs about 5 kg and is a composite of 4–5 partial samples collected from 0 cm to 20 cm depth. The plant sample focused on the aerial parts, taking into consideration the same maturity of the plant and the proportionality of the different types of tissues, or the separation of different types of tissues (leaves and stems).

In laboratory, samples of soil and tailings were oven-dried at a constant temperature of 40 ºC, manually homogenized and quartered. Two equivalent fractions were obtained from each quartered sample. One fraction was used for the determination of physico-chemical properties, and the other fraction was used for chemical analysis. The samples for chemical analysis were sieved first using a 2 mm mesh sieve, to remove plant matter, and subsequently screened to pass 250 µm [10]. Plant samples was washed thoroughly, first in running water and then in distilled water, and then dried in a glasshouse at a temperature of 50 ºC. When dry, the material was milled into a homogenous powder.

Analytical methods

The main physico-chemical properties of the samples (<2 mm fraction) were characterized using the following methods: pH was determined in water extracts (1:2.5 v/v); organic carbon was determined with the elemental analyser (Primacs SCN Analyser, Skalar); exchangeable acidity ($H^+ + Al^{3+}$) was extracted with 1M KCl; and exchangeable bases were extracted with 1M NH_4OAc at a pH of 7.0. The cations were measured using atomic absorption spectrophotometry. Particle size analysis was determined using the pipette method. Available P and K contents were determined using the Egner-Riechm method.

The determination of total element contents was performed using tri-acid digestion (HF-HNO_3-$HClO_4$ concentrations) [11, 12, 13] followed by ICP-MS (inductively coupled plasma-mass spectrometry) analysis using an Elan 6000 Perkin-Elmer spectrometer. The analytical method for total metal concentrations was assessed using the 2711 SRM reference material (Montana Soil, from LGC Promochem, Barcelona, Spain), which was included in the triplicate analyses. The agreements between the certified reference values and those determined by the analytical method were in the range 82.7% to 110.5%.

The selective chemical extraction sequence followed in this study was adopted from Dold and Fontboté [13]. Fraction 1 (FI) consisted of water-soluble metals. Fraction 2 (FII) consisted of exchangeable metals and/or those soluble in slightly acidic conditions. Fraction 3 (FIII) (easily reducible fraction) represents metals bound to short range-order Fe, Al and Mn (oxy)hydroxides and poorly-crystallized ferric hydroxysulfates. Fraction 4 (FIV) (moderately reducible fraction) represents metals bound to long-range-order Fe, Al and Mn (oxy) hydroxides and well-crystallized ferric hydroxysulfates. Fraction 5 (FV) represents metals associated with organic matter and secondary sulphides. Fraction 6 (FVI) consists of metals bound to primary sulphides. Fraction 7 (FVII) represents metals strongly associated with crystalline structures of minerals and remaining resistant fractions that are unlikely to be released under the normally encountered conditions.

The concentrations of elements in all the extracts from the sequential extraction were also determined by ICP-MS. Blanks of the different extractants were analyzed in triplicate. Calibration solutions were made with the appropriate extraction solutions. The accuracy values ranged between 70% and 110%, which are of the same order as those obtained by other researchers [2, 14, 15].

RESULTS AND DISCUSSION

The sequential chemical extraction results show that: in Ervedosa mine W is allocated by the various reagents in the sequence, but has the most significant increases in residual fraction (13.25 to 75.30%) and moderate reducible fraction (11.92 to 59.68 %), but also the organic fraction (2.45 to 45.40%), easily reducible fraction (1.35 to 16.10%) and the primary sulphides fraction (0.76 to 11.93%); In Adoria mine W arises primarily associated with the residual fraction (19.65 to 59.75%) and moderate reducible fraction (13.81 to 45.16%), but also in the primary sulphides fraction (7.02 to 27.54%), organic matter fraction (2.01 to 30.35%) and easily reducible fraction (0.04 to 5.96%); In Regoufe mine the highest concentrations of W are associated with the residual fraction (19.78 to 77.49%), moderately reducible fraction (6.73 to 50.57%) and organic matter fraction (8.12 to 51.59%), there was also moderate content in the primary sulfides fraction (4.50 to 15.22%); In Rio de Frades mine W appears essentially in the residual fraction (46.46 to 65.97%), while the remaining contents are divided by other fractions as follows: moderately reducible (11.89 to 27.19%), organic matter (5.67 to 16.12%), primary sulphides (3.91 to 16.13%) and easily reducible (2.04 to 2.67%); In Tarouca mine W presents the most significant increases in the moderately reducible fraction (37.50 to 54.76%) and easily reducible fraction (8.00 to 31.31%) and were still moderate content in primary sulphides fraction (9.49 to 17.95%), residual fraction (3.01 to 19.15%) and organic matter fraction (1.81 to 25.65%).

There is a significant difference in the W fractionation of Tarouca mine samples in comparison with other mines samples. In the samples of Tarouca the moderately reducible fraction is dominant, whereas in the other mines samples the residual fraction is the most significant. The difference should be related to the tungsten mineralogy typical of their paragenesis. The wolframite is more resistant to physical and chemical weathering, while scheelite is characterized by an easier fragmentation and dissolution, especially in acidic medium.

The absorption of chemical elements by plants depends on their bioavailability in the soil (bioavailable fraction) and on their replacement by less bioavailable fractions [16]. The dynamic equilibrium established between the different fractions of soil determines the mobility and bioavailability of elements. The pH, Eh and amount and type of soil colloids (organic matter, clays and oxides) are the most important edaphic factors that control concentrations.

For the purpose of the current work, the “mobilisable and bioavailable fraction” is defined as that portion of the total solid-phase metal concentration that is extracted by water plus the exchangeable fractions recovered in the first two steps of the sequential extraction scheme(i.e., FI and FII). According to the several studies that showed good correlations between FI+FII fractions and the simple extraction using EDTA/acetic acid (i.e., usual procedure employed to characterize the bioavailable fractions of metals) as well as the contents accumulated in various plant species [17, 18, 19, 20], the FI+FII fractions can be used as good estimates of bioavailability.

In the set of all samples, the Ervedosa mine is characterized by higher content of Mn, Cu, Cr, Co and Ni in the bioavailable fraction. The Adoria mine stands out for higher contents of Pb, Bi, Ag and U. The Regoufe mine presents the most significant levels of Zn, Cd and As. While Rio de Frades mine manifests the highest content of Fe and As in the bioavailable fraction. The Tarouca mine stands out only by the highest content of W in bioavailable fraction (Table 1).

Table 1 – Bioavailable fractions of W in soil samples of the studied mines (values in mg/kg).

	Mining areas				
	Ervedosa	Adoria	Regoufe	Rio de Frades	Tarouca
Minimum	0.004	0.010	0.010	0.030	0.070
Maximum	0.261	0.180	0.130	0.770	1.490
Mean	0.067	0.082	0.041	0.182	0.832
S.D.	0.102	0.055	0.041	0.329	0.648

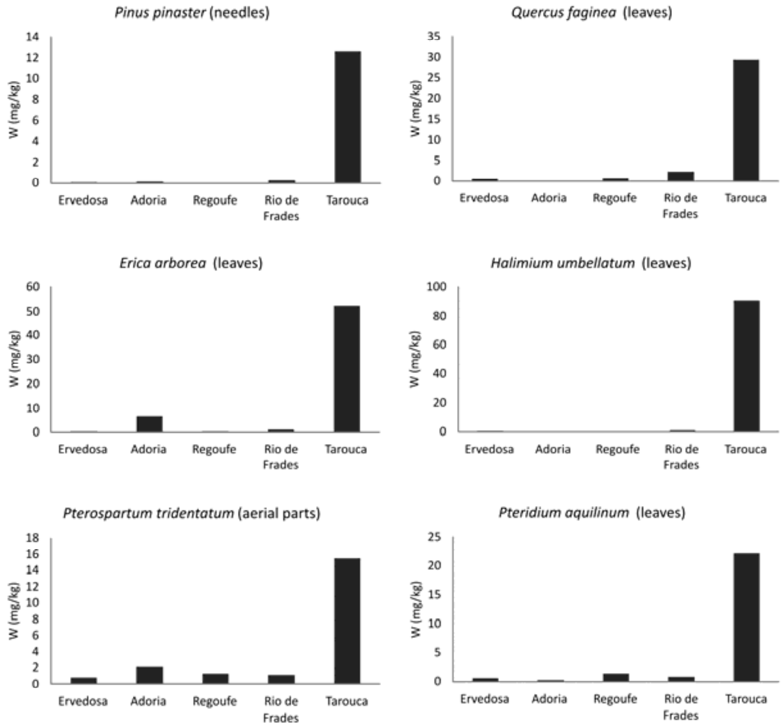

Figure 2 – Tungsten concentrations in plant species from the five studied mines.

Although the contents of W in the bioavailable fraction of the soils are low, in general, there are bioaccumulated levels that exceed the normal levels in plants, in many samples of the studied mining areas. It is in samples of Tarouca mine that occur the higher bioaccumulated concentrations of W than the set of five mines (Fig. 2). It also appears that all plant species (and organs) sampled in Tarouca have W concentrations that exceed normal levels in plants. This exemplifies the significance of the mineralogy of the soil to control the distribution of biogeochemical elements.

We also determined extraction rates (kg/ha), given the concentrations of metals in the plant tissues (mg/kg) in combination with their biomass production rate (tons/ha). The greatest W accumulation in plants of Tarouca mine becomes evident with higher values of extraction in the same species as compared to other mines. So that, beyond the accumulator capacity of each plant species are also determining the soil conditions, particularly those which determine the bioavailability of the elements.

CONCLUSIONS

The soil of the Tarouca mine area distinguished by higher content of W in bioavailable fraction as a result of easier fragmentation and dissolution of scheelite, compared to wolframite. This is reflected in the bioaccumulated concentrations in the tissues of the species at this site.

Plant samples of Tarouca mine show the highest accumulated concentrations of W of all five studied mines. All sampled species (or organs) in this mine have levels that exceed normal levels in plants. This exemplifies the significance of the soil mineralogy to control the biogeochemical distribution of elements.

REFERENCES

[1] Förstner U. Inorganic Sediment Chemistry and Elemental Speciation, in Baudo R., Giesy J. & Muntau H. (eds), Sediments: chemistry and toxicity of in-place pollutants, Lewis Publishers, Inc., USA, 1990, pp 61-97.

[2] Li X. & Thornton I. Chemical partitioning of trace and major elements in soils contaminated by mining and smelting activities, Applied Geochemistry, vol. 16, pp 1693-1706, 2001.

[3] Beltrán R., Rosa J.D., Santos J.C., Beltrán M. & Gómez-Arisa J.L. Heavy metal mobility assessment in sediments from the Odiel River (Iberian Pyritic Belt) using sequential extraction, Environmental Earth Science, vol. 61, pp 1493-1503, 2010.

[4] Favas P.J.C., Pratas J., Gomes M.E.P. & Cala V. Selective chemical extraction of heavy metals in tailings and soils contaminated by mining activity: Environmental implications, Journal of Geochemical Exploration, vol. 111, pp 160-171, 2011.

[5] Hirner A. Trace element speciation in soils and sediments using sequential chemical extraction methods, *International Journal of Environmental Analytical Chemistry*, vol. 46, pp 77-85, 1992.

[6] Cohen D., Shen X., Dunlop A. & Rutherford N. A comparison of selective extraction soil geochemistry and biogeochemistry in the Cobar area, New South Wales. Journal of Geochemical Exploration, vol. 61, pp 173-189, 1998.

[7] Pueyo M., Mateu J., Rigol A., Vidal M., López-Sánchez J.F. & Rauret G. Use of the modified BCR three-step sequential extraction procedure for the study of trace element dynamics in contaminated soils, Environmental Pollution, vol. 152, pp 330-341, 2008.

[8] Fanfani L., Zuddas P. & Chessa A. Heavy metals speciation analysis as a tool for studying mine tailings weathering, Journal of Geochemical Exploration, vol. 58, pp 241-248, 1997.

[9] Dold B. Speciation of the most soluble phases in a sequential extraction procedure adapted for geochemical studies of copper sulfide mine waste, Journal of Geochemical Exploration, vol. 80, pp 55-68, 2003.

[10] Brooks R. Biological Methods of Prospecting for Minerals, John Wiley & Sons, USA, 1983.

[11] Lucas M. & Sequeira E. Determinações de alumínio, cálcio, cobalto, cobre, ferro, magnésio, potássio, sódio, titânio e zinco totais nos solos por ataque nítrico-perclórico-fluorídrico e por absorção atómica e emissão de chama, Pedologia, vol. 6, pp 55-66, 1971.

[12] Walsh J.N., Gill R. & Thirlwall M.F. Dissolution procedures for geological and environmental samples, in: Gill R. (ed.), Modern Analytical Geochemistry. An Introduction to Quantitative Chemical Analysis Techniques for Earth, Environmental and Materials Scientists, Longman, England, pp. 29-40, 1997.

[13] Dold B. & Fontboté L. Element cycling and secondary mineralogy in porphyry copper tailings as a function of climate, primary mineralogy, and mineral processing, Journal of Geochemical Exploration, vol. 74, pp 3-55, 2001.

[14] Cuong D.T. & Obbard J.P. Metal speciation in coastal marine sediments from Singapore using a modified BCR-sequential extraction procedure, Applied Geochemistry, vol. 21, pp 1335-1346, 2006.

[15] Umoren I.U., Udoh A.P. & Udousoro I.I. Concentration and chemical speciation for the determination of Cu, Zn, Ni, Pb and Cd from refuse dump soils using the optimized BCR sequential extraction procedure, Environmentalist, vol. 27, pp 241-252, 2007.

[16] McGrath S.P., Shen Z.G. & Zhao F.J. Heavy metal uptake and chemical changes in the rhizosphere of *Thlaspi caerulescens* and *Thlaspi ochroleucum* grown in contaminated soils, Plant Soil, vol. 188, pp 153-159, 1997.

[17] Abollino O., Giacomino A., Malandrino M., Mentasti E., Aceto M. & Barberis R. Assessment of metal availability in a contaminated soil by sequential extraction, Water, Air, and Soil Pollution, vol. 137, pp 315-338, 2006.

[18] Ernst W. Bioavailability of heavy metals and decontamination of soils by plants, Applied Geochemistry, vol. 11, pp 163-167, 1996.

[19] Lin C.C., Lai H.Y. & Chen Z.S. Bioavailability assessment and accumulation by five garden flower species grown in artificially cadmium-contaminated soils, International Journal of Phytoremediation, vol. 12, pp 454-467, 2010.

[20] Meers E., Samson R., Tack F.M.G., Ruttens A., Vandegehuchte M., Vangronsveld J. & Verloo M.G. Phytoavailability assessment of heavy metals in soils by single

extractions and accumulation by Phaseolus vulgaris, Environmental and Experimental Botany, vol. 60, pp 385-396, 2007.

ADAPTIVE MANAGEMENT STUDY OF MOUNTAIN LANDSCAPE FROM THE PERSPECTIVE OF SUSTAINABLE DEVELOPMENT OF TOURISM IN THE APUSENI MOUNTAINS, ROMANIA

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ABSTRACT

In the contemporary period the impact of human activities on natural ecosystems in the mountain area is felt more strongly. As a result of irrational exploitation made over time on natural resources either as mineral deposits, in particular, but also as various forest species or as groundwater and surface hydrographic network, mountain landscape presents more profound changes and with long-term environmental effects. In large part, these situations are found in the Apuseni Mountains too, from the Romanian Western Carpathians. In this context it should be mentioned improper exploitation of the rich cultural heritage of these mountains until now. The fact that these mountains ecosystem quality, already affected heavily, is currently threatned by a project of mining exploitation of gold-silver resources at Rosia Montana based on the use of cyanide in mineral processing which is proposed by a Canadian-Romanian company it makes necessary to implement alternative development for the mountain area whose economic potential is insufficiently exploited. This study aims to develop programs to monitor interactions between human environment and the natural ecosystems, to identify strategies for mountain areas development, an adaptive management methodology tools in developing sustainable tourism and to contribute to a sustainable exploitation of economic, social, cultural and natural environment of the Apuseni Mountains.

Keywords: landscape, adaptive management, sustainable development

INTRODUCTION

Adaptive management is a planned and systematic process for continuously improving environmental management practices by learning about their outcomes. It provides flexibility to identify and implement new mitigation measures or to modify existing ones during the life of a project. Decisions to adopt specific adaptive management measures can be identified later during the project life-cycle as a result of the analysis of data generated by a rigorously implemented follow-up or monitoring program [1]. Adaptive management is a tool which should be used not only to change a system, but also to learn about the system [2]. Because adaptive management is based on a learning process, it improves long - run management outcomes. The challenge in using adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future and achieving the best short - term outcome based on current knowledge [3]. This type of management involved constant, systematic monitoring against agreed indicators, of a range of social and environmental impacts, to check that agreed optimal conditions were being met [4]. A good adaptive management in landscape conservation must have in view 5 main steps of this project cycle (Fig. 1) [5].

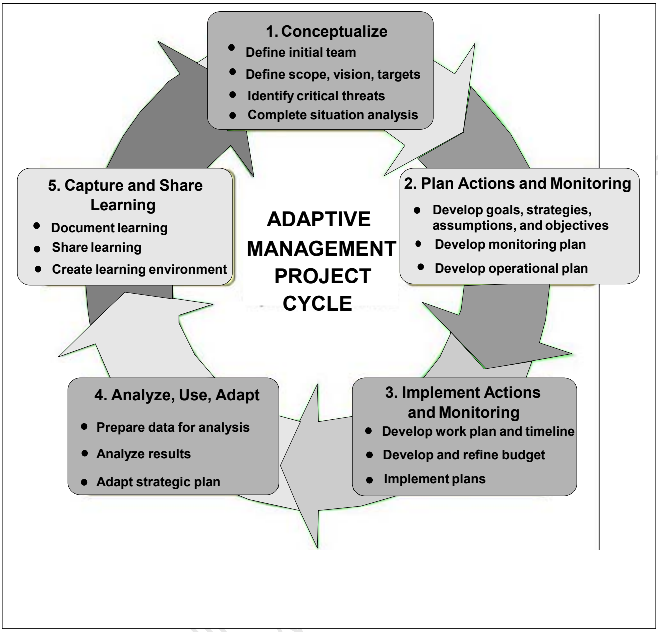

Figure 1. Adaptive Management Cycle of Conservation Measures Partnership's (Source: http://www.conservationmeasures.org/)

We believe that the mountain landscape management is a set of policies and tools to detemine the optimum exploitation of tourism resources. That both in terms of local community interests and the satisfaction level of tourists waiting through strategic planning activities and implementing the concept of quality and performance services in mountain area. The goal is to increase the tourist attractiveness and the competitiveness, stimulating the realization of investments that takes into account sustainable development, identifying opportunities to preserve environmental quality and thus improve the quality of life. In the mountain landscape management skills, they return the administrative territorial authorities at national level (Government, National Tourism Authority), regional (development agencies), local (municipalities), and various organizations working in especially in the private sector (NGOs, associations, foundations, etc..). Mountain landscape management policy in general and in the resort area Apuseni particularly aimed sustainable use of tourism resources and infrastructure, when there is a well developed tourism markets competitive, both domestically and internationally. It is extremely important to understand the importance of tourism to the local community, on the one hand, and on the other hand is necessary to evaluate its impact on the landscape, but also the area economy, social environment and cultural [6].

1. APUSENI MOUNTAINS LANDSCAPE FEATURES AND ITS ANTHROPOGENIC USE

Apuseni Mountains are the smallest in size of all units Romanian Carpathians and the shorter (maximum altitude 1848 m), but of great geological complexity, making them an extraordinary variety of landscapes, with special hydrological network, and various soil great wealth flora and fauna. Varied landscape of the Apuseni Mountains ecosystem contains a significant amount in terms of biodiversity conservation. Apuseni Mountains, is distinguished by a remarkable karst landscape both in scope and breadth and variety of landforms. Hydrology and karst areas have a distinct morphology resulting rock solubility and well-developed secondary porosity. It follows a variety of microforms huge and amazing relief both land and underground landforms.

Architectural ornaments of the Apuseni monuments constitute the so-called "civilization of wood" natural monuments along with the organic part of the unique landscape of the Apuseni Mountains, a landscape both natural and humanized by spiritualization or the seal of creative vocations. Residents of the Apuseni Mountains in the past dealt with collecting gold, both alluvial and basement, and livestock. Mineral resources were channeled since 2000 years ago the development of this area on metal mining. Especially the southern part of the Apuseni Mountains, the geological constitution because of volcanic rocks has major deposits of gold ore, silver, copper and other metals was populated during the Roman occupation of Dacia by colonists, who founded cities, to develop mines Gold. Most developed urban center was at Ampelum (Zlatna today), and most important mining of precious metals was the Alburnus Maior (Rosia Montana today). In the last months of the Second World War, was discovered near Baita a uranium nucleus by the retreating German troops. This deposit was found to be the largest uranium deposit on the surface world. During mining in the Apuseni Mountains were drilled over 400 km of galleries located horizontally, from 50 to 50 meters, 700 meters from the quota share up to 1100 m. After extraction of uranium, one of the galleries abandoned between 1980 and 1985 to set up a radioactive waste repository for low and medium activity, only in the country, located near the quarry at Baita-Plai uranium, 4 km from the hearth Baita village.

Another important resource is the forests of these mountains. This important resource has generated another important area of human activity: wood processing. An important activity was the cattle in forest-pastoral system and practicing a less productive agriculture to ensure a minimum of food locals. The existence of extensive grazing on the high peaks allowed sheep and cattle, and cultivated land were used for hay. Agriculture is practiced in a primitive to an altitude of 1,200 m. Due to cold climate and varieties cultivated potatoes “motesti” wheat, flax, rye, hemp and barely. All these activities, however, before the twentieth century, is practiced mainly in the Apuseni Mountains inhabited namely marginal and low branches that altitude, offering greater accessibility and allow the development of human settlements. Thus, the central area of the Apuseni Mountains, namely the Bihor Mountains was high in terms of the landscape a very well preserved, as there were in the late nineteenth and early twentieth century, virgin forests and untapped land in forest-pastoral system. Economic profile of human settlements in the Apuseni Mountains is primarily agricultural: crops and livestock in the West, livestock and crops in the valleys of the Aries, Cobleş, Garda, Albac, and animal husbandry in mountainous areas. In karst regions, sometimes, lack of arable land and causes people to use other forms the bottom of sinkholes and depressions (Uvala), whose soil can be used for the cultivation of agricultural plants, especially vegetables (eg plateau Districts, Scărişoara, Munună, Sohodol etc.). Relatively small share of arable land is offset by the area under pastures and meadows which nurture a critical mass of livestock (mainly cattle and sheep). Industrial activities in the past mainly consist of mining and had a high share in the active population involvement decreased over time, becoming much smaller scale and are located at several points of interest. Thus, the most important mining area in the '50s, the Baita-Plai, National Uranium Branch Bihar currently has 180 employees, in carrying out uranium ore extraction, ore deposit being evaluated are close to depletion and conservation objectives for the closure and cleanup activity stopped, which will happen by 2010. On the other hand, SC Baita SA exploit copper ore, lead, zinc and molybdenum, with 500 employees. Impact of industrial activities on land and mining are due to excavation activities, ore processing and treatment when significant amounts of sterile products with increased content of heavy metals, waste water containing toxic mineral substances (cyanides, acids, heavy metals, etc..) and emissions of toxic gases into the atmosphere. The main negative effects of mining activities on the environment are: loss of forest and agricultural areas and destruction of important flora and fauna of that area, generating erosion and landslides fluid, changing and altering the natural landscape by excavation and tailings deposits, damage soil quality, groundwater in the area and surface water quality through training of toxic products, affecting air quality through emissions of toxic gases (sulfur oxides and dust containing heavy metals, etc. increased.). By disposing of mining waste, the infiltration of sewage and toxic waste involved on the ground or in air and precipitation, soil polluting ascertaining the emergence of ecological imbalances, sometimes difficult to repair. Soil contaminated with heavy metals due to mining activities is one of the main sources of pollution and vegetation implicitly human consumption, so that imposed the elaboration of rules covering the maximum limits for various pollutants (metals, inorganic substances, etc..) whose excess leads to changes in ecosystem stranded, sometimes with serious consequences for the health of the population.

3. ROSIA MONTANA MINING PROJECT - POTENTIAL RISK FACTOR FOR LANDSCAPE APUSENI MOUNTAINS

According to academician Ionel Haiduc, President of the Romanian Academy of Sciences, the project initiated by the company Rosia Montana Gold Corporation (RMGC), the exploitation of gold and silver reserves in the Apuseni Mountains for 17 years, will lead to some negative effects on the natural environment, socio-economic and cultural area. RMGC is formed by association Minivest SA Deva (19.3% stake, Gabriel Resourses Ltd, Canada (80.0% share) and minority shareholders (0.7% share). Company obtained a concession for an area of 4282 ha, in Rosia Montana, located 80 km from Alba Iulia and 85 km from Deva. Project provides current closure of the mining company Minivest (with 775 jobs) and the organization's largest gold mine in Europe, to extract an amount of about 300 tons of gold and 1600 tons of silver surface excavation method in four open pits, estimated at 100 acres each, by stripping), which

means extracting a quantity of more than 220 million tons of ore. Waste rock dumps will be stored in two (Citadel, and Carnic 66 hectares, 70 hectares). Sludge exhausted, resulting in the production process after extraction of gold and silver, will be accumulated in a sump (open lake) with a capacity of 250 million tons and an area estimated at ca. 100 hectares (600 hectares by other sources), behind a dam 180 meters high, built of rock. Currently the project affects 38% of the Rosia Montana and about 1,800 people, which must be displaced, and demolition of 740 houses and several churches and cemeteries. At the end of exploitation of the deposit, the area will remain without jobs again, with a large number of unemployed (and a severely affected environment), social problem solving not having a sustainable long term [7]. Seriousness of unemployment will be amplified in the presence of a population coming and established here in the meantime. The technology is based on extracting gold by treating the ground ore with sodium cyanide solution. It should be added that cyanide is not the only danger, mud and water resulting from the process at high risk of serious pollution and the toxic heavy metal content of ore extracted, even more persistent than cyanide and can not be neutralized. Exploitation of the surface (in open pit) produces a significant degradation of the natural environment, in fact a real disfigurement of the landscape, leaving behind huge craters and massive deposits of sterile material, as seen in open pit immediately adjacent to Rosia glades). Air pollution, water and soil in the area, caused by technical means operating on the surface (by stripping) and massive transport, heavy machinery (trucks of 150 tons), the huge amounts of ore and tailings material can not be ignored. Destruction characteristic landscape of the Apuseni Mountains cancels the tourism potential and eliminate the prospect of sustainable recovery area designed on this basis, a large area, not only in Rosia Montana. A polluted area will not attract investment or otherwise. Targeted in the project area contains archaeological remains of great scientific interest, of inestimable value, are unique in Europe and perhaps in the world, and gold deposit operation would lead to irreversible destruction of archaeological site.
In 2007, the Center for Cultural Tourism CULTOURS proposed an alternative strategy for sustainable development in Rosia Montana area, who mentioned the following objectives: ecological reconstruction of areas affected by mining, the rehabilitation of infrastructure and public services, rehabilitation and preservation of cultural heritage industrial, mining, historical and archaeological, architectural, intangible heritage of Rosia Montana and integration in international networks, developing a diversified business environment, sustainable and competitive through the development of rural and cultural tourism, supporting the development of agriculture and forestry, small industry development and support the traditional crafts [8].

4. POSSIBLE USE OF THE APUSENI MOUNTAINS LANDSCAPE THROUGH TOURISM ACTIVITIES

Apuseni Mountains comprise the largest area of karst terrain in Romania of European importance, with many caves, some with great landscape value, science and tourism. Landscape in the Apuseni Mountains is a very important part of our country's capital, is completed by numerous cultural attractions and wooden churches, fortified churches, hamlets with traditional houses, etc.. In Table 1 are the factors in favor of tourism development in the Romanian mountain area and types of tourism that can be applied, actions that give priority to sustainable tourism development and human factors that may be involved in this highly complex process.

Table 1

Factors favoring the development of tourism in the Apuseni Mountains	**Types of tourism in Apuseni Mountains**	**Priority actions for sustainable tourism development**	**Factors potentially involved in sustainable tourism development in the Apuseni Mountains**
❖ Landscape values and special ecosystem, but also a high human intervention from other Carpathian mountain, with a rich cultural heritage, with events etnofloclorice ❖ Expansion area (the largest in Romania), complexity and diversity of karst terrain: rocky cliffs, deep valleys and gorges, ridges or "Custura" clints, which add a large number of caves, potholes, sinkholes, sinkholes, karst depressions, underground water courses (Ponor Fortresses, Fortress Laughter, Glacier Living Fire, Galbena Valley, Lost World Karst Plateau, Glacier Scarisoara) ❖ Vegetal cover is quite mosaic, consisting mostly of beech and spruce, interposed tracts of grassland and pastures ❖ Existence in a protected natural area of 150 units of accommodation Western and over 600 in its vicinity ❖ Existence in the four centers of visits (Sudrigiu, Doda Pili, Padis Garda de Sus) and 9 tourist information points (Canton Scarita Belis, glacier retreat Bihor Mountain Rescue, Garda de Sus, Răchiţele, Stei,	❖ Rural tourism and agrotourism ❖ Ecotourism, cycling, equestrian tourism, etc.. ❖ Mountain tourism - hiking, mountain climbing, winter sports ❖ Adventure tourism - canyoning, rafting, kayaking, etc.. ❖ Turismul speologic – arealele Padiş - Cetăţile Ponorului şi Meziadului ❖ Speleological tourism - areas Padis- Ponor Fortress, Meziad etc.. ❖ Recreation and tourism weekend for urban centers such as Cluj, Oradea, Turda, Alba Iulia ❖ Tourism - Spas Geoagiu and Stana de Vale ❖ Hunting and fishing tourism ❖ Scientific tourism - nature observation ❖ Cultural tourism - things of great interest in rural Campeni	❖ Enterprise infrastructure and information ❖ Revival of crafts / traditional crafts ❖ Creation and use of tourist points of interest (tourism planning of caves) ❖ Promoting the exploitation of natural products as single branding ❖ Tracking the ratio of weekend visitors who come to picnic and ecotourism to reverse strongly in favor of the latter ❖ Development of specific facilities (restoration old tourist routes and making new trails, campsites, planning sightseeing points, stops, observing the animals, setting up grills fireplaces and chimney smoke, etc. easily accessible areas ❖ Improvement of catering, promoting traditional products	❖ Government institutions: Ministry of Environment, Ministry of Regional Development and Tourism, Ministry of Culture, Ministry of Agriculture and Rural Development, Ministry of Education, Research and Innovation. ❖ Academics and university Romanian Academy, state universities and private scientific research institutes ❖ Local government: County Councils and Local Councils ❖ Administrations of protected areas - National Forest ❖ Private sector representatives: National Association of Travel Agencies in Romania (ANAT), Association of Rural, Ecological and Cultural (ANTREC) and Association of Ecotourism in Romania (AER), the National Association of Mountain Guides, Romanian Association for Accommodation and Tourism Ecological - \ "BED & BREAKFAST \" (Arctic B & B) Rangers Association of Romania (ARR) finatatoare various institutions (eg World

Oradea, Cluj-Napoca)	Arieseni, Abrud Albac etc.		Bank, etc..) ❖ NGOs and local associations ❖ The local community ❖ Tourists - the motivations offered in tourism entrepreneurs

In terms of tourism potential in the Apuseni Mountains distinguish several areas of tourist interest: tourism karst area Padis - Ponor cities, tourist area Boga - Aleu and Pietroasa - Chiscau; Sighistelului Valley tourist area, tourist area Vartop - Arieseni; area Garda tourism - Scarisoara - Keys Ordancusii - Mrs P Calineasa, Belis tourist area - Lake Fantanele, Vladeasa tourist area - Valley Stanciului - White Rocks, Albac tourist area - Poiana Horea etc.

5. APUSENI NATURAL PARK - AS ADAPTIVE MANAGEMENT MODEL

Although the first proposal of establishing a national park or natural in the Apuseni Mountains has been made since 1928 by the Romanian scientist Emil Racovita establishment has been possible only since 2000. In 2003, in the Management Plan are defined seven categories of management areas, including the first 3 will apply stricter rules.

The main topics to be addressed in order to ensure adaptive management Apuseni Nature Park was established by its Management Plan and are these [9]:

a) Conservation of biodiversity of karst topography and landscape
b) Management of tourism and recreation
c) Supporting and promoting local traditional culture
d) Coordination of management with spatial planning
e) Support local community cooperation
f) Promote environmental education, training and awareness
g) Park management
h) Monitoring.

These actions must be performed in order to achieve sustainable local systems, the economic efficiency, social equity, ecological integrity and adaptability to current and future living conditions by creating and sustaining a cultural and environmental identity of belonging to the Apuseni mountain, through a rational and competent management, based on professionalism and a continuous monitoring modalities of implementing the Management Plan.

REFERENCES

[1] * * * Operational Policy Statement. Adaptive Management Measures under the Canadian Environmental Assessment Act, http://www.ceaa.gc.ca/.
[2] Holling C.S. (ed.). Adaptive Environmental Assessment and Management, Chichester: Wiley, 1978.[3] Alana L.M. & Michael A. On Valuing Information in Adaptive-Management. Models, Conservation Biology 24 (4), pp 984-993, 2009.
[4] * * *. Making Tourism More Sustainable. A Guide for Policy Makers. United Nations Environment Programme and World Tourism Organization, 2005 (http://www.unep.fr/shared/publications).
[5]http://www.conservationmeasures.org/.
[6] Gherasim V. Determinante ale peisajului montan din arealul statiunii turistice Voineasa, Proceeding The Role of Tourism in Territorial Development, Presa Universitara Clujeana, Cluj-Napoca, pp 334 – 345, 2011.
[6] Haiduc I. Proiectul Rosia Montana intre riscuri si beneficii, http://www.istoria-romanilor.com/proiectul-rosia-montana-intre-riscuri-si-beneficii/2012/02/03.
[7]http://www.cultours.ro/library/proiecte/Strategie_alternativa_pentru_o_dezvoltare_durabila_in_Rosia_Montana/.
[8]http://www.ngo.ro/parc_apuseni/Plan_de_Management_PNAp_draft_final_exemplar_romana_13.06.pdf.

ADVANCED METHODS FOR IMPROVING THE ACOUSTIC QUALITY OF THE PRODUCTS

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ABSTRACT

Over the past several decades, the noise turned out to be an important issue in modern society. The ability to find the sound source and determine its contribution to the overall distribution of sound is the first step to address the noise problem. This paper deals about methods for identifying sources of noise in a nearby field. This paper describes the application of acoustic sensors to identify Microflown a more detailed identification of audio products.

Keywords: microflown, particle velocity, sound intensity, 3D PU probe

INTRODUCTION

Sound can be defined as the auditory sensation produced by transient or oscillatory pressures acting on the ear, or by mechanical vibration of the cranial bones at audio frequencies. More generally, sound can refer to any type of mechanical wave motion that propagates through the action of elastic stresses and that involves local compression and expansion of the medium. Often, sound is mainly described by the pressure fluctuations, relative to atmospheric pressure, the sound pressure, but in this paper, the particle velocity is treated as having the same, or more importance as the sound pressure. An essential element was the extension of the method to the use of particle velocities. Microflown is a new type of sensor, in which particle velocities are measured instead of pressures.

PRIMARY TECHNIQUES FOR MEASUREMENT OF PARTICLE VELOCITY

In acoustics, there has been a lack of a reliable sensor that accurately measures the true acoustic particle velocity.

In the meantime, sound was often described mainly in terms of sound pressure. The condenser microphone is today the accepted standard acoustic transducer for all sound and noise measurements. Even sound intensity measurements, where sound intensity is by definition the time integral of the product between pressure and particle velocity, is standardized using two spatially separated pressure microphones.[1]

The transducer is a micromachined hot wire anemometer, but based on two heated extremely thin wires and not one as in the classical anemometer. A particle velocity signal in a direction perpendicular to the wires and in the plane of the wires changes the temperature distribution instantaneously, because the upstream wire is cooled more than the downstream wire by the acoustic airflow. The resulting resistance difference provides a broad band (0 Hz up to at least 20 kHz) linear signal with a figure of eight directivity that is proportional to the particle velocity up to sound levels of 135 dB. Between 100 Hz and 10 kHz the lower (noise) level is in the order of -10 dB in 1 Hz bandwidth which is comparable to the performance of high quality pressure microphones (see Figure 1). [1]

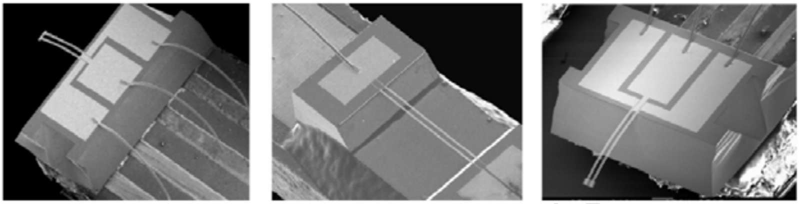

Figure 1 SEM photo's of various types of Microflowns that are realized over the last decade. [2]

SOUND INTENSITY MEASUREMENTS

Sound intensity is the average rate at which sound energy is transmitted through a unit area perpendicular to the specified direction at the point considered.

In other acoustic environments also situations exist where the energy, pressure and velocity are not zero but the intensity is. In a standing wave tube the amount of intensity that is put in the tube is reflected at the end, and thus an equal amount of energy propagates in the opposite direction. Therefore the sound intensity is zero. In a pure diffuse sound field components of a sound field propagate in all directions. Therefore the sound intensity in a certain area (i.e. the sound power) is zero.

Sound intensity is a vector quantity (it has a magnitude and direction); defined as the time averaged product of the sound pressure (scalar) and the corresponding particle velocity (vector) at the same position. [3]

For the determination of sound intensity, the two components of a sound wave, particle velocity and sound pressure, have to be known. The measurement of the sound pressure (or particle velocity) only gives the sum of the free and diffuse sound fields. However, the free-field properties are obtained from the (time-averaged) product of the instantaneous pressure $p(t)$ and the corresponding instantaneous particle velocity $\mathbf{u}(t)$ at the same position,

$$I = \frac{1}{T}\int_0^T p(t).u(t)dt \tag{1}$$

where: the intensity **I** and the velocity $\mathbf{u}(t)$ are vectors. [3]

The measured intensity corresponds in fact to the net flow of acoustic energy at a given position. If the intensity around a sound source is measured at a number of positions, the radiated sound power can be determined. Even in the presence of reverberation or background noise one can determine in this way the (free-field) radiated power of a sound source.

The product of pressure and particle velocity, $\mathbf{I}\ (t) = p(t)\mathbf{u}(t)$, is called the instantaneous acoustic intensity Since the sound intensity **I** represents the acoustical power travelling through an area, **I** is also known as active sound intensity. Often only one direction of the vectors $\mathbf{u}(t)$ or **I** are obtained and considered. In this case, the particle velocity and sound intensity are referred to as $u(t)$ and I. The sound intensity **I** in equation (1) is only sensitive for the in-phase pressure and particle velocity. In case pressure and particle velocity are out of phase with reference to each other, the sound field is known as reactive, although the term reactive intensity is generally restricted to harmonic sound fields.

The sound intensity probe that is based on this principle is, however, no longer available because of its sensitivity to dc flows (wind). Furthermore, just like the p-p probe, it is a distributed sensor with the problems associated with this type of sensing. (For example, the maximum frequency is limited by the spacing.) Finally, because of its physical dimensions, the probe is difficult to calibrate.[3]

THREE-DIMENSIONAL P-U PROBE

Prior to the design of the 0.5 inch p-u probe realisation of three-dimensional sound intensity probes had started based on microflown technologies. At the time, threedimensional sound intensity probes were all based on three microphone pairs, so that the sensors were all very large. The three-dimensional sound intensity probes were therefore quite large but most of all costly since three carefully matched microphone pairs were needed.

Therefore a new three-dimensional sound intensity probe based on microflown was constructed. Although this sensor was still quite bulky, compares with the p-p probes it was quite affordable since less acoustical sensors were involved, and thus less signals (resulting in less frontend channels), and simpler computations (only cross-spectra between three p-u pairs) could be used. The first experiments were quite successful and showed that three-dimensional sound intensity probes were feasible especially if they were to be fitted in a single small housing.

After the one-dimensional 0.5 inch p-u probe had been created, the design of a three-dimensional p-u probe was started, as is shown in Figure 2.

In the three-dimensional sensor, the microflowns are positioned around a small microphone so that all three particle velocities and the pressure are measured at almost the same position, and are positioned orthogonally to each other. Two microflown sensors are positioned at 45° with reference to the centre axis of the probe so that they are produced in the same manner and measure the sound field in the same manner.

An another advantage is that the probe can be positioned in a standing wave tube so that each microflown measures in the same direction as the one-dimensional sound field without problems. The major advantage however is its size.[1]

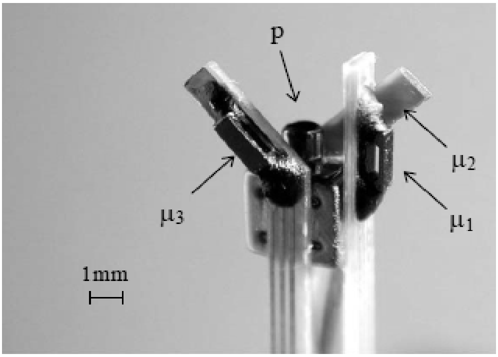

Figure 2 A three-dimensional pressure and particle velocity sensor (microflown Technologies) In the middle we see the pressure sensor, and around that the so-called Microflowns. [1]

For the first time, a complete 3-dimensional sound intensity sensor – consisting of 4 particle velocity sensors and a pressure microphone – has been integrated on a single chip, providing the possibility to do nearly point measurements of acoustic particle velocity, sound pressure, and therefore sound intensity. Principally the sensor consists of two distinct designs; a pressure sensor and particle velocity sensors.

Acoustic sound fields consist of a combination of pressure change and particle velocity. While acoustic pressure is a scalar quantity, particle velocity has both magnitude and direction. Therefore, to measure the complete sound field a sensor is needed for pressure and particle velocity, therefore consisting of a pressure sensor and a 3-dimensional particle velocity sensor (see Figure 3). Ideally, these sensors should be located in a single point, hence the integration of all sensors on a single chip. Furthermore, a small sensor significantly simplifies measurement of the sound field close to small sound sources.

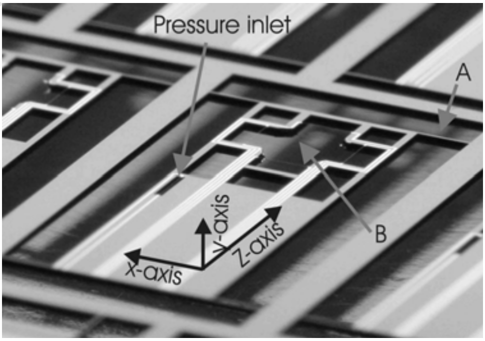

Figure 3 photo of the sensor on its wafer.[1]

POLAR PATTERN

A polar pattern (or directivity) expresses the sensitivity to the angle of incidence of the sound field. A sound pressure microphone should be omni-directional which implies a constant sensitivity for any angle of incidence of the sound field. A microflown however only measures the particle velocity in the direction for which it is sensitive. The directivity of a microflown is therefore a purely figure of eight pattern, see Figure 4, which can be expressed by equation (2):

$$\frac{\text{output}}{\text{particle velocity}} = \text{Sensitivity} \, . \cos{(\theta)} \tag{2}$$

Where θ is the angle of incidence.[1]

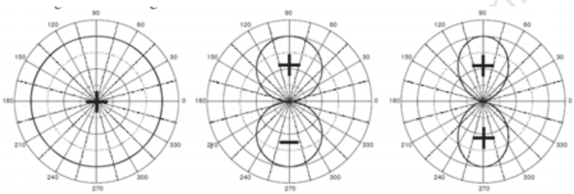

Figure 4 left: zeroth order sensor (no directionality), middle: first order sensor (cosine shape directionality) and right: second order sensor (cosine squared shape directionality).[4]

If signals are obtained from two orthogonally oriented particle velocity sensors, it is possible to mathematically rearrange the vector orientation. It is therefore possible to mathematically 'rotate' the probe in any orientation. The mathematical rotation is demonstrated for two orthogonal particle velocity sensors. It is possible to create a particle velocity sensor that has a sensitivity in any direction that is desired. Assume two sensors that are oriented in the x- and y-axis, see Figure 5 (left). A rotated figure of eight directionality is obtained if the signals of the two probes are processed in the following way (see equation (3):

$$u(t)_\theta = u_x \cos(\theta) + u_y \sin{(\theta)} \tag{3}$$

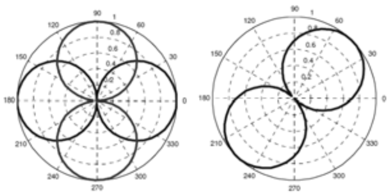

Figure 5: The particle velocity response in any direction can be obtained by combining two perpendicular particle velocity sensors.[4

CONCLUSION

In this paper are describe the theoretical aspects of acoustical particle velocity. This article deals with a sound particle velocity sensor, the Microflown, which is, by design, and due to its limited size, only sensitive for acoustical particle velocity. The acoustic velocity of particles can not be measured well, because the speed of particles has never been investigated as thoroughly as the sound pressure. The work was to show that microflown actually measured particle velocity and not pressure.

ACKNOWLEDGEMENT

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REFERENCES

[2] Raang Raangs, Exploring the use of the Microflown, PROEFSCHRIFT, Lochem, 2005.

[3] The Microflown E-Book, Chapter 3 The Microflown [online]. **[cit. 2012-04-17].** Available at <http://www.microflown.com/files/media/library/books/microflown_ebook/ebook _3_microflown.pdf>

[1] The Microflown E-Book, Chapter 5: Intensity [online]. **[cit. 2012-04-20].** Available at <http://www.microflown.com/files/media/library/books/microflown_ebook/ebook_3_microflown.pdf>

[4] Hans-Elias de Bree & Jelmer Wind, A particle velocity gradient beam forming system, NOISE-CON 2010, Baltimore, Maryland, 2010.

AN INVENTORY OF ENVIRONMENTAL RISKS INDUCED BY TAILING DAMS AND SYTEMATIC MITIGATION MEASURES

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ABSTRACT

Legal requirements are nowadays requiring ever increasing environmental protection levels, as a direct effect of the higher awareness degree of the impact induced by all types of mining activities, including those related to mine waste disposal. As to the structural stability of these mining waste deposits can be observed on slopes, manifesting a progressive trend. Therefore, the risks induced by extreme atmospheric phenomena or by their combination can have significant consequences, triggering technological accidents. Detailed site investigation by experienced geologists and geotechnical engineers is needed to determine possible potential for failure, with in situ and laboratory testing to determine the properties of the foundation materials. Within this context, in the first section of the paper, a systematic inventory is carried out concerning the effects induced on the environment by tailing dams, being identified the potential risks and the basic techniques which can be put in practice in order to prevent the occurrence of undesired events with catastrophic consequences. On this basis, in the second part of the paper there are emphasized the safety measures which should be implemented both in operational stage, and after activities cessation, to provide an adequate safety level of tailing dams.

Keywords: mining, environmental risk, tailing dam, safety level, mitigation measure

INTRODUCTION

Legal requirements are nowadays requiring ever increasing environmental protection levels, as a direct effect of the higher awareness degree of the impact induced by all types of mining activities, including those related to auxiliary operations, such as mine waste disposal.

Tailing dams an eloquent example of "peripheral" workings, which were not previously considered as priorities. The accidents and incidents occurred in recent years on worldwide and national level have, unfortunately, confirmed the need for the management of tailings to be a criterion for assessing the effectiveness of mining companies [5].

If the management of tailings and all types of mining waste is based on a proper technology and a suitable monitoring system, the approach can only be successful. Conversely, if the management organization of this operations is not considered as a priority, being entrusted to less experienced staff, the risk of situations occurrence with a high potential for danger increases considerably [2].

Putting in practice the alarm, contingency and response plans in case of accident must be linked to risk prevention and mitigation programs. In general, tailing dams safety is approached and studied only against one type of risk assumed, this being the risk induced by flooding caused by dam breaking or overflowing. These phenomena are taken into account from even the design stage, by estimating the volume of rainfall with a return period of time and using seismic data associated with the area where the tailings dam is located. Concerns dedicated to measures to be taken if levels exceeded post-materialisation of failures found afterwards are less effective.

From this perspective it rather seems natural to formulate questions such as:

- How frequently is integrated the notion of secondary safety barrier (or line-of-defence) in the design of a tailing dam?
- How many communities and, in particular, how many decision-makers have provided effective emergency measures for action in case of breaking a dam located upstream?
- How many mining companies prepared and checked the emergency response plans for partial or total destruction of the tailings storage works?

Generally, for a given site is given total trust and confidence to the professionals responsible for design and construction of the tailing dams [7]. If competent authorities endorse a large number of such constructions in a particular region, one can ask if they all are built according to existing rules and legal requirements. Which of them are dangerous facilities (not complying with the law)? How can one check the safety state in ponds located at far distances or areas difficult to reach, when it is not possible that they be monitored continuously by a specialized inspector?

In many industrial sectors in Romania it has been extended on large scale the implementation quality management systems based on the requirements comprised in ISO 9000 standard series. When will be able a certified Romanian mining company (according to ISO 9000 standards) to meet the requirements specified in the design and construction of tailings dam regulations, in conjunction with a public information and awareness campaign on the work done?

These questions are not rhetorical nor futuristic, but practical and reasonable, if we consider the safety and environmental potential impact of tailing dams. Adapting the existing facilities to the requirements imposed by the need to comply with recent standards in quality management is more expensive than building new facilities, based on the same standards. Increasingly more, encompassing concepts of environmental restrictions must have a high degree of flexibility to facilitate adjustment both to the current standards and those to be issued in the future.

The problem does not refer exclusively to the requirements of legislation. It is recommended that all mining companies to develop their own rules and regulations, taking into account the specific business and local or regional conditions [8]. Worldwide there have been registered numerous cases of mining companies closed down for a long time, pending the results of extended investigations, finally resulting in the imposition of more restrictive regulatory and legislative provisions.

POTENTIAL RISKS INDUCED BY TAILING DAMS AND MEANS OF DETECTION

In theory and practice of industrial risks, the risk is defined as a combination of the probability of an undesirable event occurrence and the seriousness of consequences generated [1]. In a broader sense, which includes environmental issues, the risk induced by mine tailing dams has the following three specific forms of manifestation:

- the dam can harm biotopes and ecosystems located in its proximity;
- controlled or accidental release of effluent (resulting by dam breakage or overflow), may result in contamination of surface waters [4];
- in case of generating and drainage of acid mine water, effects on the level of water pollution can be those of a long term pollution;
- effluent infiltration (cyanide, radioactive elements, etc.) through the lower structure of tailings can contaminate groundwater;
- infiltration can cause a local increase in groundwater levels, with negative consequences regarding the salinity in agricultural areas or adjacent biotopes;
- after sedimentation and drying, sterile powders can be driven by winds to nearby inhabited areas and ecosystems;
- in the case of certain mining companies which do employ cyanides for mineral substance processing purposes, effluent stored can generate toxic gases able to poison the birds attracted to water mirror, particularly in dry regions [6];
- modification of the landscape can sometimes be unacceptable in certain areas of scientific and tourist interest.

Table 1 summarizes the specific environmental risks of tailings dam, their generating causes and techniques applied for their detection.

SAFETY MEASURES PROPOSED FOR MITIGATION OF ENVIRONMENTAL RISK INDUCED BY TAILING DAMS

Given that preventive safety measures should be implemented from the design stage, for the existing tailing dams and ponds in Romania it is required adequate knowledge and proper application of safety measures corrective character. The following gives a summary of the main techniques applicable, structured on previously identified types of environmental risk.

a. Overflowing

- replacing the mass of material lost by erosion and repair auxiliary works affected;
- resorting to the use of geo-membranes and geo-grids to increase resistance to any subsequent releases or overrun processes;
- identifying the causes of discharge will be the base for searching on specific solutions, both in terms of repair auxiliary works affected and in the achievement of additional measures aimed at preventing future occurrence of similar events.

Table 1. Tailing dam specific environmental risks, their generating causes and detection techniques

Risk	Generating causes	Detection techniques
Overflow	Hydrologic or hydraulic wrong conception	Visual inspection
	Level loss due to ridge subsidence	Visual inspection and surveying measurements
Slope instability	Loss due to compaction of the ridge level	Visual inspection, accurate surveying measurements of alignment, levelling and inclinometry
	Inadequate control of water pressure	Piezometric monitoring and seepage control
Internal erosion due to inleakages	Un-proper inleakage control Misconception of filtering/drainage systems The erroneous design or insufficient control of the tailings, which give rise to cracks or privileged infiltration ways for water	Piezometric monitoring; Difficult to detect in its early stages, but controlling infiltration may indicate a potential risk; Visual inspection will often detect internal erosion too late to allow effective implementation of corrective measures
External erosion	Poor protection of the foot embankment slope (starter)	Visual inspection
Seismic induced damages	Inadequate geometry (e.g. slope too steep)	Visual inspection after an earthquake without serious consequences can emphasize the need for significant design changes
	Liquefaction of waste, rock embankments and foundation soil	Piezometric measurements taken before and after a minor earthquake may indicate a risk of liquefaction
Groundwater pollution	Infiltration reaching the water table due to lack or damage of the liner	Bearings performed from the observation wells

b. Slope instability

b_1. Possible break in depth [3]

- dam profile modification through:
  - reduce ridge height;
  - building a dam at the foot of additional berms;
  - reduce downstream slope gradient, .
- installing a drainage system in depth by:
  - filter points;
  - relief wells at the foot of the dam;
  - drains drilled sub-horizontally; .
- building supporting constructions (e.g., foot anchored walls).

b_2. Less profound instability

- lowering the saturation line;

- decreasing slope gradient;
- constructing drainage trenches on slope;
- soil consolidation (reinforcement, injections, buttresses);
- replace dislocated or low resistance material;
- set vegetal ground cover (top soil).

c. Internal erosion caused by seepage

- inspecting, cleaning and repair of existing drainage works;
- construction of new drainage works:
  - deep sub-horizontal drilled drains;
  - drainage trench slope downstream of the dam;
  - carpet downstream drainage slope of recharge;
  - drain filter point;
  - relief wells at the foot of the dam.

d. External erosion

- coverage of the exposed surface to wind action and rain with coarse material, which can not be eroded;
- stabilization with chemicals;
- topsoil coverage.

e. Seismical origin damages

- tailing dam's project review and execution of additional works that will produce better behaviour during and after the occurrence of a new earthquake;
- corrective measures to be taken after occurrence of an earthquake depends on the type and importance of damage and can be identified following a detailed inspection of the tailing dam.

f. Groundwater pollution

- execution of workings aimed at mitigation or diminishment of water inleakages (protective walls, injection curtains, etc);
- construction of collection devices (trenches or wells);
- pre-treatment of tailings in order to avoid or reduce groundwater pollution by means of percolation water.

g. Damage to clarifying ponds

- corrective actions will depend on the cause, nature and magnitude of damage (e.g., the destruction of the decanter overflow channel, emergency measures taken are aimed at use of auxiliary pumps, running a temporary overflow channel etc.);
- permanent repairs will be subject to detailed design.

CONCLUSIONS

Two fundamental issues should be considered in addressing security issues raised by mine tailing dams:

- stability of the work, in relation to breaking risk induced by phenomena like sliding, diving, discharges, regressive erosion etc.
- safety related to the retention of all categories of toxic substances present in waste rock stored.

Even with a satisfactory stability, remains the risk of pollution of surface water and/or groundwater due to seepage or spills. There is hazard associated with both the operational phase, and after cessation of mining activities.

Therefore, safety assessment of tailing dams will always include analysis of two categories of problems:

- mechanical stability with respect to the actual safety of the tailing dam and associated works;
- safety in respect to the environment, covering all aspects that concern by storing toxic and radioactive substances, without induction of unacceptable consequences.

If dealing with new projects, safety study in terms of tailings stability is not a particular problem because the basic data required can be collected and valued properly after systematic monitoring of the similar works.

For tailing dams in operation, the task may be considerably more difficult, due to lack of basic data of the project, particularly regarding construction methods used and how the monitoring process of its evolution in time took place. The last mentioned data are particularly important because they provide information regarding interstitial pressures, compaction factor, the infiltration level, water quality and lateral movements.

In the absence of precise knowledge of these elements, it is mandatory to carry out an "in situ" study that requires significant additional financial efforts. It also should be emphasized that regardless of the magnitude and level of detail of field trials, they can not substitute the process of systematic monitoring approach, continuous and rigorous work done since the start of construction.

The safety of tailing dams in respect to the environment is much more complex issue, if one takes into account that in safe stability conditions, pollutant substance leakages can occur or at the bottom, or on slopes. On the other hand, seepage losses are not initially polluting surface water and groundwater can generate pollution effects over time, especially if they are present in waste rock materials that increase acidity (e.g., pyrite).

The acidification increase due to altering the pH of the effluent, contribute to leaching of heavy metals, involving the risk of their training downstream. Also, in case of pyrite presence in waste rock used for construction of dam rainwater can generate effluents acids likely to pollute water courses downstream. It is obvious that safety in relation to the environment is a particular problem related to tailings site, because it does not depend exclusively on the impermeability degree and stability, but also the physical-chemical properties of the waste rock of the substances stored and used in processing of mineral matter.

In conclusion, it can be said that for estimating the safety level of a pond is required detailed knowledge, qualitative and quantitative, of the chemical and physical-chemical reactions involved and the seepage flow and variations in groundwater levels.

REFERENCES

[1] Băbuţ, G.B., Moraru, R.I., Goldan, T., Băbuţ, S. Ecological risk assessment (in Romanian), INFOMIN Publishing House, Deva, Romania, 2000.

[2] Băbuţ, G.B. & Moraru, R.I. Risk management programme for the mining industry, Annals of the University of Petroşani - Mining Engineering, vol. 4 (XXVI), Petroşani, Romania, pp. 106-113, 2003.

[3] Liu, H-M., Yang, C-H., Zhang, C., Mao, H-J., Study on static and dynamic strength characteristics of tailings silty sand and its engineering application, Safety Science, vol. 50, issue 4, pp. 828-834, 2012.

[4] Panthulu, T.V., Krishnaiah, C., Shirke, J.M. Detection of seepage paths in earth dams using self-potential and electrical resistivity methods, Engineering Geology, vol. 59, pp. 281-295, 2001.

[5] Sjodahl, P., Dahlin, T., Johansson, S. Using resistivity measurements for dam safety evaluation at Enemossen tailings dam in southern Sweden, Environmental Geology, vol. 49, pp. 267-273, 2005.

[6] van Tuyen, D., Canh. T., Weller, A., Geophysical investigations of river dikes in Vietnam, European Journal of Environmental and Engineering Geophysics, vol. 4, pp. 195-206, 2000.

[7] UNEP, *A guide to tailings dams and impoundments. Design, construction use and rehabilitation*. United Nations Environmental Programme/IGOLD, Bulletin 106, Paris, 1996.

[8] * * *, Decree no. 103/705/1292/2002 of the Minister of Industry and Resources, Water and Environmental Protection and Minister of Public Works, Transportation and Housing for approval of design, construction and operation of mining tailings dams, Official Journal of Romania, part I, no. 742/11.10.2002.

ANALYTICAL METHODS FOR THE DETERMINATION OF COPPER AND MERCURY IN SEDIMENTS

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ABSTRACT

The article deals with the content and mobility of copper and mercury in the bottom sediments from locality, water reservoir of Ružín No.1, Slovakia. Analytical methods was used to the single-step EDTA extraction and the sequential extraction (modified BCR extraction). Leachate contains group of elementary forms with similar physical and chemical properties. A single-step extraction with 0.05 mol.dm-3 EDTA efficiency and was compared with that of sequential extraction method of sediments. This procedure could reflected the mobility of contaminating heavy metals (Cu and Hg) of sediments and enabled the extraction of mobile and potentially mobile forms in the extent corresponding to the overall extraction efficiency of the first fourth steps of five-step sequential extraction. Environmental risk of elements copper and mercury were evaluated using the risk assessment code (RAC).

Keywords: one- shot extraction, sequential extraction, sediment, copper, mercury

INTRODUCTION

Sediments are normally mixtures of several components including different mineral species as well as organic debris. Sediments represent one of the ultimate sinks for heavy metals discharged into the environment [1, 2]. The bottom sediments occurring in water reservoir are results of erosion and sedimentation process in their river basin, such as weathering of rocks and volcanic activities plays noticeable role in enriching the water of reservoirs with heavy metals. They accumulate different pollutants, which have also anthropogenic origin. The region of Middle Spiš was classified as a loaded region, where the Water reservoir of Ružin No1 is also situated. Recent mining operations with the metallurgical processing of complex metals and copper ores left negative effects in this region [3]. The filling process of the reservoir began in 1972. During 40 years its volume diminished by 11 millions m^3. Bottom sediments are contaminated above all by heavy metals, namely Hg, Cu, Cd, Cr, Sb and As, which were alluvial into the reservoir from localities of former mining activities and thus they represent ecological load mainly at the inputs into reservoir. Enhanced contents of heavy metals hinder in direct application of sediments in agriculture, building and field engineering [4]. Sediment as a pollutant is harmful by itself and is even more so when combined with contaminants, such as heavy metals, nutrients, pesticides and other organic micro-pollutants. Nutrient enrichment of surface water bodies is often attributed to no- point source pollution from agricultural production areas [5]. The higher content of copper is followed for a longer period in the Rivers Hornád and Hnilec, that enter into the water reservoir Ružín No.1 assuming its deposition from wide surrounding, where the nonferrous metals with a high content of copper were exploited (Smolník and Kovohuty Krompachy). Copper occurs in soil in two-valence ions (nitrate, chloride, sulphate), which compounds are very movable. Nowadays, mercury compounds are considered to be one of the most important pollutants of environment. The mercury is trace element, which creates the large number of the inorganic and organic compounds. These compounds are toxic almost in every case. Mercury influences mainly areas with mining industry and/or thermal treatment of ores containing mercury. Siderite deposit of Rudňany belongs to risk localities.

The specificity sequential extraction can be increased with using of suitable extract solvent into extraction sequence where following agent extracts the rest of one extraction step. Extraction process evaluates the strength of bond of metal forms to different soil phases, to ion-renewable, carbonated, reducible, oxidizable and finally to resistant residue [6, 7]. The extraction was based on already known concentrations of total heavy metals content, which has been observed for many years.

EXPERIMENTAL

The samples of the sediments were collected from the sediments surface in the coastal zone Water reservoir of the Ružín No.1 Sample No.1 of the sediments is from the locality Hornád branch. Sample No.2 is from the locality Hnilec branch. Sampling was realized in the year 2009. The samples of bottom sediments were sampled into glass bottles by sample device „Multisampler“. Finally, the samples were dried at 35ºC, quartered, sieved under 0.1 mm and mineralised in a microwave pressure digestion system MWS-3. The total content of Cu and Hg were determined by atomic absorption spectrometry, flame technique (VARIAN, Australia) and by trace mercury analyzer (AMA).

Single-step EDTA extraction and sequential extraction

For the single-step extraction 0.05 mol.dm^{-3} EDTA, (ethylen-diamine-tetra-acetic acid) pH = 4.7 is optimisation of the extraction of sediments and the samples were shaken for 6 hours. Extracts contains metals in ion-changing form and bonded to carbonates. Sequential extraction methods are suitable for the evaluation of the mobility of elements in sediment and soil environment and are accepted by IRMM (Institute for Reference Materials and Meassurements The modified five-step sequential extraction by Mackových, 2003 is a modification of normed BCR procedure for the fractionated analysis of sediments [8]. The resultant five-step applied extraction tributes the isolated metals to the following fractions:

1. **Water-soluble (H_2O)-** 0.5g of sediment add 50ml of deio. H_2O, extract 16 h at t=20°C centrifugation at 3000 rpm 20min.
2. **Ion exchanged and carbonate (A)** - *e*xtracted in acid environment: add 40 ml of 0.11mol.l^{-1} CH_3COOH to the rest of the 1st step, extract 16 h at t=20°C, centrifugation 3000 rpm 20min., wash the rest
3. **Reducible (B)** - add 40ml of 0.1 mol.l^{-1} $NH_2OH.HCl$, pH=2 to the rest of the 2nd step, extract 16 h at t=20°C, centrifugation 3000 rpm 20min., wash the rest.

4. **Oxidizable, organic and sulphide (C+D)** - add 10ml of 8.8 mol.l^{-1} H_2O_2, pH=2 to the rest of the 3rd step, extract 1h at t=20°C, heat up to 85°C and dewater almost to dry, add 10ml of 8.8 mol.l^{-1} H_2O_2 again, heat up to 85°C and dewater almost to dry, add 50ml of 1mol .l^{-1} CH_3COONH_4, pH=2, extract 16 h at t=20°C, centrifugation 3000 rpm 20min., wash the rest.
5. **Residual (T)**- total degradation: add 10ml of HF and 1ml of $HClO_4$ to the rest of the 4th step, dewater, add 10ml of HF dewater almost to dry and add 5ml of HNO_3 (1:1).

RESULTS AND DISCUSSIONS

Active soil reaction (pH) and oxidation-reduction potential is presented in Table 1. It shown that, were slightly alkaline all sediments 1 Hornád and 2 Hnilec. The total organic matter content (TOM) in sediments of Water reservoir of the Ružín No.1 ranges between 10.2% and 12.3% (Table 1.). The surface run-off of the plant and animal remains adjacent to the reservoir site in various stages of decomposition, cell and tissues of soil organisms and soils microbes is considered as an additional source [9].

Table 1. Physical properties and chemical analyses of the sediments

Samples	pH /H_2O	ORP	Dry weight	TOM	Total content	
					Cu	Hg
		mV	(%)	(%)	(mg/kg)	
1Hornád	7.11	68	48.4	10.2	323.2	9.9
2 Hnilec	7.49	295	54.3	12.3	277.1	1.4

The investigation of the accuracy of single-step EDTA extraction and five-step sequential extraction, are shown in the figures 1. - 4. (SUM- contents of the 1. - 4. step sequential extraction, the distribution of Cu and Hg in the step: water-soluble, ion exchanged - carbonate, reducible, oxidizable and organic - sulphide). The step 1 and 4 are bioavailability part of metals and step 5 (residual) presents an insoluble residue. The results of the contents SUM analysis of Cu and Hg are approximately agreement with those determined using five-step sequential and single step EDTA extraction. We can see in figures 1. - 2., those copper of samples 1 Hornád and 2 Hnilec releases the most in the third step in the reducible fraction to 124 mg/kg and 94mg/kg. Copper is bonded to Fe and Mn oxides, which are unstable. In the second and fourth step, contents were from 69mg/kg to 79mg/kg of the total content of Cu extracting in the both samples. Extraction from sediments to water fraction (the first step) for studies copper does not overlap 4mg/kg. This fact shows that in the natural system water-sediment dynamic equilibrium was achieved and present 4mg/kg leached element (Cu) share by extraction into water represents solubility due to pH changes of water used by extraction. The contents copper was extracted in amount 21mg/kg - 44mg/kg of total element contents (5nd step). In the residual step is the part of bonded element to primary and secondary minerals.

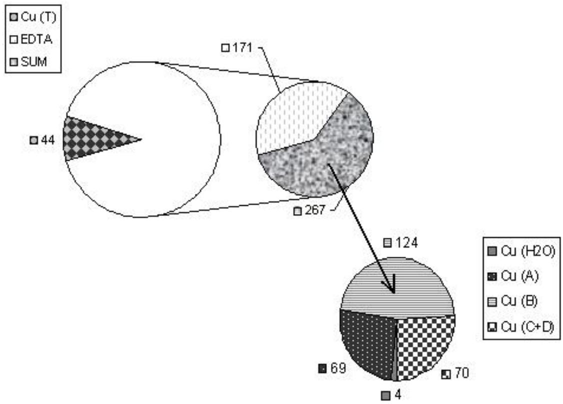

Figure 1. Comparison of copper of single-step EDTA extraction and five-step sequential extraction for sample 1Hornád branch; water-soluble (H_2O), ion exchanged-carbonate (A), reducible (B**),** oxidizable, organic and sulphide (C+D), residual (T), (SUM)- contents of the 1.- 4. step sequential extraction, single-step extraction 0.05 mol.dm^{-3} EDTA

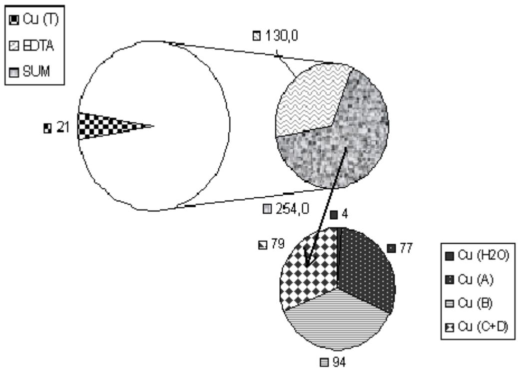

Figure 2. Comparison of copper of single-step EDTA extraction and five-step sequential extraction for sample 2 Hnilec branch; water-soluble (H_2O), ion exchanged-carbonate (A), reducible (B**),** oxidizable, organic and sulphide (C+D), residual (T), (SUM)- contents of the 1.- 4. step sequential extraction, single-step extraction 0.05 mol.dm^{-3} EDTA

We watched in Figures 3. - 4., comparison of copper and mercury of single-step EDTA extraction and five-step sequential extraction for samples 1Hornád and 2 Hnilec in each fraction is evaluated. The mercury in all sediment samples extracted mostly in the fourth step in the oxidizable, organic and sulphide fraction, namely in dependence on the sample in the amount 1.40mg/kg –11.02mg/kg of total element contents. That characterise the elements bonded in organic material and sulphides. These are released in aquatic environment as a result of degradation of organic material and sulphides by changing physical and chemical conditions. Extraction from samples 1Honád and 2 Hnilec to water fraction (the first step) for mercury does not overlap 0.011mg/kg and at the residual step 0.326mg/kg-0.878mg/kg of total element contents.

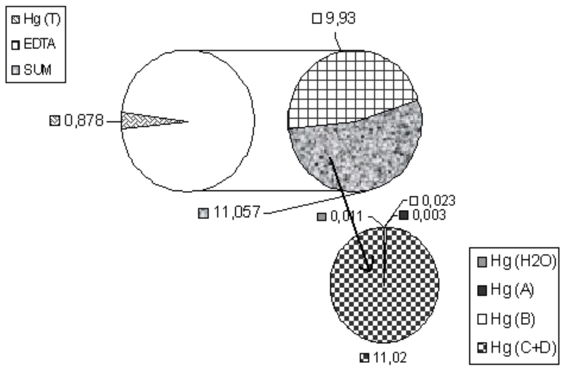

Figure 3. Comparison of mercury of single-step EDTA extraction and five-step sequential extraction for sample 1Hornád branch; water-soluble (H_2O), ion exchanged-carbonate (A), reducible (B**),** oxidizable, organic and sulphide (C+D), residual (T), (SUM)- contents of the 1.- 4. step sequential extraction, single-step extraction 0.05 mol.dm^{-3} EDTA

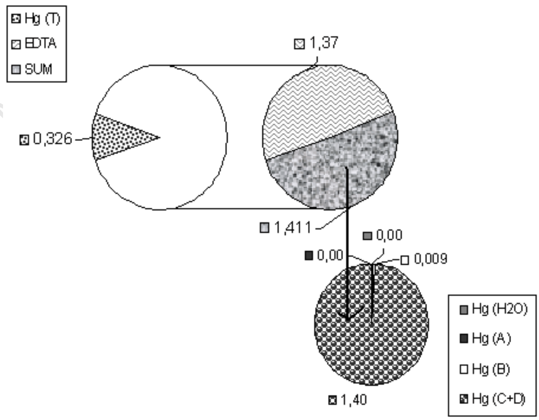

Figure 4. Comparison of mercury of single-step EDTA extraction and five-step sequential extraction for sample 2 Hnilec branch; water-soluble (H_2O), ion exchanged-carbonate (A),

reducible (B**)**, oxidizable, organic and sulphide (C+D), residual (T), (SUM)- contents of the 1.- 4. step sequential extraction, single-step extraction 0.05 mol.dm^{-3} EDTA

CONCLUSIONS

The present work aims to be a single-step extraction with 0.05 mol.dm-3 EDTA efficiency and was compared with that of sequential extraction method of sediments. This procedure could reflected the mobility of contaminating heavy metals copper and mercury of sediments and enabled the extraction of potentially mobile forms in the extent corresponding to the overall extraction efficiency of the first fourth steps of five-step sequential extraction. Environmental risk of elements copper and mercury were evaluated using the risk assessment code (RAC) [10]. RAC assesses the availability of metals in solution by applying a scale to the percentage of sediments that can reduce metals in the adsorptive and exchangeable and bound to carbonate fractions [1]. The results of the present study show that Cu poses a medium risk in exchangeable-carbonates fractions is 21.3% and 27.8%, (RAC 11%-30%) and the percentage of Hg in exchangeable-carbonates fractions is 0% posing a no environmental risk (RAC <1) for all samples. The use of a single-step extraction with 0.05 mol.dm-3 EDTA and of sequential extraction methods and also the risk assessment code (RAC) in present study provides valuable information and useful tool on the potential mobility and environmental significance of Cu and Hg. The chemical partitioning data show that there are significant differences in the distribution of these two metals.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Habes G. & Nigem Y. Assesseng Mn,Fe,Cu,Zn and Cd pollution in bottom sediments of Wadi Al-Arab dam, Jordan, Elsevier, Chemosphere, vol.65, Issue 11, pp 2114-2121, 2006.

[2] Bettinetti R. & Giarei C. & Provini A. A chemical analysis and sediment toxicity bioassays to assess the contamination of the River Lambro(Northern Italy). Arch. Environ. Contam. Toxic., vol.45, pp 72-80, 2003.

[3] Šestinova O. & Hančuľák J. & Brehuv J. & Fedorova E. The mobility of heavy metals in sediments using the sequention extraction method, 4th European Bio Remediation Conference, Chania Creta, Greece, pp 1-5 2008.

[4] Šestinova O. & Brehuv J. & Hančuľák J. & Špaldon T. & Fedorova E. Evaluation of heavy metals mobillity in sediments from the Hnilec River, Slovakia. 4th Meeting on Chemistry and Life, FCH-UT, Brno In: Chemické listy 102, pp 465-467, 2008.

[5] Kovaliková N. & Bálintová M. Kvalita sedimentov v malej vodnej nádrži Kľušov, Zborník prednášok: Sedimenty vodných tokov a nádrží, pp.220-226, 2007.

[6] Quevauvilier Ph. Methodologies in Soil and Sediment Fractionation Studies, Single and Sequential Extraction Procedures, The Royal Society of Chemistry, Chap.3, pp 28-56, 2002.

[7] Vojteková V. & Krakovská E. Fractionation analysis in dust sediments, limitation selectivity sequential leaching, Chem. papers 100, pp.1096-1104, 2006.

[8] Mackových D. & Cicmanová S. & Pramuka S. Formy výskytu vybraných toxických prvkov. ČZSGÚ: Zhodnotenie potenciálneho vplyvu geochemického prostredia na zdravotný stav obyvateľstva v oblasti Špišsko- gemerského Rudohoria. pp.65, 2003.

[9] Ghrefat H.A. Hydrochemical and geochemical study of wadi Al-Arab Dam and wells, with special regards to the environmental pollution. MSc. Thesis, Yarmouk University, Irbid, Jordan, 1999.

[10] Air Toxic Hot Spots Program Risk Assessment Gaidelines, Manual for Preparation of Health Risk Assessment,2003 California [cit. 2012-04-25] Dostupné na internete http://oehha.ca.gov/air/hot_spots/pdf/HRAguidefinal.pdf.

APPLICATION OF PYROLYSIS PROCESS IN PROCESSING OF FOOD WASTES

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ABSTRACT

Treatment and disposal of waste from food production is an important area of the total food production. In relation to the different sources of raw materials and technological procedures used in composition of individual food waste production vary widely, so the procedures and subsequent recovery is often very different. This paper presents initial laboratory pyrolysis experiments of selected food wastes, including mixed, with a focus on the composition of gaseous products of these processes, utilization of solid residue and material balance. Gas from the pyrolysis experiments was captured discontinuously at different process temperatures in glass sample tubes and analyzed by gas chromatography were analyzed by the selected components (methane, ethene, propane, hydrogen, carbon monoxide, carbon dioxide). The maximum concentration of hydrogen in the pyrolysis gas were around 20 vol. %, the concentration of carbon monoxide were analyzed in the range 30 to 60 vol. % and concentration of the measured amounts of hydrocarbons were measured about 15 vol. %.

Keywords: pyrolysis, food waste, gas chromatography, process conditions

INTRODUCTION

The food industry processes more than two-fifths of agricultural production, manufacture of food and beverages products is industry built on agriculture. The main task of the food industry is to secure food in a sufficient range and quantity. An important measure that would significantly affect the character of this production in the sense of increasing its competitiveness, it was adopted of the "Concept of Food Industry of Czech Republic for the period after accession to the EU (2004-2013)". This concept is closely linked to the takeover of EU food policy for which a food safety is a priority number one, and simultaneously addresses the perspectives in terms of national goals. Other priorities are the provision of food in sufficient quantity and range of products and influence consumers towards the principles of good nutrition. Conceptual plans also allow for environmental protection in food production [1]. Although the minimization of generated waste amount is a priority of waste management, cannot be in the future in many fields of human activities waste production excluded.

The question of their disposal or the rational use today represents a major challenge in terms of environmental protection, but also economically. Progressive methods are particularly energy recovery operations, which provide many benefits [2]. Selected types of waste have been subjected to pyrolysis with subsequent comparison of efficiency in terms of quality of individual products for specific waste process. The fundamental research and determination of the conditions of gaseous, solid and liquid products and assess their usefulness was the fundamental aim. Pyrolysis is one of the thermal reduction processes, which could eventually be applied to energy and material recovery of waste from the food industry. The basis of pyrolysis is that at higher temperatures, organic compounds are less stable and high/molecular substances are decomposed to low molecular, leading to their disintegration into volatile products and coke [3]. Thermal methods are promising technologies that transform certain types of materials (waste) to fuel quality or valuable chemical feedstock. A prerequisite for successful application is the appropriate selection of the materials and setting the optimal process conditions [4]. For these reasons, laboratory experiments was, with subsequent assessment of the quantity and quality of individual pyrolysis products, verified possible suitability or unsuitability of selected food waste for the pyrolysis process.

DESCRIPTION OF SAMPLES AND THEIR PREPARATION FOR EXPERIMENTS

In food industry the following samples of mixed waste has been selected:

- SAMPLE 1 - waste dough (Opavia-Lu)
- SAMPLE 2 - wastes from the manufacture of instant soups (Vitana, plc. Byšice)
- SAMPLE 3 - waste from the production of flavorings (Vitana,plc. Byšice)
- SAMPLE 4 - waste starch (Opavia-Lu)
- SAMPLE 5 – mixture of waste cocoa husks (Opavia-Lu) + waste frying oil in the ratio 10:1 (taken from a restaurant)
- SAMPLE 6 - dust silo (STZ, plc. Olomouc) + fatty waste water in the ratio 10:1 (STZ, plc. Olomouc)

The above listed types of waste are generated in enterprises of 80 to 100 tons per month. Most of these listed wastes is disposed by landfill. Selected types of waste were necessary due to the pyrolysis apparatus used to prepare before the experiments. It was an adjustment to size (granulometry). To adjust the size knife mill was used, whose task was to prepare the selected size and type of waste that was suitable for further use. Grain size analysis was not performed, visually can be estimated significant fraction represented about 5-10 mm in untreated samples and approximately 1-3 mm in samples treated. In the food industry are formed in addition to solid waste also liquid waste, which in our laboratory conditions can not be independently carbonisated, so they were created with a mixture of a suitable type of waste. For each sample was realized the heat-technical and elemental analysis (see Table 1).

Table 1 Thermodynamic and elementary analysis of samples 1 – 6

Sample	Moisture content [wt.%]	Ash [wt.%]	Volatile mater [wt.%]	C [%]	H [%]	N [%]	S [%]	O [%]	Calorific value [kJ/kg]	Higher heating value [kJ/kg]
1	1,8	2,3	95,8	46,8	7,5	1,6	0	40,0	23045	21460
2	6,3	10,3	83,4	44,4	7,1	1,7	0	30,2	19840	18964
3	5,7	25,3	69,0	42,9	4,4	3,8	0	17,9	17657	17067
4	9,7	0,2	90,1	31,7	5,2	0,2	0	53,0	8448	7157
5	8,5	6,3	85,2	46,2	6,3	2,7	0	30,0	19334	18560
6	13,4	6,4	80,2	35,3	5,2	1,9	0	37,8	16295	14916
Frying oil	0,1	0,1	99,8	83,2	-	0,1	0,2	-	-	-
Fatty waste water	0,3	0,1	99,6	80,0	-	0,1	0,4	-	-	-

Used liquid samples, ie. frying oil and fatty waste water, were submitted to the following determinations (see Tab. 2).

Table 2 Parameters set cooking oil and grease waste water

Parameter	Conditions	Frying oil	Fatty waste water
Kinematic viscosity [$mm^2.s^{-1}$]	20 °C	110,63	73,25
	30 °C	69,05	47,33
	60 °C	25,35	18,24
	90 °C	12,12	9,20
	120 °C	7,23	5,60
	150 °C	4,86	3,85
Point of ignition [°C]	Measurement no. 1	Nad 300	273
	Measurement no. 2	Nad 300	272
Residual coke [%]		0,58	0,43

(Used methods: Kinematic viscosity: ASTM 445-06, point of ignition: MARCUSSON, residual coke: according the tes course č.17 comming from DIN 51905/81, ISO 6998/84, ASTM D 4715-87).

EXPERIMENTAL DEVICE

The apparatus was composed of tube furnaces, in which were placed the retort, it was connected with other parts of the apparatus so that the condensate has to capture and measure the gas production from pyrolysis experiments. The retort was connected to flask cooled with ice, in which the liquid fraction was to condensed. To achieve lower cooling temperatures of process gas (app. -10 °C) ice was varied during the experiment and stirred with kitchen salt. The next stage of cooling was glass cooler, vertically connected to the flask in which condensated a residual tar shares of releasing gas. Exhaust gas outside the laboratory was designed so that it is possible at any time to take the gas sample to be analyzed, as shown in Figure 1. Heating rate of the retort was 15 °C per minute up to a temperature of 800 °C, the delays at this temperature for 7 minutes. Gas from the pyrolysis experiments was captured discontinuously at different process temperatures into glass sample tubes and analyzed by gas chromatography.

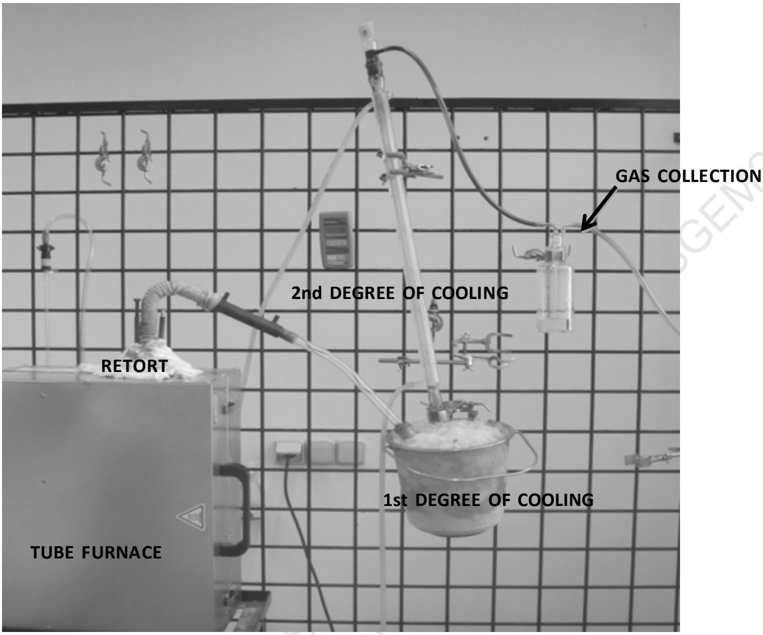

Fig. 1 Pyrolysis equipment

THE MASS BALANCE OF PYROLYSIS PROCESSES

Weighing the various inputs and products of pyrolysis (solid residue, liquid residue) was determined by mass balance of pyrolysis and gasification tests (the amount of gas was determined by grossing up 100 %).
The following figure shows the mass balance of pyrolysis process for samples 1 to 6.

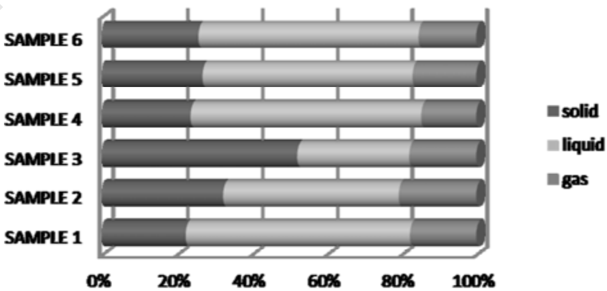

Fig. 2 The mass balance of pyrolysis process

The figure shows that the distribution of the output components after performed pyrolysis experiments is similar for all samples except waste sample 3, with high coke yield with simultaneous decrease in the yield of the liquid phase.

ANALYSIS OF THE GASEOUS PRODUCT OF PYROLYSIS

Analysis of the pyrolysis gas and the gas from gasification was performed on a gas chromatograph Agilent 7890. FID detector was used for the detection of methane, ethene, and propane; the other components selected were detected by TCD detector. A division of the mixture occurred in GasPro column (length 60 m, inner diameter 0.320 mm). For dosing the gaseous samples, and was used metering loop and the output signal was Recorded and processed by computer software HP ChemStation.

Fig. 3 Gas chromatograph Agilent GC 7890A

Conditions of chromatographic analysis are given in Table 3.
For the calibration certified calibrating gas was used, its composition is showen in the Table 4.

Table 3 Conditions for analysis of gaseous products on the gas chromatograph

Column setting		**FID detector setting**		**TCD detector setting**	
Temperature [°C]	200	Temperature [°C]	300	Temperature [°C]	260
Pressure [Psi]	15,796				
Flow rate [ml.min^{-1}]	3,3	Flow rate of H_2 [ml.min^{-1}]	30	Flow rate of H_2 [ml.min^{-1}]	2
Split ratio	10:1	Airflow [ml.min^{-1}]	400		
		Flow rate of He [ml.min^{-1}]	25	Flow rate of He [ml.min^{-1}]	5

Table 4 The composition of calibration gas for gas chromatograph GC Agilent 7890A

Component	**Certified concentration**
C_3H_8	1,01 obj%
C_2H_4	3,02 obj%
CH_4	4,00 obj%
H_2	8,81 obj%
CO	13,02 obj%
CO_2	16,03 obj%

Samplings of pyrolysis gas were realized discontinuously at temperatures when the gas began to develop, during the most intense evolution of gas and end the process. The intensity of the developed gas was visually observed in the pyrolysis gas washing tank. Based on this principle, the selected sampling of gas for each gas sample temperature samples differed (see Table 5).

Table 5 Analysis of the gaseous product of pyrolysis experiments on samples 1 to 6

Sample	Temperature of offtake [°C]	CH_4 [vol.%]	C_2H_4 [vol.%]	C_3H_8 [vol.%]	H_2 [vol.%]	CO [vol.%]	CO_2 [vol.%]
1	420-460	0,17	0,06	0,03	4,61	0,45	26,12
	515-535	2,51	0,46	0,34	5,95	8,16	39,03
	600-625	10,28	1,94	0,44	11,79	36,48	27,65
	705-727	15,60	3,52	0,16	23,12	54,94	1,20
2	354-391	0,02	0,01	0,01	-	-	8,75
	475-503	1,28	0,26	0,22	-	4,78	45,24
	594-620	3,97	0,75	0,24	7,13	17,07	17,91
	693-720	14,27	3,63	0,31	16,75	59,34	1,64
3	335-373	0,03	0,02	0,01	-	-	18,69
	450-476	1,38	0,22	0,36	-	4,88	48,29
	550-567	10,95	0,94	1,46	5,94	42,08	2,88
	685-710	18,06	0,51	0,46	28,14	49,23	1,93
4	390-415	0,08	0,02	0,01	-	-	7,56
	550-571	1,22	0,18	0,14	-	5,23	42,55
	702-717	5,46	0,26	0,18	4,66	20,79	0,25
	780-800	5,47	0,24	0,08	6,01	30,28	0,22
5	320-360	0,03	0,02	0,01	-	-	14,58
	450-470	1,70	0,26	0,35	-	5,89	62,61
	550-575	8,83	1,01	1,02	8,06	33,00	38,48
	700-720	16,20	0,55	0,40	25,01	50,82	1,56
6	390-429	0,08	0,02	0,01	-	-	24,20
	507-534	4,64	0,56	0,58	5,20	17,52	47,50
	604-630	8,20	0,90	0,59	8,52	30,82	1,52
	705-731	14,09	2,40	0,57	30,42	39,86	2,27

In all cases of waste from the food industry occurred during pyrolysis with increasing temperature an increase in the concentrations of each flammable component. The highest concentrations of hydrocarbon mixtures, hydrogen and carbon monoxide were always achieved in the fourth (final) sampling of pyrolysis gas in the temperature range of 700-800 °C. An important parameter of the usability of the gaseous product is hydrogen production as mentioned in many publications with regard to process conditions [5]. In gaseous samples collected during process temperature 700-800 ° C was the highest hydrogen concentration achieved in sample 6 (30 vol.%), while the lowest (6 vol.%) for the sample 4. Concentration of measured hydrocarbons sum were measured around 15 vol. % and concentration of carbon monoxide were analyzed approximately at 50 vol. %. Sample 4 did not reach those above mentioned values, because it shows the lowest measured concentration of all flammable components.

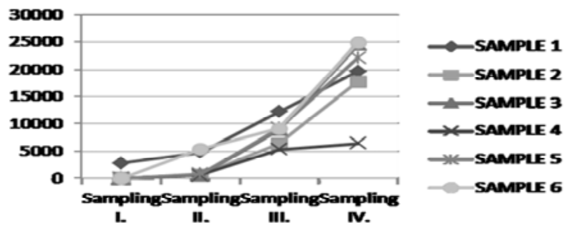

Fig. 4 Calorific value of process gas (kJ/kg)

EVALUATION OF SOLID RESIDUES IN TERMS OF ADSORPTION PROPERTIES

Solid products of pyrolysed samples were subjected to a basic determinativ to setting their sorption capacity (iodine adsorption number). One possibility of material recovery of wastes is the pyrolysis processing for the purposes of adsorbent preparation. Adsorbents are highly porous materials with a developed internal surface and relevant adsorption skills that are capable of capturing from gaseous or liquid mixtures the certain substances. The high adsorption capacity of adsorbents is due to a large number of pores of different sizes. Their application is primarily in so called cleaning technologies. In addition to natural sources of adsorbents (e.g. zeolites), manufacturers focus on adsorbents, prepared artificially, when the raw materials can be of different origin, usually of organic nature such as brown coal, hard coal and lignite. At the present time, becoming a growing trend of sorbents production from biomass and various types of waste materials, which are the raw materials readily available at minimal cost, such as wood, sawdust, bark, nut shells, fruit pits, waste plastic materials, sewage sludge from industrial waste water treatment plants and other [6]. The quality of the adsorbent is subject to the requirement made on their future use. The quality of the adsorbent is characterized by range of parameters and properties. Among the main characteristics and parameters that can characterize adsorbents include bulk density, apparent and real density, and specific surface area, pore volume of the adsorption, pore size distribution and iodine adsorption number. To determine the iodine adsorption number I, which provides information on the microporous structure of the solid product was used the DIN 53 582 [7]. The following figure 5 shows the values of the resulting iodine adsorption number of samples 1 to 6 after performed pyrolysis experiments.

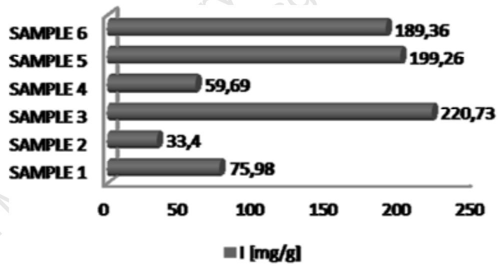

Fig. 5 Comparison of the iodine adsorption number of pyrolysis experiments for samples 1-6

The resulting iodine adsorption number of solid carboniyation product samples 3, 5 and 6 is quite high, which suggests a possibility of their use to manufacture so called "single-use sorbents" for wastewater treatment (to capture the cations of heavy metals or some organic substances).

CONCLUSION

This paper summarizes the partial results of the student´s grant project. The purpose of the experiments was to obtain basic results, which could create a more concrete idea of the perspective applications of thermal reduction processes on selected food waste and in particular the direction that should take any further experiments.

The advantage is that during the process the process gas is generated containing combustible components such as methane, hydrogen, carbon monoxide, which can be used for energy purposes. Very positive results in the case of pyrolysis experiments were achieved in all tested waste from the food industry with the exception of samples 4. Determined iodine adsorption number of some carbonized waste samples (samples 3, 5 and 6) do not exclude the possibility of their further use in the production of adsorbents. For a comprehensive assessment of the suitability of these materials for possible production of adsorbents is necessary to provide other basic parameters such as specific surface area (S_{BET}) and pore volume. As mentioned above, due to inability to perform pyrolysis for liquid samples from the food industry, mixture with appropriate types of solid waste were created. Waste cocoa husks, which formed the basis of a sample 5, were previously handled by pyrolysis separately and it can be stated that the addition of frying oil to the mixture it was achieved substantially higher iodine number (I = 199.26 mg/g). The resulting values of concentrations of flammable components, except hydrogen, were similar compared to the mixed sample 5 (CH_4 14 vol. %, H_2 34 vol. % and CO 49 vol. %) [8]. Finally, it should be noted that mentioned issue is extensive and offers a variety of modifications of the process of pyrolysis of selected waste kinds.

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REFERENCES

[1] Bursa M.: Geografie průmyslu Česka: Potravinářský průmysl, Univerzita J. E. Purkyně v Ústí nad Labem, Ústí nad Labem, 2006, 51 s, ISBN 80-7044-807-5.

[2] Obroučka K.: Termické odstraňování a energetické využívání odpadů, VŠB TUO, 2001, 143 s, ISBN 80-248-0009-8.

[3] Obroučka, K. a kol.: Výzkum vlastností a využití digestátu z anaerobních procesů kofermentace zemědělských a dalších, zejména obtížně využitelných organických odpadů. Projekt VaV ev. č. SP/3g4/103/07, VŠB TU Ostrava, Centrum environmentálních technologií, 2007 - 2010.

[4] Holcová P., Kaloč M.: Hodnocení vlastností pyrolýzních produktů z odpadní biomasy, Úprava nerostných surovin, VŠB TU Ostrava 2006, s. 63-71, ISBN 80-248-1050-6.

[5] Abuadala A., Dincer I.: Efficiency evaluation of dry hydrogen production from biomass gasification, Thermochimica Acta, vo. 507-508, August 2010, p. 127-134.

[6] OTERO M., ROZADA F., CALVO L. F., GARCIA A. I., MORAN A.: Kinetic and equilibrium modelling of the metylene blue removal from solution by absorbent materials produced from sewage sludges, Boichem Eng. J., vol. 15, 2003, p. 59-68.

[7] DIN 53582: Prüfung von Ruβen; Bestimmung der Jodadsorptionszahl (Testing of carbon black; determination of iodine adsorption number) 1983.

[8] Grycová B., Stepková K., Kuča R., Obroučka K.: Aplikace procesu pyrolýzy a zplyňování při zpracování vybraných potravinářských odpadů, Waste forum 3/2011, s. 185-192, ISSN 1804-0195.

APPLICATION OF THE SHORELINE DEVELOPMENT INDEX FOR SIUTGHIOL LAKE, ROMANIA

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ABSTRACT

This paper presents a rapid method to assess the development of lake shorelines located in urban areas, with respect to how human activity affects the functionality of the shoreline. A multi-metric index was developed and used to examine the interconnectivity between aquatic, biotic environment, shore and riparian areas along Lake Siutghiol in Constanta, Romania.

The shoreline development index was developed as part of an International Research Experience for Students (IRES) project funded by the US National Science Foundation, and applied first in summer of 2008, for Tăbăcărie Lake and in the summer of 2011 for Siutghiol Lake. Both lakes are located in urbanized landscapes in the vicinity of Mamaia seaside resort and are heavily used for recreational and leisure activites leading to drastic anthropogenic impacts on the shorelines.

Aquatic, riparian and shore variables were observed along the shoreline by using a modified transect methodology. Metrics related to vegetation, waste, organic debris, soil cover and land use were observed at each station around the lake. Biotic components were evaluated by observing wildlife at each station. Landuse and landscape aspects were characterized using a qualitative assessment of the quality of "natural" space, "cultural" areas and "built" environments (e.g. parking lots, damaged buildings or shopping areas) located along the shore. The data collected were processed in a scale point, and given a score for 147 transects around Siutghiol Lake.

Together with the shoreline development index we performed analyses for water quality at different points around the lake/functional zones in order to correlate water chemistry with the other shoreline metrics. These scores obtained by applying this methodology serve as integrative indicators of environmental health and human activities for this complex human-environmental system. They can also help to monitor the progress toward sustainable development around Siutghiol Lake.

Keywords: Siutghiol, shoreline development index, natural component, urban lake, environmental health indicators

INTRODUCTION

The Romanian coastal lakes, situated between the Chituc grind and Constanţa municipality, (Tăbăcărie, Siutghiol, Taşaul, and Corbu lakes from south to north respectively) contain complex interacting ecosystems with diverse ecological communities. These lakes are also of economic significance because of exploitable natural resources and specific human activities. Siutghiol Lake is situated in the northern part of Constanţa municipality and it represents an important attraction for tourism, its eastern shore being parallel to the important summer resort of Mamaia. The lake provides socio-economic value to the surrounding localities in addition to its importance for agriculture and industrial activities. Other ecosystem services of the lake include it being a significant area for aquatic migratory birds and its fisheries resources[1].

Despite widespread public awareness of the direct benefits that humans derive from ecosystems, the full magnitude of benefits attributable to ecosystems is woefully underappreciated by the public[2]. The public's failure to recognize these benefits increases the likelihood that natural resources will be managed and developed in a manner that leads to ecosystem degradation[3]. Such resource development, in conjunction with increasing human population and land use intensification (taking place especially in the summer season, when Mamaia resort is overcrowded), can stress ecosystems to a point where their ability to provide the benefits is compromised[4].

There is a growing need to monitor and evaluate the impacts of development on lake ecosystems[5],[6] and to develop indicators that include biotic and abiotic aspects related to sustainable development in and around coastal zones[7],[8].

The purpose of this study is to develop a multi-metric index to gather the necessary data for quantification and understanding the relationships between human activities on the lake shore area and its ecological integrity. This index requires a methodology that rapidly evaluates the shore components which ensure ecological integrity of the shoreline and offers a vision on spatial relationships as part of identifying and monitoring sustainable development opportunities.

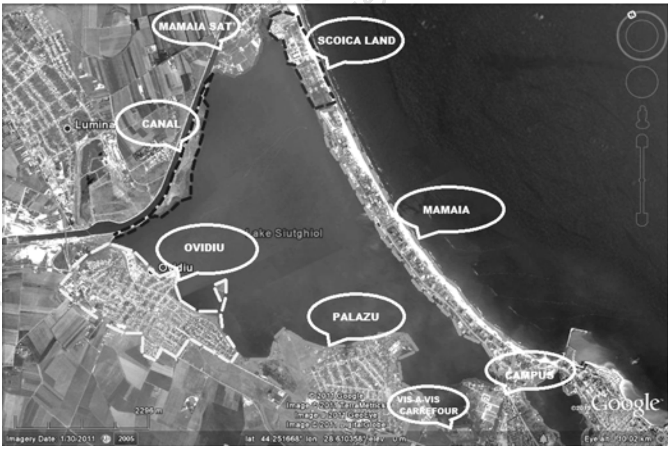

Figure 1 – Functional zones for Siutghiol Lake

Accomplishing a framework for integrating the sustainable development of Lake Siutghiol from Constanta, Romania was possible by applying an interdisciplinary study. A stage consisted in defining the spatial characteristics of natural and built environment, in an attempt to define "functional zones" that could serve as a basis in developing a systematic model for studying the social, economic and environmental factors (Fig . 1).

Based on examination of satellite images, land around the lake was divided into different areas, describing the same time the human activities there. Established functional areas are: 1. Scoical Land, 2. Mamaia, 3. University Campus, 4. Vis-à-vis Carrefour, 5. Palazu, 6. Ovidiu, 7. Canal, 8. Mamaia Sat.

Human activities affect the shore, which in turn affects the aquatic area. This is a connectivity problem that involves joining small parts. Functional areas are connected to the shoreline of Lake Siutghiol[9].

MATERIAL AND METHODS

The methodology used for this study is explained in detail in the literature[9]. One of our aims was to obtain an overview on Siutghiol lake water quality and to capture eventual correlations.

Water samples were collected 11 sampling points inside the lake and 7 in the lake shore area (all around the lake, in different functional zones). An YSI multiparameter sonde was used to register a set of physico-chemical quality parameters of surface waters: dissolved oxygen, temperature, pH, conductivity, salinity, turbidity and chlorophyll.

For water sampling we used a Van Dorn type probe. Samples were then transferred into sterile bags Whirl bag, labeled and placed in the laboratory of Applied Ecology and Environmental Protection from Ovidius University of Constanta (Faculty of Natural and Agricultural Sciences). Samples were then immediately processed to determine biogenic indicators, such as phosphates and nitrates, using a DR/2400 HACH spectrophotometer[10]. Data where then analyzed with Jump statistical software.

In order to determine the functional areas (Fig. 1) the land around the lake was divided into several parts, depending on space use, activities carried out there, and type of bank. Thus, the eastern part of the lake is surrounded by a maritime belt on which is situated Mamaia sea resort. The bank is low, not too stable and now strengthened through concrete almost on the entire length. In Scoica Land zone, besides the concrete shore there is a small area of shore composed of sand or gravel. Throughout the eastern portion the anthropogenic activity is intense because of tourism.

In the northern extremity the shore is formed by loess, and due to the seafront shelter created in the way of wind, a reed vegetation was installed, sometimes even forming floating reed islands[11], so that the human intervention is least felt in functional areas Mamaia Sat and Canal.

In the west and south, due to north-east wind exposure (very common) and large surface of blowing on the lake mirror, the western and southern lake coast, except where there is reed bays, is subject to direct lake abrasion, which acts intensely. In these parts the lake is represented by an active cliff[11]. In areas Ovidiu, Palazu, and Vis-à-vis Carrefour, the bank is covered by vegetation, human activities are intense because of existing human settlements there. Campus area is heavily modified, the shore being reinforced with concrete.

In the functional areas have been established many stations, so producing a visual examination of a total of 147 locations around the lake Siutghiol. In order to characterize the current situation and for the quantitative and qualitative sizing of anthropogenic factor influences we had in our view the need to consider observations on five components of the shoreline development index: aquatic, shoreline, riparian, biotic and aesthetic. For each sampling point, a transect depth of 5m into the aquatic zone and 10 m into the riparian zone, with a 1m depth from the water edge for shoreline was used at each location. For the aquatic, riparian and shoreline, the percent coverage with vegetation, land use and ground coverage were estimated visually. The presence of birds, amphibians or generally fauna at each station were noted as present (1-5 individuals), absent (0 individuals) or abundant (more than 5 individuals)[9].

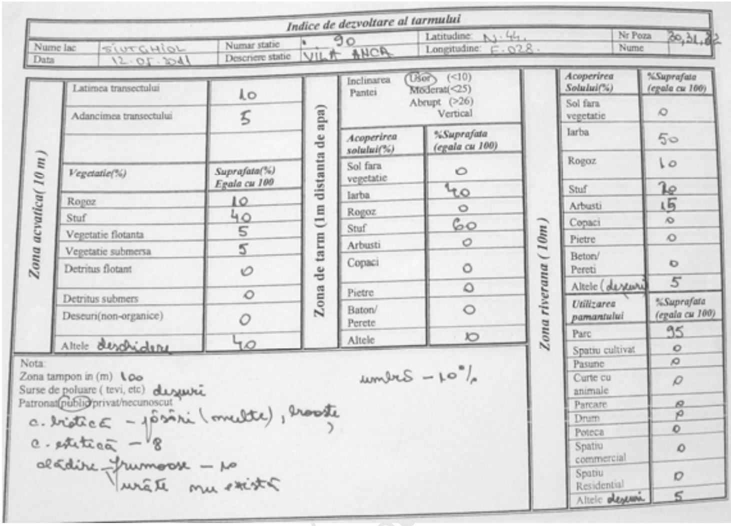

Figure 2 – Field observations sheet

Observations also concerned pollution sources, public or private property and buffer zone located between the lake and surfaces built by humans. These observations are a quick way to assess the locations, allowing identification of pollution sources and magnitude of human impact on the area studied.

For accurate records we have filled in observation sheets for each station and did some photos: one from the aquatic area, one from the shore and an overview. For precise localization of the stations we used GPS.

After completing the observation sheets (Fig. 2) an Excel database was established, to include both raw data, obtained from field observations, and scores resulting from data processing by providing scores of individual variables.

For each component of the shoreline development index (aquatic, shoreline, riparian, aesthetic biotic) was given a score based on ratings obtained from field observations, thus assigning a positive score to variables not affecting the environmental integrity, and finally these scores were summed to have a final positive result. Similarly, the negative variables were approached in the same manner. By adding the positive variables it resulted a total positive score for each component, the same thing happening in the case of negative variables. Finally, all variables have been summed, thus obtaining a total score for each component. The total score for the shoreline development index was obtained by summing the total scores, which was assigned a value corresponding to a rating: poor, fair, good, very good, excellent[9].

RESULTS AND DISCUSSIONS

Most stations (47) received a good score, but there were also cases where the score was poor due to the presence of large quantities of waste, discharge pipes, or degraded built area which contributed to lower value for the area (Fig. 3). Reduced natural space and low values for the biotic component led to a decrease of the shoreline development index, some locations getting a poor rating.

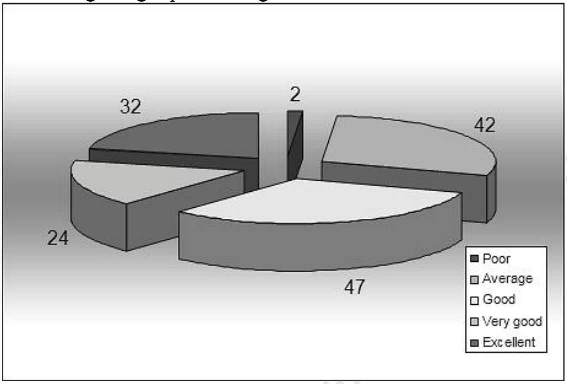

Figure 3 – Distribution of scores for Siutghiol Lake Shoreline Development Index

Aquatic component recorded a relatively uniform value, most locations presented submerged and floating vegetation, which is a plus in terms of aquatic positive score. However, in stations from Palazu functional zone, presence of wastes and floating debris lower the value given to this component.

As for the shoreline component, Mamaia, Campus and Scoica Land functional zones received very low scores (Fig. 4). Concrete banks along the entire resort and the absence of other positive variables forced us to give score zero. The campus is another location where shoreline component value is low, especially at nautical base, where a large portion of the shore is made of concrete.

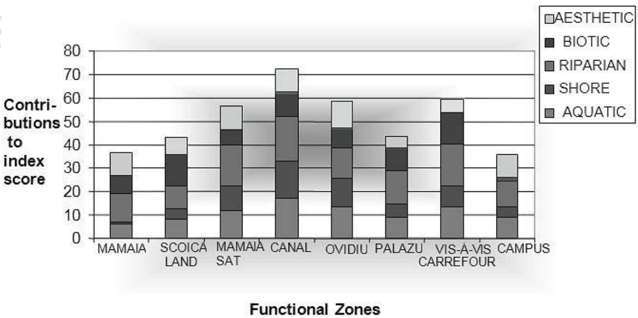

Figure 4- Shoreline Development Index components – contribution to scores

Despite the high human impact on the lake, however riparian component received a high enough score in most locations. Existing green space, trees and shrubs represent positive variables encountered in most functional areas established. Areas where riparian component received the highest score are Canal and vis-a-vis Carrefour. On a large portion of Canal zone the riparian component is represented by reed and other associated species, and the rest of the locations have grass and trees.

In Carrefour area the riparian component is represented mainly by vacant land, which is mostly covered by vegetation, shrubs and trees. The area which received a lower rating for this component is Scoica Land, where, because of the strong anthropogenic influence the natural landscape has suffered over the construction.

Biotic component refers to existing vegetation and a healthy and well cared for natural environment. Carrefour and Scoica Land areas, despite the strong human intervention, showed a good representation of biotic component (amphibians, birds), as well as areas with abundant vegetation (Canal area).

Aesthetic component received high scores in most stations due to the existence of aesthetically pleasing buildings. There have been rare stations where abandoned wharves and untidy or damaged buildings were encountered, leading to lower scoring, as happened in the Palazu area.

For Mamaia area most stations were rated average, and there were recorded also areas where shoreline development score indicates a poor condition. This was mainly due to the presence of negative variables (concrete, floating debris, waste) at the expense of positive ones. As shown in Fig. no. 5, the water quality data correlates with the poor conditions in this functional zone. Nutrient data showed larger amounts in the shoreline area and water quality increases inside the lake.

As we move north and northwest of the lake, starting with Scoica Land area, the number of stations for which grades are fair decreases and the number for which grades are good and very good increase - the Mamaia Sat and Ovidiu areas.

In Canal area - Galesu channel - the most stations were rated excellent, human intervention being minimal, without built or concrete surfaces. Vegetation is abundant, and there were encountered areas where floating reed islands have formed. In these stations the rich vegetation form the shoreline and aquatic components correlated to increased number of fauna individuals. This area represents a good example and has the potential to be used as a model for rehabilitation of riparian, shoreline and aquatic zones of Siutghiol Lake.

Palazu area recorded low scores. Although in this functional area the shore was kept in natural conditions, some stations have received poor rating due to wastes in large quantities, and floating debris. Here the water quality analysis showed high amounts of nitrates, which probably comes from the agricultural land found in this functional zone (Fig. 5).

A number of 32 stations received an excellent rating, the score increasing due to the natural environment unaffected or little affected by anthropic intervention, but also due to elevated values of biotic component. Out of the 147 monitored stations 38% received good and excellent rating while other 30% received fair and poor ratings.

The most affected functional zone was Mamaia, as shown both by applying the shoreline development index and water quality assessment. This image is strengthened especially in the summer season, when the higher amount of population (tourists) increases the pressure on Siutghiol Lake system.

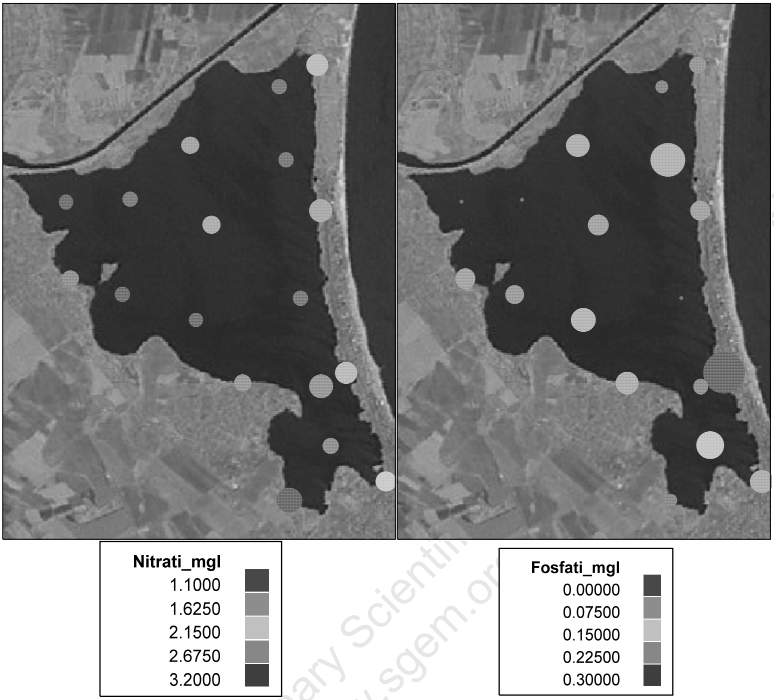

Figure 5 - Levels of nitrates (left) and orthophosphates (right) in Lake Siutghiol

CONCLUSIONS

By their existence, and especially by the diversity of forms that have been taken in their process of development, coastal lakes have an important role both in landscape and in regional economic activity, so there is a need to solve gaps created by the impact of human activity on the environment.

This paper presents a fast method that has been created to assess the development of the shoreline of a lake located in an urban area in which human activity affects the functionality of the various zones of the lake shore. The effect of human activities on the shoreline of Lake Siutghiol is felt increasingly more, which impacts the aquatic area as well. The index used in this work requires a methodology that rapidly assesses the components that provide environmental integrity of the shore and offers a vision of spatial relationships as part of identifying and monitoring sustainable development opportunities.

This index may serve as a method of monitoring of impacts, as well as for the identification of development opportunities that ensure a better functioning of the lake system. For effective conservation, regulatory programs should consider the cumulative effects of development and land use on aquatic systems[5].

REFERENCES

[1] Bucur, M., Vasile D., Jensen J., Shaker S.R., Tofan L. Prezentarea unor aspecte de monitoring al lacului Siutghiol utilizând tehnologia GIS, Analele Univ. Ovidius Seria Biologie-Ecologie, vol. 15, pp 73-76, 2011;

[2] Daily, G.C. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington D.C., 1997

[3] Flather, C., Holthausen, R., Iverson, G., Samson, F., Spies, T. Ecological sustainability - http://www.fs.fed.us/r1/projects/wildlife-ecology/national_ecological_sustainability_whitepaper.pdf – retrieved February 3rd, 2012.

[4] Rapport, D.J., Regier, H.A., Hutchinson, T.C. Ecosystem behaviour under stress, American Naturalist, pp 617-640, 1985;

[5] Jennings, M. J., Emmons E. E., Hatzenbeler, G.R., Edwards, C., Bozek, M. A. Is littoral habitat affected by residential development and land use in watersheds of Wisconsin lakes? Lake and Reservoir Management, pp. 272-279, 2003;

[6] Rowan, J.S., Carwardine, J., Duck R.W., Bragg, O.M., Black, A.R., Cutler, M.E.J., Soutar, I. Boon P.J. Development of a technique for Lake habitat survey (LHS) with applications for the European Union Water Framework Directive. Aquatic Conservation-Marine and Freshwater Ecosystems, pp. 637-657, 2006;

[7] Jackson, M.W. & Provo Ut. Development of Shoreline Degradation Index (SDI): monitoring environmental change using landscape ecology metrics and high resolution remotely sensed imagery. Geoscience and Remote Sensing Symposium, IEEE International, 2002, pp 2844-2846;

[8] Butler, R. G. & de Maynadier P. G. The significance of littoral and shoreline habitat integrity to the conservation of lacustrine damselflies (Odonata), Journal of Insect Conservation, pp 23-36, 2008;

[9] Tofan, L., Ehlinger T. J., Helt-Baldwin, M., Cerjak, D., Vasile D., Shaker R., Bucur M., Buiculescu A.M. Formulation of a shoreline development index to examine the relationship between development and ecological integrity. Volum cu lucrările Conferinței de la Constanța, Ed. EX PONTO, Romania, pp 144-153, 2008.

[10]Artiola, J.F., Pepper, I.L., Brusseau, M. Environmental Monitoring and Characterization, Elsevier Academic Press, 410 pp, 2004.

[11]Gâştescu P. Lacurile din România. Limnologie regională, Editura Academiei Române, Bucureşti, Romania, 1971;

ASSESSMENT OF ENVIRONMENTAL RISKS DURING THE CONSTRUCTION PROCESS

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ABSTRACT

The construction process can be seen as a tool to achieve the particular goal – a final construction. The part of this process presents the eventual negative impact of construction process on the individual components of environment. The submitted paper is focused on the monitoring of environmental risks and analysis of risks perception in the real environment of construction process. There has been created a questionnaire to obtain the knowledge for this analysis. Questionnaire survey was attended by respondents (constructors and building site managers). Subsequently, the questionnaire was processed and evaluated.

The aim of this research is to assess the impact of various types of construction to environment and monitoring of environmental risks during the construction process and the impact of environmental management quality system (ISO 14 001) to construction process. Next part of research is focused on monitoring of the most common measures to reduce of the negative environmental risks.

Keywords: construction process, construction industry, monitoring, environmental risks, questionnaire

INTRODUCTION

The increasing environmental impact from the construction becomes a serious problem that can cause significant damage, not only to ecosystems but also to the health and wellbeing of field workers and nearby residents [1] of construction sites. Therefore, is necessary to approach and continuous effort within the industry in order to achieve the objectives sustainable construction and reducing of the environmental impacts of construction in each life cycle phase (construction project, realization, occupation, management and demolition) of structures.

The realization of construction is not environmental friendly activity. A recent study shows that construction is the third larges industry sector in terms of environmental pollution [1]. Nowadays, new innovative environmental friendlier construction materials, technologies and machineries are used in the construction industry. On the other hand, we are still witnesses of the negative impact of construction process to the environment. In the present, we perceive the various types of negative impact to environment. It is depended on the type of structures, type of construction works, type of used construction materials and technologies. The construction process can be defined as a transformation of the inputs (construction sources – materials, machineries, working force) into the outputs (construction or its part).

The aim of submitted paper is to identify, monitor and assess the environmental impact of construction process through the questionnaire survey. Environmental risk identification and monitoring presents the process of identifying the existence of environmental risk and specifying its properties, is to identify all kinds of dangerous factors and major hazard installations in the construction and manufacture of project [2].

ENVIRONMENTAL RISKS IDENTIFICATION AND MONITORING OF CONSTRUCTION PROCESS

The identification of construction process impact to the environment was processed by the questionnaire survey. This survey monitors the environmental risks perceptions of construction by the participants of construction process.

The environmental risks were divided into five categories:

- air pollution,
- water pollution,
- soil pollution,
- noise pollution and vibration,
- construction waste.

These five categories of pollution present main environmental risks of construction for the environment. There were defined the basic measures used to protect, reduce or elimination of negative impact of construction to environment in each field of environment.

Questionnaire survey

The questionnaire was prepared in an electronic and printed form and divided into 5 parts:

1st part – "information about company" – there are identified the basic information about construction company, for example number of employees, year of establishment. This information provides a basic characteristic of company.

2nd part – "information about construction" – there are identified the basic information about construction, such as are the kind of construction, construction technology, characteristic of construction, processing of building organization plan (BOP).

Note: Considering the Slovak law, there is necessary to process the plan of construction organization – technical report and draw of construction site, its facilities and interactions.

3rd part – "environmental risks of construction process" – there are described and scored the environmental risks. There are assessed the particular negative impact by the questionnaire respondents. These possible negative impacts are occurred in the construction site by the construction process

4th part – "measures" – there are described and scored the measures used to protect, reduce or elimination of negative impact of construction on environment.

5th part – "environmental management system" – there are questions about the environmental management system (EMS) (STN EN ISO 14001). This part of questionnaire is focused on monitoring of EMS, its application and its impact in construction companies.

The questionnaire includes open, closed and semi-open types of questions. The questions were scored on the scale 1 – 5 points, where score "1" presents the least impact and score "5" presents the most impact.

The research sample was comprised go 22 respondents – 22 employees of 17 construction companies in Slovak republic . The respondents were persons who manage or coordinate the realization of construction process (building site managers) at the 22 particular constructions of different types.

Assessment of questionnaire survey

The questionnaire is focused to determination of perception the negative impact of construction on the environment by the site managers, which are identified in the 3rd part of questionnaire. Considering the answers of respondents, it is created on order of importance impact of construction (table 1). The most important impact of construction on environment in building site presents the production of construction waste. It was assessed by 3,3 score. On the other hand, the least important impact according the site manager perception presents the water pollution (surface water and groundwater).

Table 1: Impact perception of construction on the environment

The impact of construction on the environment	*Score*	*Rank*
Construction and demolition waste	3,3	1
Noise pollution	2,9	2
Air pollution (dust and emissions)	2,8	3
Excessive vibration	2,5	4
Soil pollution	2,2	5
Water pollution	1,7	6

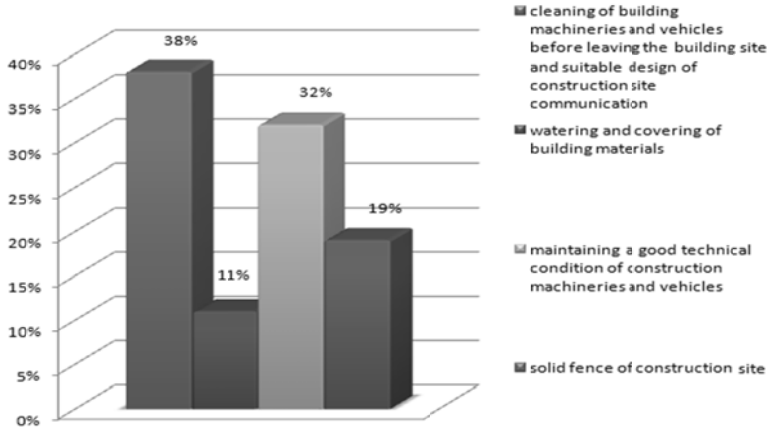
The next part of questionnaire survey and its results describe the suitable measures used to reduce and elimination of negative impact of construction on environment. The analysed measures are divided according the fields of impact on the environment.

Air pollution

The most risk factor of potential air pollution which is created by the dust emission presents the earthworks on building site (2,41p). The most air pollution by the gaseous emissions presents a creation of gaseous air pollutants for construction vehicles and machineries (2,91p). This impact is affected by the constantly increasing volume of transported building material. The least impact on air pollution presents a production of mortar and concrete mixtures on building site (1,78p).

The respondents of questionnaire have to suggest the measure to eliminate of air pollution. The most important measure in the real environment of site (figure 1) presents the suitable design of construction site communication and cleaning of building machineries and vehicles before leaving the site (38%). This measure is the most effective and cheap solution for the elimination of construction impact on the air pollution.

Figure 1: Measures to reduction of impact on air pollution

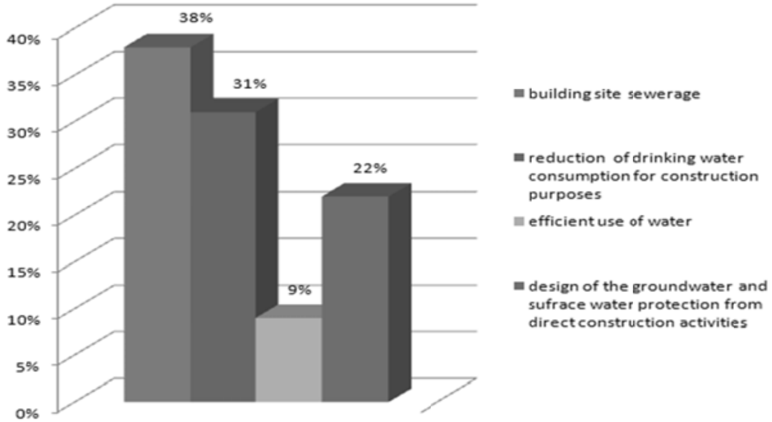


Water pollution

Many of construction machineries and vehicles are used during the construction process. Their function depends on the use of oil, what is closely connected with the oil leak into the ground water and surface water. This process presents the most impact of construction to water pollution (2,55p).

The measures for the water protection in construction site (figure 2) are design already during the design of the construction project. The 38% of respondents considered the building site sewerage as a main and the most effective measure and 31% of respondents determined the reduction of drinking water consumption for construction purposes. This reduction is proposed in building organization plan.

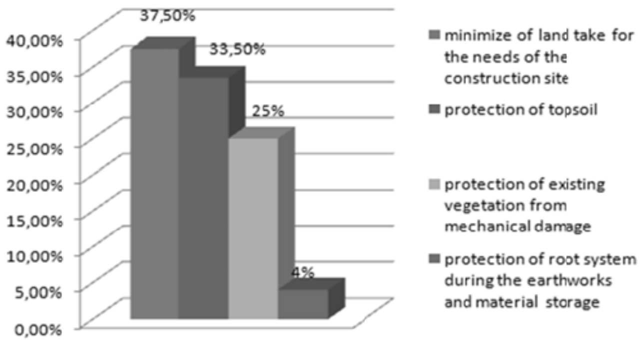
Figure 2: Measures to reduction of impact on water pollution



Soil pollution

The most impact of construction on the soil degradation and pollution was marked by respondents the creation of illegal landfill of construction waste (2,36 p). On the other hand, the most effective measure is considered the minimize of land take for the needs of the construction site (37,5 %) and the protection of topsoil (33,5 %). These measures are not expensive. The constructors are able to re-use the topsoil in the landscape on the particular construction.

Figure 3: Measures to reduction of impact on soil pollution

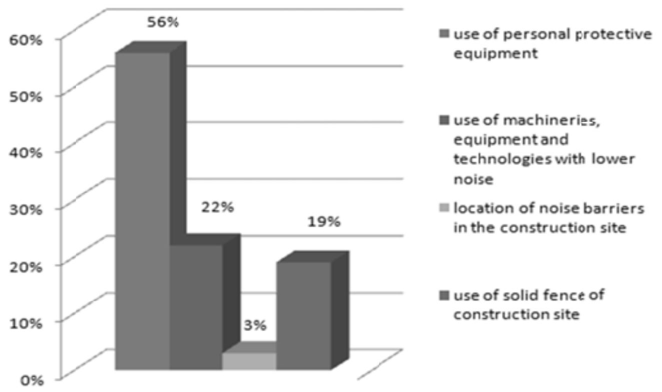


Noise and vibration

The respondents in the survey have to express the greatest sources of noise and vibration that occur in the site during the construction process. They determine the use of construction machineries and vehicles as a largest source of noise – particular machineries for earth and demolition works, pile driving suits, vehicles used to transport of building materials, construction equipments (compressors, circulars, etc…) and hand tools (hammers, drills, etc….). The largest source of vibration presents the pile driving suits, heavy construction machineries, vehicles used to transport of building materials, striking hammers for demolition works, vibrators and vibrator plates.

The most used and most effective measure for reduce the impact of noise was identified by respondents the using of personal protective equipment (56%). This measure is useful also for the reduction of vibration impact to workers. Other measures are mentioned on figure 4.

Figure 4: Measures to reduction of impact on noise

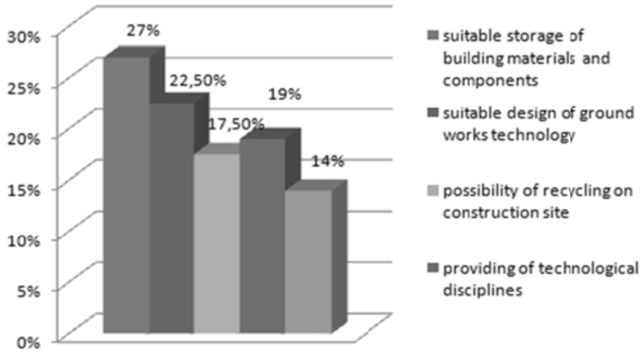


Construction and demolition waste

According the results of survey, the greatest impact on waste generation presents the demolition works, demolition of construction (building, roads, utility lines, etc….) or its parts (3 p). On the other hand, only 50% construction companies recover the construction and demolition waste by the recycling, when the recycling is environmentally friendly way of waste disposal and represents the financial benefits for the constructors.

As the most widely used measure to minimize construction and demolition waste was indicated the proper and suitable storage of building materials and components (27 %). The next measure was identified as a suitable design of ground works technology where is produced the minimum volume of excavated earth (22,5 %) (figure 5).

Figure 5: Measures to reduction of construction and demolition waste

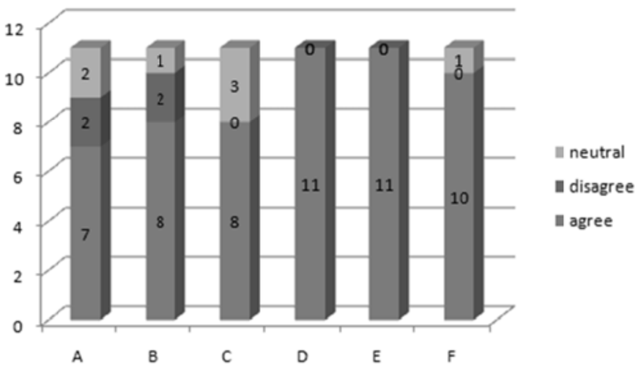


The importance of the environmental management system within the environmental risks minimization

The last part of questionnaire survey was focused on the environmental management system which is defined by the standard SNT EN ISO 14001. This system has been applied in 65% construction companies, particularly large and medium constructors. The picture 6 provides the survey of perceptions of respondents, the advantages and disadvantages of environmental management system use by construction companies.

Figure 6: Perceived benefits of the environmental management system application by construction companies

(A – energy saving, B – lower costs for disposal of construction waste, C – minimizing fees and fines for environmental pollution, D – increase of the work ethic in the organization, E – improve of the company image, F – good public relations)



CONCLUSION

The construction process presents the comprehensive activities created by the construction phase, realization phase, occupation phase and demolition phase. The particular construction process is dependent on the sources of construction (material, machineries and working force). Nowadays, the significant aspects of the construction process are the price and duration of construction. On the other hand, the issue of environmental protection, impact of construction process on environment and its perception are important in terms of sustainable construction. The submitted paper monitored and identified risks and impact of construction on environment and described the perception of this issue by the constructors at the building sites in Slovakia. This research was created by processing questionnaire survey.

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REFERENCES

[1] Li X., Zhu Y. & Zhang Z. An LCA-based environmental impact assessment model for construction processes, Building and Environment, vol. 45, pp 766 – 775, 2009

[2] Zheng L., Zhao B. Wang H. & Liu H. Environmental risk identification of port construction project, vol. 10, pp 2783 – 2787, 2011

[3] Krajči J. Protection of environment in construction industry, Slovakia, pp 217, 1998

[4] Klímek V. & Kostelničák P. Construction industry and environmental protection, Slovakia, pp 272, 1991

[5] Kozlovská M. & Hyben I. Site manager – manger of construction process, Slovakia, pp 161 – 165, 2005

[6] Sičáková A. & Terpáková E. Influence of chemical aggressive environment on the mechanical properties of high performance concretes, Czech republic , pp 250 – 256, 2008

[7] Terpáková E. Zhodnocovanie odpadov a stavebná činnosť, Slovakia, pp 199 – 204, 2002

[8] STN EN ISO 14001

[9] www.pqm.sk

ASSESSMENT OF EXPOSURE TO FLOUR DUST AND EFFECTIVENESS MEASURES DURING MANUAL PRODUCTION OF BAKERY PRODUCTS

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ABSTRACT

Many studies have shown that flour dust exposure causes respiratory symptoms and is associated with impairment of lung function. The respiratory effects of exposure to flour dust are influenced by the dose and duration of exposure, and these differ from one work environment to another. The aim of this paper is to assess exposure of a solid aerosol (flour), which is produced during manual production of bread in a small group of exposed workers. The assessment was done before and after measures to determine their effect.

Keywords: dust, measures, exposure

INTRODUCTION

In general, dust control in the baking industry is variable, particularly in the small bakeries. Exposure to flour dust occurs across a range of food industries and in this paper there is assessed exposure to flour dust during manual production of bakery products. [3] Flour dust is a plant solid aerosol with mostly irritant effects. It is an asthmagen and is known to cause sensitization, allergic rhinitis and asthma. In May 2006, a maximum acceptable exposure limit (NPEL) for flour dust was set at 4 $mg.m^{-3}$ (8 hour time-weighted average, TWA). [2]

METHOD

During sampling were used two personal sampling, in one case stationary sampling was used. Personal samples were collected in the workers' breathing zone using IOM sampling heads with glass fiber depth filters (GF/A, liquid nominal pore size of 1.0 μm). The flow rate was calibrated to 2 $l.min^{-1}$.

Assessment of the measurement was realized using gravimetric analysis. The filters were weighed twice in a laboratory before and after sampling were undertaken and the personal dust exposure calculated – TWA. Time-weighted average is a regulatory value defining the concentration of dust to which a person is exposed in ambient air in the working environment, averaged over a period, usually 8 hours. [1]

$$TWA = \frac{\sum c_i t_i}{\sum_{i=1}^{n} t_i} = \frac{c_1 t_1 + c_2 t_2 + \ldots.. + c_n t_n}{t_1 + t_2 + \ldots.. + t_n} \quad (1)$$

c_i – concentration [$mg.m^{-3}$], t_i – exposure time [min]. [1]

The same procedure was done before and after applying measures. In the tab. 1 there are performed the results obtained before applying the measures. Sample P1 and P2 are workers who are exposed to flour dust during manual production of bakery products. Sample S1 is stationary and it is situated approximately 2 m from the workbench in the height about 1 m above the floor.

Tab. 1 Inhalable dust exposure for workers before measures

S	**Stationary sampling**	**Measured value**	**Assessed value**
		$mg.m^{-3}$	$mg.m^{-3}$
1	Workbench	1,34	0,84
P	**Personal sampling**	**Measured value**	**Assessed value**
		$mg.m^{-3}$	$mg.m^{-3}$
1	Baker	21,15	13,22
2	Baker	11,83	7,39

Fig. 1 shows working place (workbench) where bakers make manually bakery products. The workbench on the photo is without measures. Workers use respirators during workday.

Fig. 1 Workbench before applying the measures

In the tab. 2 there are performed the results obtained after applying the corrective measures. The assessed values are lower than values during first measurement (measurement without measures).

Tab. 2 Inhalable dust exposure for workers after measures

S	Stationary sampling	Measured value	Assessed value
		$mg.m^{-3}$	$mg.m^{-3}$
1	Workbench	0,58	0,36
P	**Personal sampling**	**Measured value**	**Assessed value**
		$mg.m^{-3}$	$mg.m^{-3}$
1	Baker	7,06	4,41
2	Baker	4,45	2,78

Fig. 2 shows working place with installed corrective measure. It is solved by exhaust device along the work table.

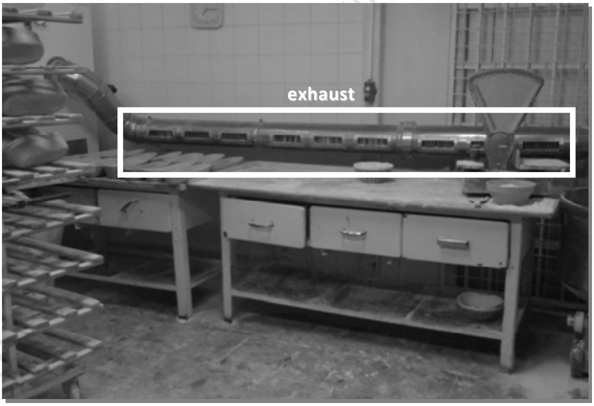

Fig. 2 Workbench after applying the measures

RESULTS

One stationary measurement and two personal measurements were performed in small bakery before and after application of corrective measures. The results of measurement before applying measures exceeded the exposure limits (NPEL). The results of stationary (S1) and one personal (P2) measurement after applying corrective measures don`t exceed the exposure limits. The result of one personal measurement (P1) exceeds the limit only slightly.

The exposure concentration decreased significantly. The corrective measures are effective. They will have a positive impact on employees in the long term.

ACKNOWLEDGEMENTS

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REFERENCES

[1] EN 689: Workplace atmospheres. Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy.

[2] Government regulation Slovak republic amending the Slovak Republic Government Order no. 355/2006 of protection workers from risks related to exposure to chemical agents at work.

[3] Jeffrey P, Griffin P, Gibson M et al.: Small bakeries a cross-sectional study of respiratory symptoms, sensitization and dust exposure. Occup Med. 49. pp. 237 – 41, 1999.

ASSESSMENT OF NATURAL RADIOACTIVITY LEVEL IN ROCKS OF DITRĂU ALKALINE MASSIF AREA , EASTERN CARPATHIANS, ROMANIA

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ABSTRACT

The natural radionuclides which occur in typical rocks of Ditrău Alkaline Massif area (Eastern Carpathians, Romania) are ^{238}U, ^{232}Th and their decay progeny, and the primordial radionuclide ^{40}K. The specific activity were measured in laboratory, using gamma-ray spectrometry with high purity germanium detector(HPGe). The activity concentrations of the uranium decay series (^{238}U) were determined using gamma-ray emissions of ^{214}Pb at 352 keV and 295 keV, ^{214}Bi at 609 keV and 1120 keV, ^{226}Ra at186 keV. In the ^{232}Th-series were used the emissions of ^{228}Ac at 338.4 keV and 911.2 keV , ^{212}Bi at 727 keV and ^{208}Tl at 860 keV. ^{40}K activity concentration was determined directly from its emission at 1460 KeV γ-line. Concentration of ^{232}Th ranged from 1.2–407.0 ppm, of ^{238}U from 0.2 – 376.0 ppm and of ^{40}K from 0.1 – 10,9 %. The Massif of Ditrău consist of a large variety of rocks (hornblendites, diorites, syenites, nepheline syenites monzonite, monzodiorites, aplite, granodiorites). Thorium and uranium are constituents of the accessory minerals zircon, monazite, sphen, allanite, apatite, xenotime, rutile. Radionuclide K-40 is present in alkali-feldspathic syenites. The alkaline massif of Ditrău, unique in Romania by size and petrographical variety, is emplaced with-in metamorphic basement rocks at the interior of the East Carpathians. The massif is an intermediate size massif (about 200 Km^2) and exhibits an eccentric ring structure in which the more basic rocks tend to lie to the west, with an arcuate zone of syenitic rocks, extending from the far north to the south-east, and a large area dominated by nepheline syenites on the eastern side.

Keywords: natural radioactivity, gamma-ray spectrometry, potassium, thorium, uranium

INTRODUCTION

This paper present the results of natural radioactivities measured for the rocks sample of Ditrău Alkaline Massif (DAM) using laboratory gamma ray spectrometry with HPGe. While many naturally occurring elements have radioactive isotopes, only potassium, and the uranium and thorium decay series, have radioisotopes that produce gamma ray of sufficient energy and intensity to be measured by gamma ray spectrometry, because they are relatively abundant in the natural environment.[6]

Uranium decay series (^{238}U), thorium decay series (^{232}Th) and potassium ^{40}K were analyzed in the main petrographic types present in the massive Ditrău area hornblendites, diorites, syenites, nepheline syenites monzonite, monzodiorites, aplite, lamprophyres, granitoides. Natural radioactivity in Ditrău massive is given by the naturally-occurring radioactive elements in the mineral's composition. The degree of radioactivity is dependent on the concentration and isotope present in the mineral. The DAM is the *locus typicus* of several radioactive minerals from Romania. Uranium, thorium are concentration in zircon, monazite, sphen, allanite, apatite, xenotime, rutile and potassium is present in alkali-feldspathic syenites.

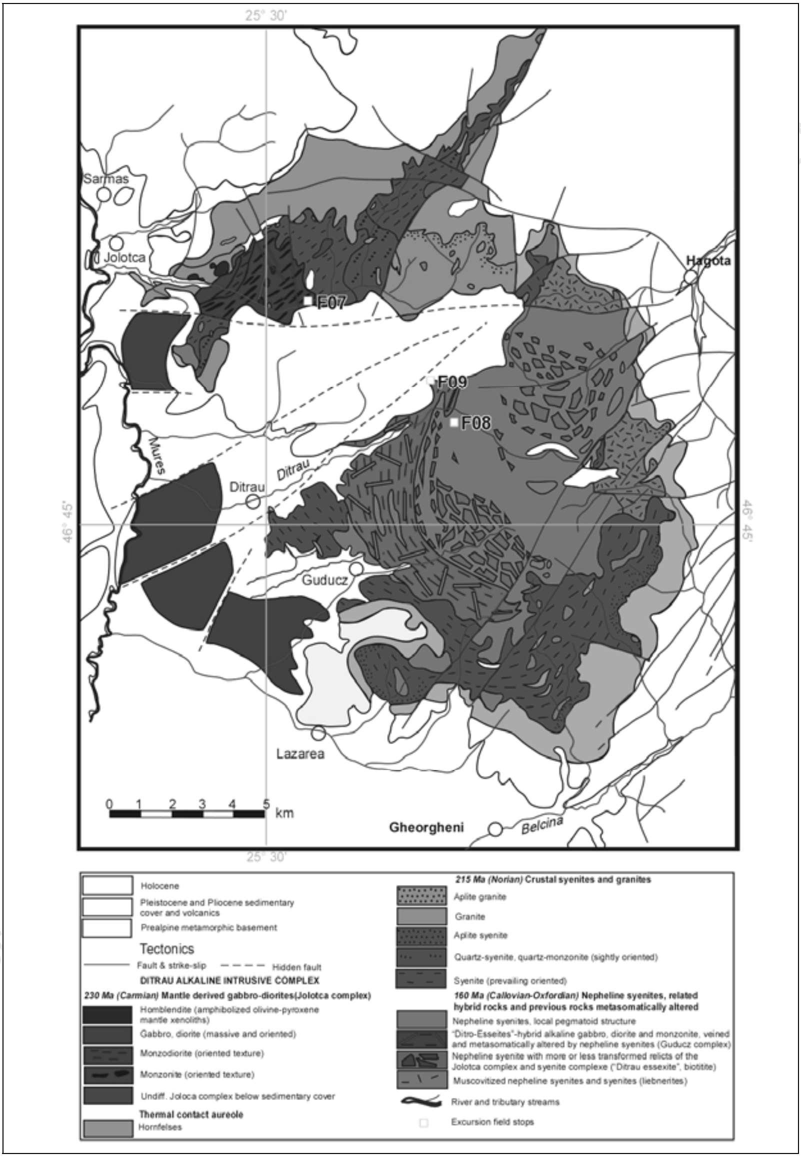


Figure 1. Geological map of the Ditrău Alkaline Intrusive complex (Kräutner&Bindea,1998)

GEOLOGY AND PETROLOGY OF THE STUDY AREA

The Ditrău Alkaline Massif (DAM) is considered to represent an intrusion body with a internal zonal structure, witch was emplaced into pre-Alpine metamorphic rocks of the Bucovinian nappe complex close the Neogene – Quaternary volcanic arc of the Calimani-Guurghiu- Harghita Mountain chain [8], [9]. (Figure.1.) The massif lies at the inert border of Mesozoic crystalline zone, within the Tulghes Group (Tulghes Terrane according to Balintoni et al., 2009). [3] The alkaline massif of Ditrău has an intrusive character and its trend of enrootment has been by petrologic and geophysical arguments, too. It constitutes a multistage magmatic intrusion in a high level of the Earth's crust [1],[2] Parts of the DAM are uncorformably overlain by andesitic piroclastics with some interbedded basalt-andesite lava flows from the Neogene Harghita – Calimani and by Pliocene to Pleistocene lignite-bearing lacustrine deposits of the Jolotca basin. [12] The center of the Ditrău massif was formed by nepheline syenite, witch is surrounded by syenite and monazite. North–western and north–eastern marginal sectors are composed of hornblende gabbro/hornblendite, alkali diorite, monzodiorite, monzosyenites and alkali granite. Small discrete ultramafic bodies (kaersutite-bearing peridotite, olivine, pyroxenite and hornblendite) and alkali gabbros occur in the Jolotca area. The later are also known from drill-cores in the Ditrău area.[10] Hornblende gaabro/hornblendite and diorite represent the earliest intrusive phase, and are embedded within younger syenite and granite. [10] All this rocks are cut by late-stage dykes with a large variety of composition including tinguaite, phonolite, nepheline syenite, microsyenite, and aplite. [1],[2]

EXPERIMENTAL

The rock samples were collected between 1983-1986 years using natural openings created by hydrographic network and roads that cross massif. Rock samples were collected throughout the massif area from all type of representative rocks. Were also analyzed rock samples taken from areas with radiometric anomalies (after gamma aero-spectrometric map). Mineralization and highly mineralized rocks samples were not analyzed. Because ^{238}U, ^{232}Th and ^{40}K are long life isotopes, rock samples have been reanalyzed using new techniques of analysis. The samples were measured in year 2009. Rock samples are crushed to a grain size 1 mm, and placed into sample containers. The containers is usually plastic and is sealed so that no radon can escape. All rock samples were kept in air-tight containers (Marinelli beakers-500 ml), daughter products for about 40 days to ensure that the radionuclides ^{227}Ra and ^{228}Th attained radioactive equilibrium with their daughter products. [6]

The samples were analyzed non-destructively using gamma-ray spectrometry with high purity germanium (HPGe) detector. The detector has a relative efficiency of 27%, resolution of 1.90 keV and peak/Compton ratio of 56:1 at 1.33 MeV and it is coupled to conventional electronics connected to a multichannel analyzer card (MCA- DSPEC jr.2.0-ORTEC) installed in a PC computer. An advanced Multi-Channel Analyzer emulation software (MAESTRO-32) allows data acquisition, storage, display and online analysis of the acquired γ-spectra.[7] The detector was shielded from the background radiation using a 10 cm thick lead, which was internally lined with a 2 mm copper foil. The system was calibrated for energy using radioactive standards of known energies such as ^{152}Eu, ^{137}Cs and ^{60}Co. For the efficiency calibration, a multi-element standards containing radionuclides with known activities in 500 ml Marinelli beaker was used (IAEA – RGU-1, RGTh-1, RGK-1). The standard has the same size and geometry as the sample under study. Each sample was counted for 86,000s. The background correction was accounted for by measuring a distilled water sample spectrum in the same geometry, and was subtracted from each spectrum. Each measured γ-ray spectrum has been analyzed offline by a dedicated software program (Gamma Vision-32), which performs a simultaneous fit to all the significant photopeaks appearing in the spectrum. Menu-driven reports are available for summaries including centroid channel, energy, net area count, background counts, intensity and width of identified and unidentified peaks in spectrum, as well as peak and average activity in $BqKg^{-1}$. The accuracy and precision of the results depends on many factors: the size and energy resolution of the detector; the mass and geometry of the sample; the shielding of laboratory background; counting time; data processing procedures; and the quality of the radioactive standards. The result of reported natural radionuclides concentration obtained for measured samples and average concentration for samples of typical rocks are summarized in table 1.

Uranium is a reactive metal with an average abundance of about 3 ppm in the Earth's crust. Uranium appears in the valence state U^{4+} in igneous rocks with crystallochemical properties close to Th^{4+} and the Light Rare Earth Elements (LREE), which explains the coherent geochemistry of U, Th and (LREE) in igneous rocks. [4] This coherence is lost in supergene conditions, where uranium is partially or totally oxidized to U^{6+}, which forms soluble complexes with anions: CO_3^{2-}, SO_4^{2-} and PO^{3-}. [11] Generally uranium occurs in igneous, sedimentary and metamorphic rocks. The accessory minerals zircon, monazite apatite, allanite and sphene are common in igneous and metamorphic rocks, of which zircon and monazite are the most resistant to weathering. As U becomes mobile under supergene conditions, a large variety of U^{6+} minerals many form. Thorium is an actinide element with a valence state of Th^{4+} in solution with evidence for lower valence states in solid state. It forms with anion phosphate insoluble precipitates. The can be dissolved in acid solutions and the general abundance of Th in the Earth's crust is low, typically in the range of ppb to ppm with the average of about 12 *ppm.* [5] Th is an constituent of the accessory minerals zircon, monazite, allanite and xenotime. Th is the parent of a decay series of which the highest energetic gamma ray (2.62 MeV) are emitted by the daughter isotope ^{208}Tl. In general, about 60 years is required to establish radioactive equilibrim in the Th series, and gamma ray activity is thus a good measure of Th concentration. Potassium is a volatile lithophile element an is monovalent under natural condition. Potassium occurs as alkali feldspar and micas in felsic rocks. The feldspar mineral series, the feldspathoids leucit and nepheline, and the micas biotite and muscovite, together contain virtually all the potassium in metamorphic and magmatic rocks.[6]

RESULTS AND DISCUTION

The radioelement concentrations show an increase in average radioelement concentration with an increase of SiO_2. Is a typical example of uranium and thorium in magmatic processes. Comparing the content data obtained for alkaline massif Ditrău observed enrichment in thorium for all types of rocks.

Granitoides occurring in the north-east of the massif have the highest thorium content than other types of rocks. Thorium is the average of two times higher than average level permitted for granitic rocks while uranium content within the range of known for

character granitic rocks. Geochemical point of view is characteristic of radioactive elements (uranium and thorium) accumulation at the end of magmatic differentiation process. [13] This accumulation is more evident in rocks rich in potassium and sodium saturated volatile compounds. From those mentioned, the empirical law of uranium concentration in magmas rich in potassium and thorium in sodium-rich magmas, explains the enrichment of thorium in rocks from massif Ditrău.
After data content presented (figure.2), we see that nepheline syenites, the richest in potassium have the highest content of uranium, while hornblendites with the minimum concentration potassium also have the lowest uranium content.
Another aspect of the geochemistry of radioactive elements is the variation in content, sometimes very high in all types of rocks. Hornblendites and diorites from Jolotca area have lower average uranium and thorium contents than that determined in Ghiduţ area in the same types of rocks.

- Hornblendites: Jolotca - 1.7 ppm U, 10 ppm Th; Ghiduţ - 4.1 ppm U, 21.5 ppm Th.
- Diorites: Jolotca - 2.1 ppm U, 14.5 ppm Th; Ghiduţ - 5.8 ppm U, 25.7 ppm Th.

Concentrations of radioactive elements in samples collected from the anomalies are higher than those of representative rock types (figure 3 - content for samples collected after radiometric anomaly zone -gamma aero-spectrometric map) [6] In 2 and 3 figures are plotted average uranium, thorium and potassium content from table 1.
Analyzing the data (figurs 2 and 3) show that uranium and thorium values present large variations limits. For uranium largest variations posed sienites, nepheline sienites and lamprophyres and for thorium diorites, aplites and lamprophires. This unevenness in the distribution of radioactive elements proves that both uranium and thorium how are concentrated mainly in accessory minerals (minerals zircon, monazite, sphen, allanite, apatite, xenotime, rutile).
Irregular distribution of these minerals directly influences the oscillation range of values of uranium and thorium. Although accessory minerals occur in small quantities in rock mass should consider that they have content thousands of times higher compared with the main rock-forming minerals.
Correlation analysis U-K, Th-K and U-Th shows that some aspects can be summarized as: positive correlation U-K and Th-K for philonian rocks (aplite and lamprophyre); positive correlation for U-K and Th- K values for diorites, syenitdiorites and hornblendites; negative correlation, low evidenced, between U-K and Th –K in granites rocks and marginal syenites; a positive correlation between concentration of uranium and thorium almost all types of rocks. These data indicate that potassium does not control accumulation of uranium and thorium in rocks.

CONCLUSIONS

Based on the content of radioactive elements can be expressed few conclusions:

- for all types of rocks the radioactive elements content increases from basic to acid rocks;
- content of radioactive elements in the massif area increases from west to east and from north to south;
- tinguaites and syenites rocks from the center of the massif have higher uranium content;
- marginal areas of the Massif Ditrău are enriched in thorium;

- uranium and thorium content values present large variations limits for the same types of rocks in the study area;
- uranium, thorium and potassium concentration for the same type of rock varies with spatial position of the samples;
- in all types of rocks potassium does not control accumulation of uranium and thorium in rocks.

Table 1. Concentrations of the natural radionuclides in typical rocks from Alkaline Massif of Ditrău.

Type of Rock **R** – *type of representative rock* **A** – *samples from radiometric anomaly zone*	Number of samples	Concentration U, Th (ppm) K (%)		
		^{238}U Range *Average*	*^{232}Th Range* *Average*	*^{40}K Range* *Average*
Hornblendite	R 37	0,2 – 4.7 2.2	1.2 – 21.8 12.8	0.1 – 2.1 1.4
Diorite	R 68	0.1 – 13.5 2.8	5.3 – 39.0 16.8	1.1 – 4.8 2.1
	A 9	1.5 – 13.3 4.8	11.0 – 56.6 26.7	1.2 – 4.9 3.8
Syenite	R 119	0.3 - 15.9 4.3	2.4 – 77.5 19.2	0.2 – 8.7 4.6
	A 146	1 – 165 10.1	1.2 – 390.0 62.2	0.6 – 10.9 3.7
Nephelin syenite	R 112	0.5 – 36.9 6.2	1.9 – 39.7 17.4	0.4 – 6.7 4.4
	A 82	1.0 – 376.0 26.5	3.0 – 407.0 31.1	1.7 – 7.2 4.5
Monzonite	R 13	0 – 12.0 3.5	4.5 – 71.3 21.6	1.8 – 6.16 3.9
Granitoide	R 59	0.8 – 28.1 4.9	9.4 - 70.7 33.3	1.5 – 6.9 4.5
	A 31	1.0 – 10.0 5.3	5.0 – 84.0 33.0	2.0 – 7.7 3.3
Aplite	R 112	0.1 – 15.6 4.3	3.7 – 116.1 31.9	0.3 – 7.3 3.3
	A26	1.0 – 49.0 5.8	5.0 – 174.0 110	1.7 – 7.8 3.9
Tinguaite	R12	3.5 – 27.1 13.7	13.5 – 78.1 35.1	1.3 -6.5 3.6
	A20	1.0 -58.6 23.8	24.5 – 89.4 44.3	3.2 – 5.6 4.3
Lamprophyre	R 12	0.4 – 4.4 2.4	2.0 – 37.4 11.6	0.2 – 4.7 1.9
	A 5	1.5 – 13.0 5.0	10.8 -65.0 35.0	0.2 – 8.1 3.2
Corneene	R 23	1.4 – 9.9 3.2	2.6 – 33.1 17.6	0.4 – 4.9 3.2
	A14	1.5 – 13.0 5.0	13.0 -278.0 65.6	0.2 – 8.1 3.2
Crystalline shale	R 25	1.4 – 9.9 3.8	7.6 – 28.8 18.2	1.0 – 6.5 3.9
	A 26	1.0 – 24.0 4.2	1.2 – 129.0 31.3	0.2 – 5.6 2.8

Figure 2. *Thorium, uranium and potassium element concentration in samples of the characteristic rock typs present in DAM*

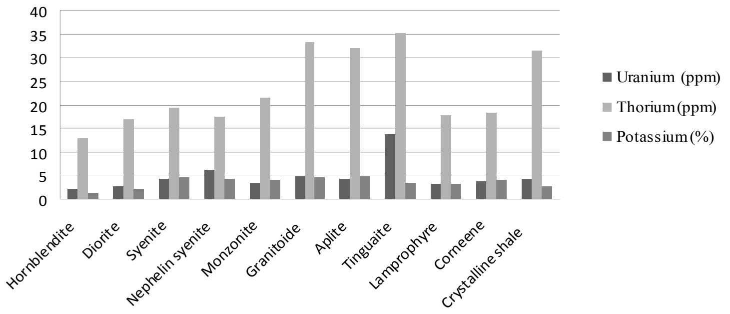
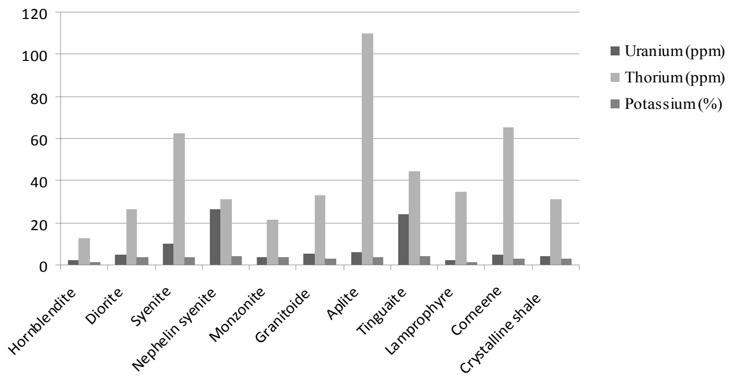


Figure 3. *Thorium, uranium and potassium elemental concentration in samples of the characteristic rock typs from radiometric anomaly zone present in DAM*



REFERENCES

[1] Atanasiu, N. & Constantinescu, E. Structure and petrogenesis of the alkaline massif of Ditrău, Unpublished geological report, IPEG "Harghita", Miercurea Ciuc Archives (in Romanian), 1979;

[2] Atanasiu, N., Garbaşevschi, N., Jakab, G & Vlad, S. Mesozoic rift related magmatism / metallogeny at Ditrău. In Borcos, M. & Vlad, S. (eds.). Plate tectonics and metallogeny in the East Charpatians and Apuseni Mts.,. Field trip guide, IGCP Project No. 356 Bucharest, Geological Institute of Romania , pp 14 – 16, 1994;

[3] Balintoni, I., Balica, C., Ducea, M.N., Fikun Chen, Hann H.P.& Şablovschi, V. Late Cambrian-Early Ordovician Gondwanan terranes in the Romanian Charpatianas: A zircon U-Pb provenance study, Gondwana Research, pp 119 – 133, 2009;

[4] Bea, F., Uranium. In Enciclopediya of Geochemistry, Marshal, C.P and Fairbridge, R.W. (editors), Kluwer Academic Publishers, London, pp 712; 1999;

[5] Dickson, B.L. & Scott, K.M. Interpretation of aerial gamma ray surveys-adding the geochemical factors. AGSO Journal of Australian Geology & Geophysics, v. 17, n.2, pp187-200; 1997;

[6] Ghon, E., IsvoranuI, I., Scurtu, S., Heredea, N. Gamma aero-spectrometric research in Masiff Ditrau area and adjacent formations. Unpublished geological report, Geological Instititut of Romania Archives, Romania, 1974;

[6] IAEA- TECDOC-1363.Guidelines for radioelement mapping using gamma ray spectrometry data, Vienna. International Atomic Energy Agency, pp. 45 – 51, pp 115 – 122,2003,

[7] Ion, A. & Anastase, S. Natural radioactivity in soil samples from the area between Bistrita and Trotus valleys", Geology- Proceedings of the International Symposium – Geology of natural Systems – GeoIasi, Geologie Series, Al. I. Cuza University, pp. 60 – 64; 2010;

[8] Kräutner, H.G. & Bindea, G. The Ditrău alkaline intrusive complex and its geological environment. In Guidebook to excursion E, (3rd Symposium on Mineralogy, Bucharest, Romanian Journal of Mineralogy,vol. 77, suppl.3, 1995, pp 18;

[9] Kräutner, H.G. & Bindea, G. Timing of the Ditrău Alkaline Intrusive Complex (Eastern Charpatians, Romana). Slovak Geological Magazine, vol. 4, pp 213 – 221, 1998,

[10] Morogan, V., Upton, B.G.J. &Fitton , J.G. The petrology of the Ditrău alkaline complex, Eastern Carpathians, Mineralogy and Petrology, vol. 69, pp 227 – 275, 2000;

[11] Langmuir, D. & Hermans, J.S. The mobility of thorium in natural waters at low temperatures. Geochemica et Cosmochimica Acta, vol. 28, pp 1753 – 1766,1980;

[12] Radulescu, D. Considerations on the origin of magmas of the Neozoic subsequent volcanism in the East Charpatians, Geological Institute of Romania Anuar, vol. 41, pp 67 – 76,1973;

[13] Tiepa, I., Romanescu, O.& Stoian, M., Synthesis of geochemical data for radioactive elements and rare earth elements in Ditrău Massif. Unpublished geological report, Geological Instititut of Romania Archives, Romania, pp 6 – 15, 1986;

ASSESSMENT OF SOCIALLY SIGNIFICANT CONSTRUCTION IN LOCAL METROPOLIS VIA EIA PROCESS

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ABSTRACT

The institutions with high social and environmentally educational significance include inter alia gardens, parks, botanical gardens, greenhouses and zoos. In order for these institutions to be able to fulfil social functions, they are placed in areas with high concentrations of population, which are typically regional centres, town. This contribution assesses the potential effects of operation of a modernized exposure and entrance area on the environment and public health. Using a complex multi-criteria evaluation the authors conclude on the admissibility of such an investment and a its social necessity and also define the limits of operation of this plan with regard to environmental protection.

Keywords: impact assessment, EIA process, public health, public institutions

INTRODUCTION

The EIA process is globally aimed at promoting the participation of the public (both expert and general) in the process of preparation and discussion of important buildings, which may decisively influence the environmental conditions in local, regional and national or international scale.

In the Czech Republic the EIA process was legislatively founded soon after the fall of the totalitarian regime – by the Act no. 244/1992 Coll. This act was after about 10-year experience replaced by the Act no. 100/2001 Coll. [5], which is upon minor amendments valid to the date and is in compliance with the environmental law of the European Union. The current wording of the Act contains an attachment that precisely defines the objectives and their scope, when it is necessary to complete the EIA process. Structure of the EIA process has several steps, which may or may not take place in each project under consideration, which depends on the expected potential impacts on the environment and public health.

Evaluation of expected impacts is often based on specialized studies that will then become an integral part of the main EIA document - Notice or Documentation. These studies are usually the following:

- Impacts on Natura 2000 system (European system for protecting biota)
- Biological evaluation

- Noise study
- Dispersion study
- Impacts on Public Health
- Impacts on landscape character
- Alternatively others (such as shadow effect of wind turbines, etc.) [1],[2],[4]

Based on the input information and reaction of the public then the competent authority decides on the final standpoint to the projects discussed in terms of their environmental admissibility.

PURPOSE AND DESCRIPTION OF THE PROJECT

An example of the project that requires the EIA process are also the entertainment centres, shopping and cultural complexes such as car parks with a capacity of over 100 cars, which usually constitute their essential part. All these characteristics are fulfilled by the project, which was assessed for the second largest city in the Czech Republic - Brno. It was an important cultural and educational institution with a large community-wide function for families with children and students. The zoological garden in Brno was founded in the first half of the last century far behind urban buildings for permanent residential housing, near the dam – i.e. in the region with the then prevalent recreational function. Access to this area was secured by tram transport and only occasionally it considered access by passenger cars.

During operation of the zoo, the conditions in the surrounding building development and social conditions associated with the methods used for private transport changed considerably. There are already residential and shopping areas, the zoo does not have the necessary infrastructure to transport visitors and the entrance area is still of the same character as a few decades ago. The intention of modernizing the Zoo entrance area therefore pursues a comprehensive solution of all the accumulated problems that restrict the use of the area and increase the attractiveness and comfort for visitors.

The essence and the individual elements of the project, which is represented by the implementation of a new entrance area to the Zoo Brno in the total area of 42,100 square meters are the following:

- The main building with entrance hall, marine aquarium lounge, restaurant, office part, workshops and technical background facilities
- Entrance building with background facilities for visitors
- Outdoor store building with a transformer station
- Roads and parking lots
- Green areas

The parking lot capacity is designed for 300 parking spaces for passenger cars and 8 parking spaces for buses, the restaurant capacity is designed for 150 meals / day. The paved areas include also pedestrian flyover connection of the entrance area through the pass-through access road to Zoo, the project will also incorporate surface adjustments and landscaping, planting and greening of areas. [3]

Expected benefits of the project:

- Use of current brownfield site and its revitalization
- Providing capacity opportunities for access, entrance and parking of the visitors at the level and standard reflecting the importance of the ZOO as an institution in the city of Brno and the importance of Brno amongst other Czech cities
- Providing opportunities for the construction of exposure of aquatic animals in a place that corresponds to the spatial needs for marine and freshwater exposure and which is equipped with the necessary background facilities in terms of water resources and connections to sewer system

POTENTIAL INFLUENCE ON THE ENVIRONMENT AND PUBLIC HEALTH AND DISCUSSION

The proposed solution of the investment project "ZOO Entrance" is conceptually designed as a construction of new buildings of entrance to the Brno ZOO, facility for aquatic organisms exposure and the complementation and construction of technical and transport infrastructure. It will also ensure the surface finish of the field and orchard planting of valuable trees and shrubs.

The individual buildings will be constructed using modern building materials and using construction technologies that conform to current requirements for insulation, durability and environmental hygiene in the buildings. Energy demands will be addressed by means of condensing natural gas boilers with high efficiency. The distribution of objects on the area in question makes use of the natural terrain configuration, whereas the objects will perform the function of the noise barrier. Buildings will be equipped with green roofs, so as to make them blen with the surrounding greenery when viewed from above lying areas. Building technologies will be designed in accordance with the requirements of technical standards for components that will ensure reliable operation in the area of water management and appropriate internal climatic conditions for visitors, employees and animals kept.

Transport infrastructure will consist of car park, which is laid out so s to minimize the traffic impacts on the surrounding permanently inhabited area.

Tab. 1: Evaluated potential impacts of the project on the environment and public health

Potential impact on:	Part of the project
Air (atmosphere)	Transport activity
	Parking lot
	Power engineering
Water	Municipal wastewater of the visitors
	Waste water from the aquarium technology
	Runoff water from car park

Wastes	Waste packaging
	Municipal waste
	Waste from catering
Noise and vibration	Traffic noise
	Noise level from visitor activity
Impacts on Public Health	Exposure to physical harmful substances (noise)
	Exposure to chemical pollutants (air)

On the basis of expert supporting data, which included a number of specialized studies a comprehensive analysis has been carried out of the expected impact of the project on various environmental components and their summary multicriteria evaluation. Based on that the plan was marked as acceptable and measures were formulated for each stage of its life cycle:

- Period of preparation
- Period of realization (construction)
- Period of operation
- Period of termination

The expert and general public had the biggest concerns during the discussion of the impact of the project on air quality. Therefore, this area was given special attention.

EXPECTED POTENTIAL IMPACTS OF THE PROJECT ON THE ENVIRONMENT IN THE AREA OF AIR PROTECTION

To clarify the expected impact of the intent of realization of the entrance area of Brno Zoo a detailed dispersion study was prepared, which was complemented several times. The expected effects of the project are listed in Table. 2, which assesses the individual reference points located in the closest and potentially the most vulnerable surroundings of the project. The range of the evaluated pollutants corresponds to the spectrum of chemical substances released into the atmosphere due to traffic. The assumption of traffic rate is more than 1000 passenger vehicles / day, equivalent to approximately one parking space used by three vehicles per day.

Tab. 2: Expected effects of the project on air quality in the form of air pollution contributions

Referents points	**NO_2**		**PM_{10}**		**Benzene**	**B(a)P**
	annual average	hourly maximum	annual average	daily maximum	annual average	annual average

	$\mu g.m^{-3}$	$\mu g.m^{-3}$	$\mu g.m^{-3}$	$\mu g.m^{-3}$	$\mu g.m^{-3}$	$ng.m^{-3}$
RP1	0,019	6,85	0,014	1,71	0,0016	0,011
RP2	0,024	6,89	0,018	1,72	0,0021	0,013
RP3	0,024	7,22	0,018	1,75	0,0020	0,013
RP4	0,034	6,90	0,026	1,65	0,0029	0,019
RP5	0,024	6,54	0,018	1,58	0,0020	0,013
RP6	0,019	6,15	0,015	1,49	0,0016	0,011
RP7	0,023	6,11	0,019	1,48	0,0020	0,013
RP8	0,028	6,09	0,024	1,45	0,0024	0,016
RP9	0,025	5,85	0,023	1,46	0,0022	0,015
RP10	0,039	6,25	0,036	1,49	0,0034	0,023
RP11	0,044	6,84	0,040	1,52	0,0037	0,024
RP12	0,042	6,82	0,039	1,52	0,0036	0,024
RP13	0,033	6,79	0,031	1,51	0,0027	0,017

Explanatory notes: RP ..... reference points (emission contributions of the monitored pollutants

CONCLUSION

The effects of all the assessed projects are evaluated comprehensively by operation of law with the fact that according to their specifics the areas of greatest risk are usually identified, characteristic for a particular purpose. In the case of New Entrance to Brno ZOO it was especially the issue of the impact of its operations on the air quality in the most immediate vicinity.

Emission contributions, which are listed in Table. 2, show a negligible impact of the project on air quality in the period of its maximum operation and in relation to possible damage to human health in the surrounding area as a result of inhalation of released pollutants the effect of the project represents only a theoretical risk that can not practically manifest. A similar methodology was used to evaluate also other environmental components and impacts on public health (see Table 1). The effects of the project on these components are however even smaller in comparison with a potential impact on air quality they were assessed as negligible. Therefore, the potential impact of the project on air was selected as a suitable example for the presentation of the methodology applied.

REFERENCES

[1] Bartusek S.: Ochrana životního prostředí (Environmental protection). VSB-Technical University of Ostrava, 2008, 1st edition, e-learning text, 162 pages;

[2] Adamec Vl., Bartusek S. et al.: Environmentální technologie a ekoinovace v České republice II. (Environmental technologies and eco-innovations in the Czech Republic II.) 135 pages, published by CENIA, Prague 2010. ISBN 978-80-85087-90-1.

[3] Postbiegl S.: Nový vstupní areál ZOO Brno (New Entrance Area to ZOO of Brno). EIA documentation for the project, AMEC Brno, 2010, 90 pages.

[4] Skácel A.: Hygiena a ekologie vody (Water Hygiene and Ecology). Textbook of the University of Ostrava, Published by: OU, 2005, 78 pages.

[5] CR Act no. 100/2001 Coll. On the assessment of environmental impacts, as amended by subsequent regulations and amendments.

ASSESSMENT OF SOIL COPPER, COBALT AND CHROMIUM CONTAMINATION IN OLD MINING AREAS FROM ROMANIA

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ABSTRACT

The aim of this study is to measure the levels of heavy metals (Cu, Co, Cr) in contaminated mining areas compared with those in reference clear areas, to determine their potential Contaminations Factors and Pollution Index and to predict the evolution in time by using mathematical models. Compared with the reference, in soil, higher values than intervention threshold values (ITV) were found for Cu and Cr. The results of this study regarding metal contents in mining contaminated soils, recommend a permanent monitoring of the mineral contents of the studied areas and suggest that the consumption of some plants cultivated in this areas are not free of risks.

Keywords: Heavy metals, contamination factors, pollution index, mathematical models

INTRODUCTION

Heavy metals are considered environmental pollutants due to their toxic effects on plants, animals and human being [18] and the contamination of soil results from anthropogenic such as mining, smelting procedures, agriculture as well as natural activities. Chemical and metallurgical industries are the most important sources of heavy metals in the environment [21].

Copper is found often near mines, industrial settings, landfills and waste disposals and when released into soil, it can become intensely attached to the organic material and other components (clay, sand, etc.), and can accumulate in plants and animals [2]. Copper is regarded as one of the most versatile of all agriculturally important microelements in its ability to interact with soil mineral and organic components. Copper can occur as ionic and complexed copper in soil solution, as an exchangeable cation or as a specifically absorbed ion, complexed in organic matter, occluded in oxides, and in minerals [12]. Soil copper levels correlate very poorly with plant accumulation and plant tissue levels. Copper is also an essential nutrient that is incorporated into a number of metalloenzymes involved in hemoglobin formation, carbohydrate metabolism, catecholamine biosynthesis, and cross-linking of collagen, elastin, and hair keratin [5, 22], being critically important for a large number of body functions. The ability of copper to cycle between an oxidized state, Cu (II), and reduced state, Cu (I), is used by cuproenzymes involved in redox reactions. However, copper is also potentially toxic because the transitions between Cu (II) and Cu (I) can result in the generation of superoxide radicals and hydroxyl radicals [22].

Cobalt is one of the world's essential elements having many industrial uses but it is also a vital central component of Vitamin B12. Co ranks 33 in abundance, and it is occurring naturally in the earth's crust, and therefore in soil. The earth's crust contains an average cobalt concentration of 20–25 $mgkg^{-1}$. However, elevated levels of cobalt in soil and water may result from anthropogenic activities such as the mining and processing of cobalt-bearing ores, the application of cobalt-containing sludge or phosphate fertilizers to soil, the disposal of cobalt-containing wastes, and atmospheric deposition from activities such as the burning of fossil fuels and smelting and refining of metals. Cobalt cannot be destroyed once it has entered the environment. It may react with other particles or adsorb on soil particles or water sediments. Soils that contain cobalt at <0.5–3 $mgkg^{-1}$ are considered deficient, since vegetation growing on such soils has insufficient cobalt (<0.08–0.1 $mgkg^{-1}$) to meet the dietary requirements of ruminants. Generally, concentrations of up to 800 $mgkg^{-1}$ have been reported in soils near ore deposits, phosphate rocks, ore smelting facilities, and soils contaminated by airport traffic, highway traffic, or other industrial pollution [24]. Soils near mining and melting facilities may contain very high amounts of cobalt, so that the uptake by animals through eating plants can cause health effects. Cobalt will accumulate in plants and in the bodies of animals that eat these plants, but cobalt is not known to bio magnify up the food chain. In the environment cobalt is not often freely available [1], but when the particles are not bound to soil or sediment fragments the uptake by plants and animals is higher and accumulation in plants and animals may appear [29].

Chromium occurs universally in nature (< 0.1 μg/m3 in air) [38]. It appears in bound forms that constitute 0.1–0.3 $mgkg^{-1}$ of the earth's crust [11]. Cr preferentially concentrates in various rocks throughout the earth's crust with concentrations dependent on the rock's origin and source. Chromium concentrations are also quite variable in secondary geochemical environments, particularly in soils, sediments, streams and lake water [26]. It enters the air, water and soil in the chromium (III) and chromium (VI) forms through natural processes and human activities [30]. Worldwide chromium concentrations in soils average about 200$mgkg^{-1}$. The health hazards associated with exposure to chromium are reliant on its oxidation state. The hexavalent form is toxic. Plants regularly absorb only chromium (III). This may be the essential kind of chromium, but when concentrations go above a certain value, negative effects can still occur [30]. Due to its involvement in the synthesis of fatty acids and cholesterols, metabolism of carbohydrates, proteins, lipids and with role to assist the action of insulin, chromium is a trace mineral necessary for human health [7, 14]. Chromium exists in soils mainly in the +3 and +6 oxidation states. The intermediate states of +4 and +5 are metastable and rarely meet up [27].

MATERIAL AND METHODS

The main goal of the present research was to assess the Cu, Co and Cr distribution in some Romanian areas, known as old mining cores. The study is including two areas from Banat Region, Rusca Montana and Moldova Noua (Caras-Severin County). The studied areas are metalogenetical areas: Rusca Montana (Pb, Cu, Zn, Mo) and Moldova Noua (Cu) [8], known as old mining areas; one reference area Golet (Caras-Severin County), known for ecological agricultural practices, and, for comparing the pollution level of the old mining areas we have included also an area well known for its chemical industrial background: Tarnaveni (Mures County). Tarnaveni, situated on the Tarnava Mica River, is well known as a industrial center were past activities have included producing of Hg, Au, Bi, barium salts, copper sulphate, sodium and potassium dichromate, sulphuric acid [21].

Samples collection and preparation

Soils were randomly collected at a distance of 2 km from the source of contamination. Eight samples were collected at each location at the imaginary intersection of the diagonals. All soils were sampled at the surface (0 to 20 cm in depth) using hand driven stainless steel augers. Exact locations for all sampled sites were determined using a global positioning system. The typology of soil sampling was applied for all areas, exception being reference 1 (village, uncontaminated area) where the samples were randomly taken. The collected soil samples were dried out two days and sieved and the impurities removed. The surface soil samples were analyzed using the procedure recommended by SR ISO: 11047 [20].

Analytical determinations

Atomic Absorption Spectrometry analysis: After total burning, 0.5 N nitric acid solution was added up to 50 mL. The obtained solutions were used for total metal content determination by Flame Atomic Absorption Spectrometry (FAAS) in University Environmental Analysis Research Test Laboratory. The standard solutions (1000 mg/L) were analytical grade from Riedel de-Haen (Germany) The nitric acid 65% solution used was of ultra pure grade (Merck, Germany). All solutions were geared up using deionised water. Analyses of Cu, Co and Cr content were made with ContrAA-300, Analytik-Jena device, by FASS in air/acetylene flame [9]. The device working parameters (air, acetylene, optics and electronics) were adjusted for maximum absorption for Cu, Co and Cr. All analyses were made in triplicate and the mean values were reported.

Assessment of metal contamination

Assessment of metal and level of contamination in soils oblige preanthropogenic knowledge of metal concentrations to act as unspoiled values. In this manuscript, the degree of anthropogenic pollution was established using soil contamination factor and pollution index loadings, as follows:

Soil Contamination Factor: The level of contamination of soil by metal is expressed in terms of a contamination factor (CF) calculated as:

$$CF^{i} = \frac{C^{i}_{0-1}}{C^{i}_{n}} \qquad (1)$$

Where C^{i}_{0-1} is the mean content of metals from at least five sampling sites and C^{i}_{n} is the pre-industrial concentration of the individual metal [3]. As reference value for the pre-industrial concentration of the metal we have used the concentration of elements in the earth crust [17]. According to Mmolawa [13], contamination factor CF < 1 refers to low contamination; 1 ≤ CF < 3 means moderate contamination; 3 ≤ CF ≤ 6 indicates considerable contamination and CF > 6 indicates very high contamination.

Pollution Index of Soil loadings [PI_L]

For further assessment of the contamination levels of the metals in the studied regions it was calculated the pollution index of soil loadings (PI_L) developed by Thomilson [23].

$$PI_{L} = (CF_{1} + CF_{2} + ... + CF_{n})^{1/n} \qquad (2)$$

Where n is the number of metals studied (three in this study) and CF is the contamination factor calculated as described in Equation 1. The PI_L provides comparative means for assessing a site quality, where a value of $PI_L < 1$ no contamination with the studied metals; $PI_L = 1$, baseline levels of pollutants are present and $PI_L > 1$ indicates that, on an average, element concentrations are above the permissible level and it's a deterioration of site quality [23].

Statistical analysis

The data were statistically analyzed using PAST 2.14 [4].

Principal Components Analysis (PCA) is a mathematical model that permits to identify patterns in data by "expressing the data to highlight their similarities and differences" [4, 19].

Generalized linear models (GLMs) are a large class of statistical models for relating responses to linear combinations of predictor variables [10]. The model depends on the equation [16]: $y_i = \beta X_i + \varepsilon$ (3)

RESULTS AND DISCUSSIONS

Compared with the reference in soil higher values than intervention threshold values (ITV) were found for Cu in MN area and Cr in Ref2 area. Copper contents in root vegetables are higher in Moldova Noua area (exceeding ITV) [6]. The reference values are presented in table 1.

Tablel 1: Value concentration of elements in the earth crust [17] and Romanian guideline on the admitted concentrations of the heavy metals in soil [15].

Reference values / Metal	Cu	Co	Cr
Upper Continental Crust	28	17.3	92
Normal contents, for Romania	20	15	30
Alert threshold values for Romania	100	30	100
Intervention threshold Values for Romania	200	50	300

The mean heavy metal concentrations (in mgkg-1) of the eight soil samples for each of the studied areas were computed with equation 1, to obtain the contamination factors and with equation 2, to obtain the pollution index of soil loadings for each studied site. The obtained values are presented in table 2. The data show that Rusca Montana is having a moderate contamination with Cu, CF_{Cu}RM Area = 1.99 and Moldova Noua is presenting a very high contamination with Cu, CF_{Cu}MN Area = 7.69. Tarnaveni, the reference 2 area is presenting a moderate contamination with Cr, CF_{Cr}Ref2 = 1.12. The pollution index of soil loadings calculated for Moldova Noua, PI_LMN Area = 2.73 is showing a deterioration of site quality.

Table2. Contamination Factors reported to the Continental Crust values and areas pollution index

Area metals loadings	CF_{Cu}	CF_{Co}	CF_{Cr}	PI_L
RM Area	**1.99**	0.54	0.11	0.88
MN Area	**7.69**	0.43	0.08	**2.73**
Ref1 Area	0.93	0.37	0.08	0.46
Ref2 Area	0.53	0.24	**1.12**	0.63

Legend: **RM Area – Rusca Montana; MN Area – Moldova Noua; Ref 1 Area – Golet; Ref 2 Area – Tarnaveni; CF_{Cu} = soil contamination factor with Cu; CF_{Co} = soil contamination factor with Co; CF_{Cr} = soil contamination factor with Cr; PI_L = pollution index of soil loadings**

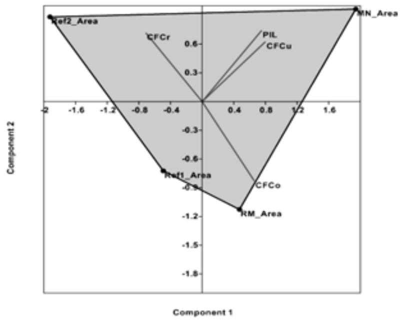
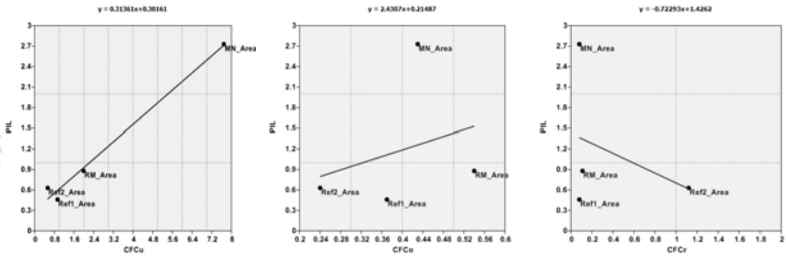


Figure 1. PCA Scatter representation of soil pollution

PCA (*Figure 1*) is bringing new information regarding the pollution of the studied soil samples. The correlation variance on PC1 is 66.10%, on PC2 29.26 % and PC3 4.64 % which is recommending PC1 as most significant axis to represent the eigenvalues. As shown in *Figure 1*, the highest contamination with Cu is in Moldova Noua samples, area that is presenting also the highest pollution index of Cu loadings. As we can observe the high value of PI_L is given by the CF_{Cu} the other 2 metals having less influence due to no contamination.

Applying the Generalized linear model to estimate and predict the contamination with Cu we have obtained the equation and graphical evolution presented in *Figure 2*. The applied model was computed using normal distribution, Identity as link function with estimated phi. If the CF_{Cu} value will increase PI_L will also increase based on the equation: $y = 0.31361 \cdot x + 0.30161$ (4)



Cu: $y = 0.31361 \cdot x + 0.30161$ **Co:** $y = 2.4307 \cdot x + 0.21487$ **Cr:** $y = -0.172293 \cdot x + 1.4262$

Figure2. Generalized linear model of contamination estimation for Cu, Co and Cr

CONCLUSIONS

The contamination factor showed that in Rusca Montana we have moderate contamination with Cu and in Moldova Noua high contamination. Golet the reference1 area is having no contamination while the reference 2, the industrial area Tarnaveni, is presenting moderate contamination with Cr. The Pollution index of soil loadings is announcing a dangerous situation only for Moldova Noua Area. Environmental Indices combined with mathematical model help predicting the development and evolution of heavy metals contamination. The results of this study regarding metal contents in mining contaminated soils indicate a permanent monitoring of the mineral contents of the studied areas and suggest that the consumption of some plants cultivated in this areas are not free of risks. The pollution levels in the studied mining areas require a broader approach to identify the contamination level for more metals, in order to predict a possible evolution of the soil and vegetation contamination.

REFERENCES

[1] Abraham J.L., Hunt A., Environmental contamination by cobalt in the vicinity of a cemented tungsten carbide tool grinding plant. Environmental Research, 69, pp 67–74, 1995;

[2] Agency for Toxic Substances and Disease Registry, Public Health Statement, Copper 3, Atlanta, Georgia, p:1-3, http://www.atsdr.cdc.gov/toxprofiles/tp132-c1.pdf;

[3] Dasaram B., Satyanarayanan M., Sudarshan V. and Keshav A.K., Assessment of Soil Contamination in Patancheru Industrial Area, Hyderabad, Andhra Pradesh, India, Research Journal of Environmental and Earth Sciences 3(3), pp 214-220, 2011;

[4] Hammer, O., Harper, D. A. T. and Ryan, P. D., Past: Paleontological statistics software package for education and data analysis, Palaeontologia Electronica, 4, pp 1-9, 2001;

[5] Haque I., Aduayi E. A. and Sibanda S., Copper in soils, plants, and ruminant animal nutrition with special reference to sub-Saharan Africa, J. of Plant Nutr., Vol. 16, Issue 11, pp 2149-2212, 1993, doi: 10.1080/01904169309364680;

[6] Harmanescu M., Alda L.M., Bordean D.M., Gogoasa I., and Gergen I., Heavy metals health risk assessment for population via consumption of vegetables grown in old mining area; a case study: Banat County, Romania, Chem Cent J. 5: 64, 2011, doi: 10.1186/1752-153X-5-64

[7] Hummel M., Standl E., Schnell O., Chromium in metabolic and cardiovascular disease, Horm Metab Res., 39 (10), pp 743-751, 2007;

[8] Ianos Gh., Sources And Concentrations Of Heavy Metals In South-West Romania, Metal Elements In Environment Medicine And Biology, Tome III, Publishing House "Eurobit" Timisoara, pp 225-230, 1998;

[9] ICPA,http://www.icpa.ro/Cod/Evaluarea_continutului_de_nutrienti_din_sol.pdf;

[10] Jackman S., Generalized Linear Models, Stanford University, http://jackman.stanford.edu/papers/glm.pdf;

[11] Jinhua Z., Wang M., Wusheng J. and Donghua L., Chromium Accumulation and its Effects on other Mineral Elements, in Amaranthus Viridis L., ACTA Biologica Cracoviensia, Series Botanica 48/1, pp 7–12, 2006;
[12] McBride M.B., Forms and distribution of copper in solid and solution phases of soil, In: Loneragan J.F., Robson A.D., Graham R.D., eds, Copper in Soils and Plants, New York: Academic Press, pp 25–45, 1981;
[13] Mmolawa K. B., Likuku A. S. and Gaboutloeloe G. K., Assessment of heavy metal pollution in soils along major roadside areas in Botswana, African Journal of Environmental Science and Technology Vol. 5(3), pp 186-196, March 2011, http://www.academicjournals.org/AJEST;
[14] Muhammad S., Haroon K., Murad A. K., Faridullah K., Saeed A. K. and Naveed M., Quantification of Various Metals and Cytotoxic Profile of Aerial Parts of Polygonatum Verticillatum, Pak. J. Bot., 42(6), pp 3995-4002, 2010;
[15] Order no.756/1997 of the Ministry of Waters, Forests and Environmental Protection;
[16] Puja S., Saini M., Empirical Studies to Predict Fault Proneness: A Review, Int.J. of Comp. Applicat. (0975 – 8887), Volume 22, No.8, pp 41-45, May 2011;
[17] Rudnick R. L. and Gao S., 3.01. Composition of the Continental Crust, Treatise On Geochemistry, Volume 3, Elsevier Ltd., pp 1–64, 2003,
[18] Sharma R.K, Agrawal M., Biological effects of heavy metals: an overview, J Environ Biol. Jun;26 (2 Suppl), pp 301-313, 2005;
[19] Smith L.I., A tutorial on Principal Components Analysis, 2002http://www.sccg.sk/~haladova/principal_components.pdf;
[20] SR ISO: 11047, Soil quality. Determination of Cd, Cr, Co, Cu, Mn, Ni and Zn, Spectrometric methods by flame atomic absorption and electro thermal vaporization;
[21] Suciu I., Cosma C., Todica M., Bolboaca S.D., and Jäntschi L., Analysis of Soil Heavy Metal Pollution and Pattern in Central Transylvania, Int. J. Mol. Sci. 9, pp 434-453, 2008;
[22] Tchounwou P.B., Newsome C., Williams J., and Glass K., Copper- induced cytotoxicity and transcriptional activation of stress genes in human liver carcinoma (HepG2) cells, Met Ions Biol Med. 10, pp 285–290. 2008,
[23] Thomilson D.C., Wilson D.J., Harris C.R., Jeffrey D.W., Problem in heavy metals in estuaries and the formation of pollution index, Helgol. Wiss. Meeresunlter, 33(1–4), pp 566–575, 1980;
[24] WHO, Geneva, Switzerland; Cobalt and inorganic cobalt compounds/prepared by James H. Kim, Herman J. Gibb, Paul D. Howe, Concise international chemical assessment document, 69, 2006;
[25] WHO, Geneva, Environmental Health Criteria 61, Chromium, 1988;
[26] William E.M. and Todd Engineers, 2, Chemistry, Geochemistry, and Geology of Chromium and Chromium Compounds, Chromium (VI) Handbook, pp 23-88, 2004,
[27] Zayed A.M., and Terry N., Chromium in the environment: factors affecting biological remediation, Plant and Soil, 249, pp 139–156, 2003;
[28] http://www.uraweb.org/reports/anrc9803.pdf;
[29] http://www.lenntech.com/periodic/elements/co.htm#ixzz1snBpGaPJ;
[30] http://www.lenntech.com/periodic/elements/cr.htm#ixzz1snD8hvLF;

ASSESSMENT QUALITY OF GROUND WATER AND SOIL IN THE AREAS AFFECTED BY OIL WORKING

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ABSTRACT

Underground water pollution with salted waters, gases or hydrocarbons produced as a consequence of oil drilling has unwanted effects on its quality, prejudicing its use as drinkable water and entirely affecting the living matter from aqueous layers. Due to soil pollution with crude oil, a pellicle forms at its surface reducing the diffusion capacity and suffocating the vegetation. Accidental discharging of formation waters directly on the soil results in the alteration of the soil chemical and physical structure, with negative effects especially on the development of organisms in the soil. The current paper presents a study on underground waters and soil pollution level with oil products, chlorides and heavy metals in areas where crude oil exploitation works are performed. Environmental pollution assessment caused by oil working off has an essential role in establishing pollution prevention measures and drawing-up adequate technologies for reducing the pollution level.

Keywords: underground water pollution, soil quality, oil exploitation.

INTRODUCTION

The development of oil industry, both of the extractive one and of the processing one, including the oil and oil products transport, is sometimes accompanied by the appearance of certain secondary, unpredictable phenomena having more or less damaging effects on the environment and on human life. One of these phenomena is the soil pollution with oil wastes with or without salty water, and also with other residual products resulted from the activities of exploiting and extracting crude oil, adding here the losses of the conducts transporting crude oil or oil products. In the extraction areas of crude oil, the phenomena of pollution with wastes and oil products, and also with used waters sometimes full of salts, are quite extended, and the impact on the ecosystems overtakes the intensity of other anthropic actions. In case of the soil that is a complex component of the environment where the component factors are in a balance accomplished and got to a certain degree in a longer lapse of time, if the pollution makes this poise go out of focus, it cannot recover in a short time unless we remove the cause [1].

The greatest weight of soil pollution sources is represented by wells and pipes and the polluting agents that affect soils quality are crude oil and formation waters, but soil pollution is also caused by solid and half solid waste consisting of: sand and clays deposits from tanks; deposits of crusts and corrosion products from wells, transport lines, heat exchangers; crude oil emulsions accumulated in treatment plants; slimes from waste waters treatment; active coal, waste molecular sieves from gas treatment plants; sand and ground contaminated with oil excavated from pipes breakage areas; detritus and drilling fluids. All these waste is stored in specially arranged catch pits where infiltration is possible along with soluble salts passing into the ground-water sheet. This pollution may be removed by building waterproof catch pits or slime cells. In oil working off activity, underground waters pollution occurs by failures of sealing or products discharging during intervention or on the pipe in case of breakage especially due to the corrosion process. The main polluting sources of surface and underground waters are: production wells and transport pipes, collection parks and treatments plants of crude oil and water, waste water injection stations, pipes and wells. Formation water separated from crude oil is injected as such or after having been filtered, either for technological purpose, either through discharge. The great frequency of faults is due to corrosion and relatively great pressures at which injection is made, which occurs due to the content of suspensions and emulsions from the injection water [2].

Besides major water pollution sources there are other sources as well like free eruptions, acidifying operations or stimulation. The soil pollution produced as a consequence of the direct or indirect discharge of crude oil and of salty water is influenced by a series of factors as we further present. The field slope and the relief influence the draining on small slope fields, and this is produced slowly on the fields with average and strong pitch, as the displacement speeds of the wastes are big. The rain system may also favour the surface spreading of the polluters or their deep penetration in the soil profile. Thus, if the fields are dry, the porosity is much higher and the polluters may penetrate at great depths, in a short time, and if the soil has low humidity, the clean water that infiltrates, washes the superficial soil layers and transports the wastes (hydrocarbons or salts) to the deep, supplying even the water table. The environmental temperature acts in interdependence with the precipitations system, and this influences, in the first place, the development of the oxidant microorganisms, as the heat favours the strong biodegradation of the oil products. During winter, the soil freezing leads to stopping the polluters from penetrating the soil, so to their surface sedimentation or depositing in the snow layer, if there is one [3].

The underground water is influenced by the pollution process and at its turn, it may influence this process. The underground water infested in all its mass, by capillarity phenomena, may penetrate the higher horizons. The phenomenon occurs in summer when the soil humidity decreases very much and there is an increase of the tensions on the capillaries walls. The pollution by capillary means is less intense, but it may manifest on large surfaces. The presence of oil in the soil determines a major change of its property, both physical-chemical and hydrological changes. The crust formed at surface and also the residual concentration, especially in the soils with average, fine and very fine texture, stop the circulation of current water in the soil and also the gas exchange soil-atmosphere. The plants suffer by having the roots asphyxiated in the soil and, as a consequence of decreasing the intensity of the oxydo-reduction processes, there is also a decrease of the metabolic activity of the bacteria. The organic carbon found in oil in big quantities changes the carbon/nitrogen report in the soil, by strongly influencing the microbiological activity and the nitrogen nutrition of the plants. The accumulation of the sodium chloride determines an increase of the osmotic pressure of the soil solutions, as the plants have no longer power to absorb the elements necessary for the development. Researching the way the physical and chemical processes succeeding the appearance of the polluters by one of the sources previously shown, evolve, is extremely important for establishing certain technologies preventing pollution, the choice of the agricultural recovery measures and keeping the productive potential [4].

CASE STUDY. EVALUATING THE POLLUTION LEVEL IN TICLENI AREA OF GORJ COUNTY AS A CONSEQUENCE OF THE EXPLOITING ACTIVITIES OF OIL

Ticleni oil structure is located in the south-west of Romania in the north of Oltenia, on the territory of Gorj County and has a surface of approximately 3000 ha. The main activities developed within section Ticleni consist in extracting crude oil and gases from pools, collecting and transporting them to the separation parks, phases separation (crude oil – formation water – gases), gases compression and delivery to third parties, crude oil treatment and storage in specially arranged places within the operation area, waste water resulting from the extraction process is injected in the underground through local injection stations. The main phases of the technological process are the following:

- extraction of gross crude oil (mixture of crude oil, formation water and related gases), through extraction wells;
- mixture transport to separating parks and/or collection points, through collection pipes;
- liquid phase separation (crude oil, formation water and impurities) from the gaseous phase in two-phase separators in separating parks;
- temporary storage of crude oil mixed with formation water resulted after gases separation, in the tanks existing in separating parks;
- waste formation water is collected and injected through injection wells.

In order to assess the impact of oil working off activities upon some areas from Gorj County that have a high risk of pollution, in collaboration with the Environmental Protection Gorj Agency, monitoring was developed through physical and chemical analyses of underground sheet quality markers and the soil taken from working off sites that belong to Ticleni oil structure. In studies on the pollution of underground waters in the neighbourhood of Ticleni section, the water samples were analyzed in the laboratory in order to determine pH, chlorines and oil products markers.

The results of the physical and chemical tests made on underground water samples taken from the drills located near the objectives within Ticleni section are described in table 1.

Table. 1. The test results for groundwater samples from the Ticleni section.

Name objective	Name sample	Sampling depth (m)	Indicators review		
			pH	Chlorides (mg/dm^3)	Petroleum products (mg/dm^3)
Big Park	AF (in the park)	20,00	6,59	83,53	< 0,05
Park 92	AF (in the park)	2,50	6,65	55,64	< 0,05
Park 440	AP (monitoring of trunk F10 with H_{end} = 5,5m)	2,00	6,40	34,80	< 0,05
Intervention threshold (IT)			6,5 ÷ 9,5	250	0
Alert threshold (AT 70 % of IT)				175	0

Results interpretation was made by comparing the measured values with the admitted limitations according to the relevant legislation. Results analysis reveals that the values are included in normal limitations without recording excesses of alert thresholds for any of the analyzed samples. Results comparison with the admitted limitations according to the relevant legislation may be described in figure 1.

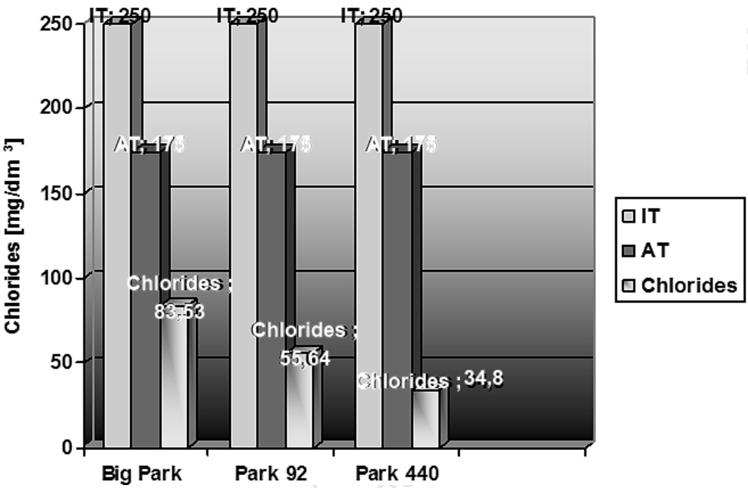

Fig.1. The concentration Cl^{-} ions from the Ticleni section.

Physical and chemical tests performed for the soil samples taken from Ticleni area generally indicate a moderately salinized soil as we can see from the results mentioned in table 2.

Table 2. Determinations for pH and chlorides indicators in the Ticleni (year 2010).

Area	Sampling point from	Depth profile (cm)	Indicator		
			pH (pH units)	Cloruri ($mgCl^{-}$/100g soil)	Comments
Ticleni	Section injection	0-10	6,2	110,05	Moderately saline soil
		10-20	6,6	99,4	Moderately saline soil
	Area Turbo A	0-10	6,1	78,1	Moderately saline soil
		10-20	6,4	63,9	Moderately saline soil
	Park No.14	0-10	6,3	71	Moderately saline soil

For evaluating the degree of soil pollution with oil products, we had soil samples from the studied field and the results of the determinations have been compared both to the alert or intervention limits and with the witness samples. The data obtained for the analyses of the soil samples from Ticleni area in 2010 are presented in table 3.

Table 3. The data obtained for the analyses of the soil samples from Ticleni area in 2010.

S1- Section injection; S2-Park 14; S3-Big Park ; SM- Soil test witness.

Indicator quality	Limits admitted	S1		S2		S3		ST
		Depth of sampling (cm)						
		0-10	10-20	0-10	10-20	0-10	10-20	0-10
Electrical conductivity (μS/cm)	<2000	910	863	512	292	2180	2660	188
Sodium (mg/kg soil)	200	96	95	33	39	102	140	2
Extractable hydrocarbons	1000	33000	37000	4400	81	5900	5700	140

The investigation consisted of visiting the area and identifying the pollution sources and the fields polluted by oil products (crude oil or oilfield water). We considered the history of the polluting events in the area, especially by following the polluted field surfaces where there were no pedo-agro-improving works. The polluted surfaces are generally placed on plane fields in areas with a great density of extraction sources, along the fascicle layouts of mixture from the wells to the separator parks, of transporting crude oils from the parks to the central deposit (Ticleni Big Park). Beside infesting the soil with crude oil, there is also the soil pollution with salty water, provoking the soil charge with soluble salts, sometimes in a very strong way, so this becomes practically unproductive. The soils are differently affected by pollution, both regarding the polluter nature and its intensity. Also, we should specify that, in the studied area, there were several modernizing programs of the installations of separation and collection, involving the restraint of the surfaces useful for the parks and, implicitly, the release of the fields to the natural circuit. By the determinations accomplished on the soil samples, we followed the evaluation of the contamination degree well fluids, in comparison both to the alert or intervention limits and to the witness samples. In case of the fields for which the impact on the soil is obvious, the application of the following measures is imposed: finding the pollution sources; reducing the polluter concentration under the intervention limit; applying measures for de-polluting the soil in that area; additional monitoring of the potential polluting sources.

The technologies of soil de-pollution generally consist of physical and chemical treatments on the soil profile in order to favour and accelerate the biodegradation processes of the oil products, as of the sedimentation ones of the excess salts, in case of oilfield water pollution. Serious assessment of oil working off locations is the basis for drawing up adequate techniques in order to reduce pollution risk of such activities. The assessment of the pollution level caused by oil working off has to be made in a planned order, every stage having the role of revealing the information that will be the basis for the following stage. In an investigation program of soil and waters, four stages are generally used: inventorying available resources, initial investigation of the location, detailed investigation of the location and remediation actions [5].

In choosing the best soil remediation technology, we have to consider the information previously collected during the investigation stages, regarding: the type of present polluting agents and their concentration; the amount of polluted soil that requires treatment; locating the area affected by the polluting agent; soil characteristics; destination of the future location and risk assessment.

The main advantage of insulation techniques and in situ remediation is that they require minimum soil dislocation and apply in crowded places undergoing excavation. In situ remediation disadvantages consist in the need for a further investigation of the location, monitoring and longer period of treatment. The main in situ techniques consist in:

- soil covering resulting in a minimum perturbation of the area, but polluting agents remain at the location;

- development of separating barriers – the pollution source is therefore separated from the receptor thus temporarily solving the problem, but this technique cannot be used for long term;

- in situ bioremediation – is a technique used in case of low volatility hydrocarbons being inadequate for heavy metals pollution, having a long duration of the process and being unsuitable for low permeability soils.

Among the ex situ remediation techniques, the most important are the following:

- ex situ bioremediation: in the case of this technique the soil can be used again, pollution is treated at the site and being applicable for the entire range of oil products. This technique is not adequate for heavy metals and has a great risk for waters contamination and requires a longer period for removing polluting agents.

- vitrification: is the transformation of soil mixed with polluting agent in a solid mass at the temperature of 2000^0C. All organic and inorganic products are destroyed. This technique has a high cost and soil has to be transported outside the area it was collected from.

- incineration: is the destroy of organic products at the temperature of $600\text{-}800^0$C and of remaining products at the temperature of $1100\text{-}1300^0$C. the advantages of this technique: organic polluting agents are destroyed, large amounts can be handled and it applies at the site or anywhere else. The main disadvantages: high cost, it does not remove heavy metals and does not treat emissions in the atmosphere.

- catalytic oxidation – which allows to achieve combustion at low temperatures ($200\text{-}300^0$C) in the presence of a catalyser of organic compounds. The advantages of such a procedure consist in the fact that it does not require additional treatment of emissions and has high removal efficiency.

- thermal desorption is a special process compared to the incineration process, because it does not aim to destroy polluting agents, but to physically separate them. The main advantage is that it allows to reduce volume, toxicity and mobility, but it also has a series of disadvantages like: a complicated technological flow, limited performances, impurities negatively affect the process.

CONCLUSIONS

The exploitation of the natural oilfields of hydrocarbons is a potentially polluting activity, and the environment capacity of suffering a perturbation is limited. The extractive oil industry is featured by the circulation of big fluid quantities such as crude oil, gases, oilfield water that become, after the existence of certain accidental losses (eruptions, conduct breaks, damages of the reservoirs etc.), polluting agents for the environmental factors. The complexity of the activities in the oil industry makes the polluting sources diversified, including the polluting sources resulted from human activities and the specific polluting sources. As the polluting sources specific to the oil industry are the most important, and their infesting effect has a negative long-lasting effect on the environmental factors, it is necessary to identify those polluting sources but also, at the same time, their action ways on ecosystems. For a knowledge as exact as possible of the environmental situation in the framework of the extraction scaffolds, it is necessary the accomplishment of certain studies that should present the impact determined by the productive exploiting activities, but also by the auxiliary ones on the respective structures.

Environmental pollution assessment caused by oil working off has an essential role in establishing pollution prevention measures and drawing-up adequate technologies for reducing the pollution level. In Gorj county, oil working off is one of the significant activities in the economy of the area and, at the same time, it has a significant effect upon environmental factors quality, mainly upon the soil and ground water sheet. Starting from the significance of environmental pollution prevention measures that should be the main principle in the management of activities from the oil field, the investigation of pollution sources and their effects reflected in the volume of monitored quality markers is the starting point in assessing the environmental impact. Studies performed on the current status of ground water sheet and soil in the area of operation objectives belong to Ticleni structure have revealed a series of major problems regarding environmental protection namely: potential pollution of soil and underground waters as a result of faults at collectors and mixture lines and due to the losses of oil products and formation water from extraction wells; the need to identify processing or treatment solutions for the slime or other waste loaded with oil products resulting from specific activities, taking into consideration that the existing waste dump has no storage capacity; the need to arrange and maintain pollution free mess halls by: checking, maintaining and improving plants and equipments, cleaning and maintaining wells cellars, cleaning and confining mess halls; significant soil pollution with oil products inside certain parks; exceeding the concentration of the reference sample at the chlorines marker for all the analyzed soil tests.

Consequently, it is essential to take into consideration and implement adequate measures for monitoring and controlling pollution in the affected area, efficient managing the waste generated by oil working off, periodically checking the technical status of operating plants and equipments, maximum decreasing the negative effects of oil activities upon environmental factors, within the context of sustainable development in this economic field.

REFERENCES

[1] Gavrilescu, E. - Sources of pollution and environmental pollutants, Sitech Publisher, Craiova, 2007.

[2] Ionescu, C., Ciuparu, D., Dumitraşcu, Gh. – Pollution and environmental protection in oil and petrochemical, Briliant Publisher, Bucharest, 1999.

[3] Moise, N. – Methodology for assessing the environmental pollution, ICPT Câmpina, 1996.

[4] Toti, M. – Determination of the degree of pollution of soil, groundwater and surface water due to oil and gas extraction industry in Romania, ICPA Bucharest, 1993.

[5] Răută, C., Cârstea, S. – Preventing and combating pollution of soil, CERES Publisher, Bucharest, 1982.

BIOLOGICAL TREATMENT OF MINE WATERS BY WATER HYACINTH

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ABSTRACT

Extraction and processing of mineral deposits is a traditional occupation in Romania for over 2000 years old. In ore deposits, the useful minerals can present as solid, liquid or gas; hence results a series of prospecting, exploration and exploitation methods.
After 1990, the Romanian State, due to losses in the mining sector had to provide substantial subsidies to this sector, which led to the launch of a comprehensive restructuring. Current trends in mining from Romania are the transformation to obtain the best results in economic terms, to avoid losses and to make profit. At present in coal sector operates six State-owned economic entities: National Society of Lignite Oltenia, National Coal Company Ploiesti, National Coal Company and Energy complexes Turceni, Rovinari and Craiova. Our study takes place at Plostina mine who is a member of the National Society of Lignite Oltenia from Romania and we started this study because the strategy of Romanian State is to reduce costs to mines which exploiting coal deposits. Use of water hyacinth for wastewater treatment is considered a simple technology that does not require expensive machinery and equipment, much work or complex maintenance processes, and efficiency is high. Water hyacinths are aquatically plants suitable for nutrient removal from water polluters, due to the rapid growth and that the float. These plants play an important role on Earth because they are able to hold miraculous 1,200 times more pollutants than can store wastewater. Another important role of water hyacinth is to generate a large amount of oxygen, oxygen is vital to the mining premises due to large amounts of dust generated by existing coal conveyor belts and car park. Therefore, water hyacinth culture is increasingly seen more as an alternative for water treatment methods.

Keywords: ore deposits, water hyacinth, pollutants, mine water

INTRODUCTION

Monitoring of water quality represents the activity of observations and standardized and continues long-term measurements for understanding and evaluating characteristic parameters of water management and to define the status and trends of evolution in quality and reflect the permanent status of water resources. One of the problems facing any mining is given by system disruption and surface water pollution.
Romania has a very complex geological structure, with numerous mineral deposits such as: ferrous metal ores; non-ferrous metal ores; mineral fuels and useful rocks.

Figure 1. Mines exploitation spread in Romania [1]

In I zone, namely the mining basin of Oltenia is about 90% of the total reserves of lignite in Romania, and includes the following mines: Motru, Jilţ, Rovinari, Berbeşti-Alunu, Husnicioara. The lignite production of Oltenia is mainly for thermal power stations Rovinari, Turceni, Craiova to produce electricity and heat.
Motru coal basin is located in Gorj county, located on the middle course of the Motru river and its tributaries as evident from figure 2:

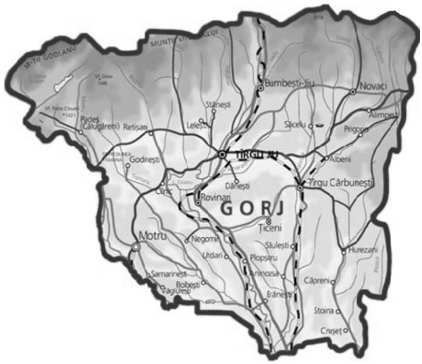

Figure 2 Gorj county map [9]

In 1966 it founded I.M Motru due to the elimination of Oltenia Mining Enterprise, over time some changes have occurred in the organization until 1997 when EMS Motru is founded with the following mines: Lupoaia, Rosia, Plostina, Horăşti, Boca, Leurda.
At the 2012 EMS Motru has the following structure with mines: Lupoaia and Plostina other mines are resign to conservation programs, closure and greening through their output production system.

Plostina exploitation area is located in the north-west of Oltenia, in the southwest of the Gorj county, within localities Ploştina, which belongs to the administrative territory of Motru, and Silveşti. The precinct is located on the right slope of the Cireşul brook, left tributary of the Ploştina brook. Because exhaustion of coal reserves located in the upper layers exploitation activity held in an average depth of 90 m, Plostina mine is a deep mine. [3]

Figure 3 Entry in coal mine (Riti, 2011)

After excavation, coal is transported from underground to the surface through a circuit of scraper conveyor belts or ribbon. Production transportation from underground is in continuous flow. Mine waters are routed through pipes to settling at the mine mouth, and subsequently led to Cireşului valley, which in the enclosure was adjusted as two guard channels.

Figure 4 Settler situated at entry of mine (Riti, 2011)

From there the waste water is discharged into the Ploştina valley located on the western boundary of the mining area. Mine waters, because of high mineral suspensions, also contribute to pollution of surface waters in which they are discharge.

MATERIALS AND METHODS

This study includes dimensioning mine water settler at Plostina mine and proposal purifying mine water with water hyacinth. Mine water from draining aquifers near coal layer and infiltration and is discharged into a settler. Mine water coming from draining aquifers near coal layer and infiltration, and it is discharged into a settler. Since settling is clogged and undersized we proposed to make a horizontal settler with two-stage settling. Evacuation of deposits will be hydraulically without energy and without further costs. After purification step of mine waters by settling we propose them to discharge into a pool where still achieve biological treatment of water hyacinth

RESULTS AND DISSCUSIONS

Materials in suspension of the technological wastewater (mine water) from Plostina mine were monitored in 2004 - 2010 and are presented in figure 5. The maximum value was recorded in 2007, namely 133 mg/l is twice the maximum admissible concentration. Maximum admissible concentration has been exceeded six times in 2007, and in other years at least once. The maximum in 2007 were registered caused by poorly maintained settlers at the mine mouth and inside the mine due to mine workings inside mine. The quantity of water with suspension is greater, had no time to settle in the settlers of mine (sumps). These exceeding were registered especially in spring and autumn months when the rains prevailed, leading to infiltration of large quantities of water in underground. In the remaining years were registered normal framed between 32-50 mg/l. From the graph we can see that in 2010 recorded values are quite close to the maximum admissible value due to poor maintenance more settler at the mine mouth was even exceeded in october.

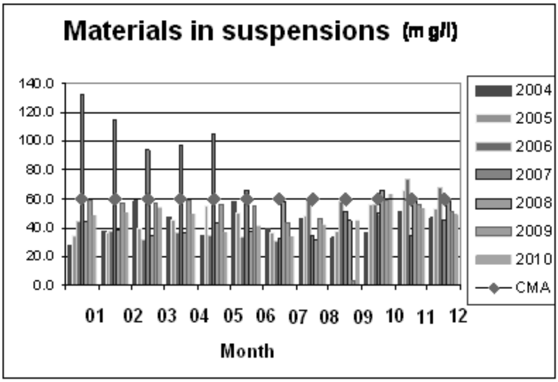

Figure 5 Materials in suspensions

Starting from the fact that settling for mine water is exceeded in every way we proposed to make a new horizontal settler, after which water is treated and a biological treatment step with water hyacinth to reduce costs.

Dimensioning horizontal settler
Entry datas:

$$Q_{day\,\max} = 90\, m^3/day = 0.0010411667\, m^3/s$$

$v = 0.005\,\mathrm{m/s}$ (horizontal velocity of water with values of 0.002-0.005 m/s from settler without coagulant)

$t_d = 3h$ (settling time, considered 2-4 hours)

$\gamma_d = 1200\, kgf/m^3$ (specific weight of deposits, in daN/m^3)

$c = 0.1$ (solids concentration of sludge applied, held for 5-10%)

$T = 8 days$ (time between two cleansing, in seconds)

1. Horizontal sectional area: $S = Q_c/V_s = 5.21m^2$, $V_s = 0.002\, m/s$ (sedimentation rate, in m/s)

2. Settler length: $L = \alpha \cdot V \cdot t_d = 17.28m \approx 17.5m$;

   $\alpha = 1.2$ (safety factor with values between 1.2-1.4);

   $V = 0.002\, m/s$ (horizontal velocity of water with values of 0.002-0.005 m/s from settlers without coagulant)

   $t_d = 2 hours$ (settling time, held for 2-4 hours)

3. Settler width: $B = S/L = 0.30m \Rightarrow 1.5m$

4. Number of compartments: $n = B/b \geq 3$; $n=2$

5. Width of a settler: $b = B/n = 0.75m$

6. Height usable water: $H_u = Q_c \cdot t_d / S = 1.44m$

7. The volume of deposits: $V_d = p \cdot a \cdot Q_c \cdot T/\gamma_d \cdot c = 0.63m^3$

   $p = 0.7$ (sedimentation rate, which takes 70 to 80%)

$a = 0.15\,kg/m^3$ (suspensions concentration in water that decants, $a = 150 \cdot 10^{-3}\,kf/m^3$)

$T = 8days$ (time between two cleanings)

8. Average height of deposits: $H_d = V_d / B \cdot L = 0.024m = 2.4cm$

9. The total height of the settler: $H = H_s + H_g + H_u + H_d = 2.114m$

Hs=0.15m (height safety; *Hs = 0.1 - 0.15*)

Hg=0.5m (height of frost; *Hg = 0.3 - 0.5*)

10. Degree of clarification provided by the settler: $K = (p_b - p_d) \cdot 100 / p_b = 52.38\,\%$

p_b = *105 mg/l* (content of suspensions in settling out of the filter to reach)

p_d = *50mg/l* (suspensions containing gross settler entering)

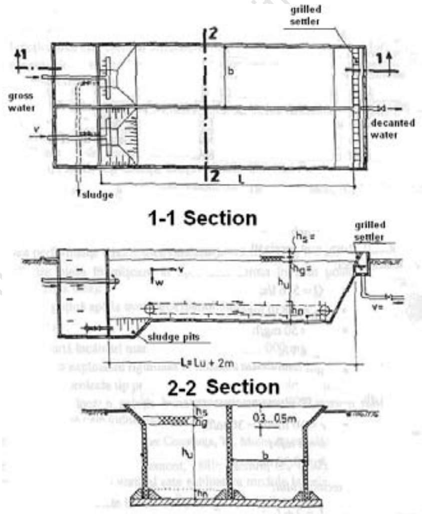

Figure 6 Proposed horizontal settler

Mine water treatment with water hyacinth

Proposed this step purification with water hyacinth as using water hyacinth for wastewater treatment is considered a simple technology that does not require expensive machinery and equipment costs are minimal or absent. Water hyacinths are aquatic plants suitable for nutrient removal from water polluters due to rapid growth and rapid multiplication. Ten hyacinth can grow up to 60,000 and can cover an acre of water in just eight months according to research done by professor Mrs. Marioara Godeanu, President of Biology Department in the Academy of Scientists from Romania, who made a study between 1980 - 2004, research on these plants were made inside the Wastewater from Arges county.

Figure 7 Water hyacinth [10]

These plants play an important role on Earth. These plants play an important role on Earth. It was found that a hectare of water hyacinth generates a quantity of oxygen necessary for providing 500 people for 24 hours. However, a hectare of water hyacinth could accumulate in sewage generated nitrogen and phosphorus generated almost 595 people to 180 people, producing 67 tones of dry matter annually. [2]

Hyacinths, for survival need nitrogen, phosphorus, potassium - which are the main pollutants. Another important characteristic of this plant is the assimilation of toxins, pesticides and heavy metals.

Winter sprouts obtained in air-conditioned systems are used to populate the surface of water when the air temperature reaches 10-15 Celsius degrees, and water is at least 10 Celsius degrees. Plants are placed in water in the upstream so as to float and are strictly root in water, and not reversed, not to form algae on them. [2]

Since water flow discharged from the mine not very high, aim to achieve a basin of water hyacinth with the following dimensions: length - 20m, width - 15m, depth - 0.7m, area - 300m^2.

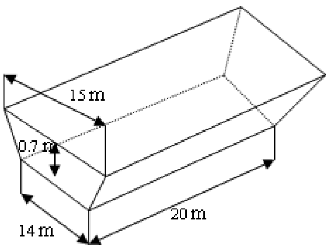

Figure 8 Basin dimensioning for water hyacinth

To cover the surface of 300m^2 with water hyacinth we need two plants will cover the entire area in about 4 months. To implement basin, specific consumption of guidance rules are determined by equipment used and the specific conditions of execution. Is executed a mechanical excavation with a caterpillar excavator, which is the cup volume 0.71 to 1.25 m, the heat engine and hydraulic control in soil with natural moisture, storage-discharge.

Before making the costs have to find basin volume:

$$V = \frac{(B+b)\cdot h}{2} \cdot L = \frac{(15+14)\cdot 0.7}{2} = 203m^3$$

Total price of the work is appreciatively 400 euro.

CONCLUSIONS

One of the problems facing any mining is given by system disruption and surface water pollution.

Eichhornia Crassipes (water hyacinth) is considered by some authors the most productive plants on earth, having the capacity to double their mass in just two weeks.

Plant harvesting and use of biomass as alternative two-step water treatment process, which completes the recovery technology of polluted substances in aquatic ecosystems.

After harvesting can be used to improve the inside soil mine. Another advantage of the hyacinth is to improve air quality inside Plostina Mine due to the amount of oxygen produced enormous. Therefore, hyacinth culture is increasingly seen more as an alternative water treatment method.

Our research will continue on this topic, following publication of results in further articles.

REFERENCES

[1] Baican G., Fodor D., Courses of action necessary to follow the Romanian mining, Mining Journal no. 9-10, 2003;

[2] Godeanu M., Study between 1980-2004 on the wastewater Arges county, Romania;

[3] N.H.N. Ecoinvest S.R.L., „Environmental Balance, I level for Plostina Mine”, 2001;

[4]*** HG 352/2005, Norms of discharge wastewater into the aquatic environment.

[5]***. Database Jiu Water Directorate, 2004-2011;

[6]*** Database EMS Motru, 2004-2011;

[7]*** NTPA 001/2005, Pollutant loading limits for industrial and municipal wastewater to discharge into natural receivers.

[8] www.cnlo.ro

[9] www. transport-adely.ro

[10] www.adevarul.ro

BOX JENKINS METHODOLOGY APPLIED TO THE EVALUATION OF AIR QUALITY IN BUCHAREST

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ABSTRACT

In time series analysis, the Box-Jenkins methodology applies autoregressive moving average ARMA models to find the best fit of a time series to past values of this time series, in order to make forecasts.

The model uses an iterative three-stage modeling approach: model identification and model selection, parameter estimation using non-linear least-squares estimation in order to calculate the coefficients which fit the selected mode, model checking by testing whether the estimated model conforms to the specifications of a stationary univariate process. The first step is to determine if the monitoring data formed a time series, if the time series is stationary and if there is any significant seasonality that needs to be modeled. The data that result from the monitor of the degree of environmental pollution in a target zone form a time series because it shows variability and homogeneity.

This paper applied the Box-Jenkins methodology to analysis and modeling the monitoring data measured by A.P.M. Bucharest in some important crossroads of Bucharest during 2005 - 2011. The hourly registration of NO_2 concentrations in air form a univariate time series that consists of single scalar observations recorded sequentially over equal time increments. The initial run sequence plot of the data indicates a rising trend and a simple linear fit should be sufficient to remove this upward trend from the data. This time series display seasonality that show sinusoidal variation over 24 hours and also over entire year and this seasonality was also removed from the data. The seasonal pattern was pointed out with the autocorrelation plot and the coefficients of sinusoidal models were determined with non linear regression method. The Box-Jenkins methodology was applied in order to determine the ARMA model that correlates the data without trend and seasonality.

Keywords: environmental monitoring, Box-Jenkins methodology, air pollution, time series

1. INTRODUCTION

Various aspects referring to statistics of environmental monitoring data applied in evaluation of air pollution are developed by the authors in a series of papers [1 - 12] and a monograph [4]. We can see other statistical methods in [14] and [15].

In time series analysis, the Box-Jenkins methodology applies autoregressive moving average ARMA or ARIMA models to find the best fit of a stationary time series, in order to make forecasts. A time series, TS, is a sequence of observations which are ordered in time. If observations are made on pollutant concentration throughout time, the data are displayed in the order they arose, since successive observations probably are dependent.

2. APPLICATION OF BOX-JENKINS METHODOLOGY

2.1 First step of Box - Jenkins methodology

The first step in Box - Jenkins methodology is to prove that the collected data form stationary TS with the following properties: homogeneity, variability, periodicity, and interdependence [2], [3], [13]. TS of pollutant concentrations are homogeneous because its terms are similar in their nature and are measured in the same conditions.

The variability of TS terms arises from the tendency that each term is obtained by measuring individual data with corresponding changes determined by the random factors and the dynamics of pollution sources. In the case analyzed, the main pollution source is given by the exhaust gases from road vehicles. As a result, the NO_2 concentration in the air will be dependent on the road traffic intensity, technical state of vehicles, quality of the commercial fuels, etc.

The periodicity or cyclic character of the analyzed TS was put in evidence by the diagram from figure 1. This diagram clearly shows the weekly periodicity and the seasonality of TS and the trend of the experimental data.

The interdependence of TS terms results from the succession of measurements. The Hurst method put in evidence the interdependence of the data from TS [16]. For different data sets, the value of Hurst coefficient for the TS analyzed is ranging between 0.56 and 0.72. This shows that the value of NO_2 concentration in air measured at a given moment is influenced by the value measured before, and therefore the data form TS.

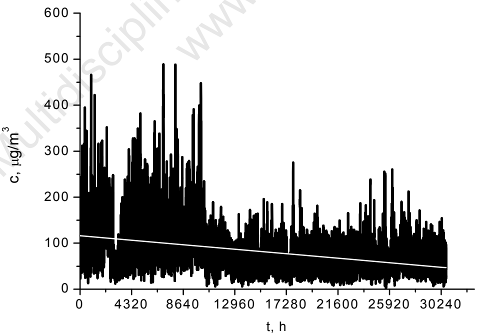

Fig. 1. NO_2 concentration in the air during 2007 - 2010 in Bucharest, Mihai Bravu intersection

TS is stationary when its statistical properties such as mean, variance, and autocorrelation are all constant over time. As a result, stationary TS have no trend and periodicity. The data analyzed in figure 1 reveals that during 2007 - 2010, the TS is non stationary, as shows the following equation obtained by linear regression of the data:

$$c = 116.9 - 2.2\ 10^{-3}t \tag{1}$$

The moving average smoothed data presents in figure 2 highlights more clearly that the TS non stationary.

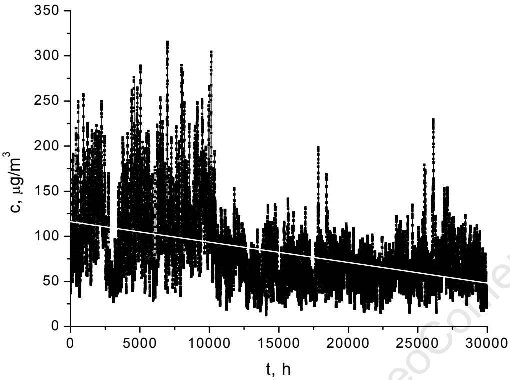

Fig. 2. Smoothed data of NO_2 concentration in the air during 2007 - 2010 in Bucharest, Mihai Bravu intersection with moving average.

The autocorrelation diagram from figure 3 puts in evidence the periodicity of the data and as result the NO_2 TS data set is non stationary. The results presented in figure 4 reveals the seasonality on the analyzed TS.

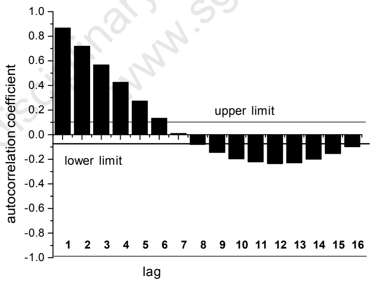

Fig. 3. Autocorrelation diagram of NO_2 concentration in the air during March 2009 in Bucharest, Mihai Bravu intersection.

Most statistical forecasting methods are based on the assumption that the TS can be rendered approximately stationary through the use of mathematical transformations. In this case it may be necessary to transform it into a series of period-to-period mean values. The new series shows an apparent linear upward trend as reveals the diagram from figure 5. The linear correlations of the data presented in figure 5 are:

- for period mean concentration: $c = 81 - 0.5\ t$
- for standard deviation: $\sigma = 0.4 - 0.0064\ t$.

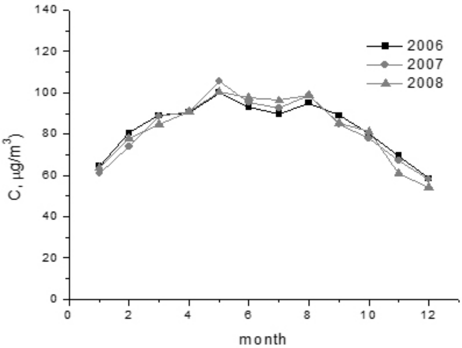

Fig. 4. The seasonality of NO_2 concentration in the air during June 2006 – June 2008 in Bucharest, Mihai Bravu intersection.

In both cases, the coefficients that reveal the time variation are very small and therefore the new TS can be considered stationary.

2.2 Second step of Box - Jenkins methodology

The second step in Box - Jenkins methodology is data smoothing with moving average method. This method formed new TS where each terms are an average of artificial subgroups created from consecutive observations. In figures 6 and 7 the smoothed data are the average of 3, 6 and 12 consecutive terms. The increasing subgroup data number clearly put in evidence the daily periodical evolution of NO_2 concentration during the considered period. The best results are obtained when n = 12.

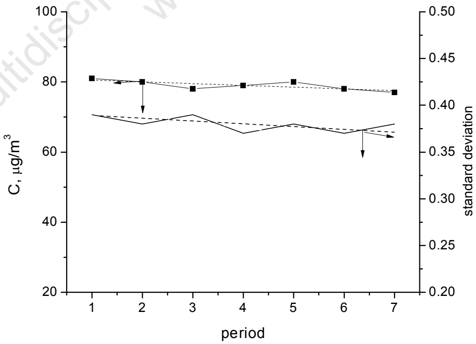

Fig. 5. The new TS with mean period values as terms

The same results are obtained when are smoothed the daily and monthly average concentrations. The data presented in figures 8 and 9 reveal the weekly and seasonal sinusoidal variation.

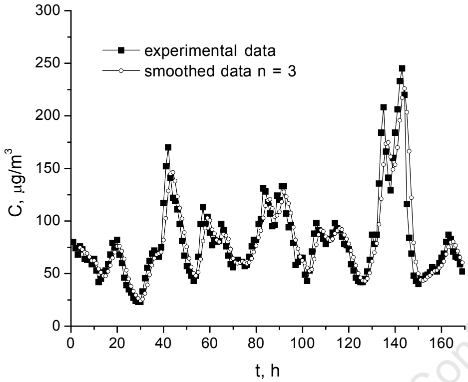

Fig. 6. Original and smoothed data of NO_2 concentration in air on Bucharest, Mihai Bravu intersection during 15 - 21 February 2010; smoothed data were calculated with subgroups of 3 consecutive data.

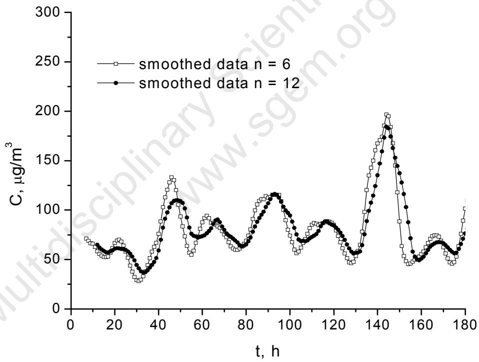

Fig. 7. NO_2 concentration in air on Bucharest, Mihai Bravu intersection during 15 - 21 February 2010; smoothed data were calculated with subgroups 6 and 12 consecutive data.

2.3 Third step of Box - Jenkins methodology

The third step in Box - Jenkins methodology is to correlate the smoothed data in a mathematical model. The smoothed data from figure 8 shows sinusoidal variations of hourly NO_2 concentration during days. The sine wave model can fit these data. The model constants are determined by nonlinear regression and the following relationship results:

$$C = 45.75 + 17.61 \sin(2\pi t/24 + 0.78) \quad (2)$$

It can be noticed, that the period of sinusoidal variations of daily concentrations measured is equal to the duration of a night-day alternate. The differences between smoothed data and those calculated with mathematical model (figure 8) demonstrate the influences of the random factors, like meteorological conditions, on the measured values. In diagram from figure 9 the TS data show a weekly periodicity. In this case, the smoothed data was fitted in the following model:

$$C = 46.75+19.61 \sin(2\pi t/7 + 0.68) \quad (3)$$

The differences from the smoothed data and the model data are still significant, but quite reduced relative to the case presented in figure 9. This demonstrates that by averaging the daily concentrations, the influence of random factors was diminished and the cyclic character of data becomes more evident.

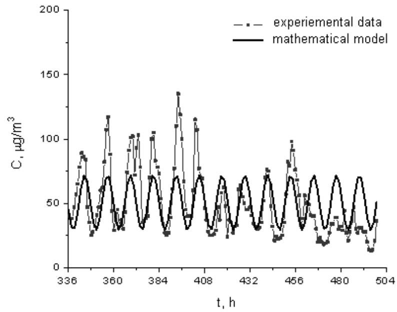

Figure 8. Comparison between the sine wave model data and smoothed data of NO_2 concentration in air in Bucharest, Mihai Bravu intersection during 1 - 9 March 2009.

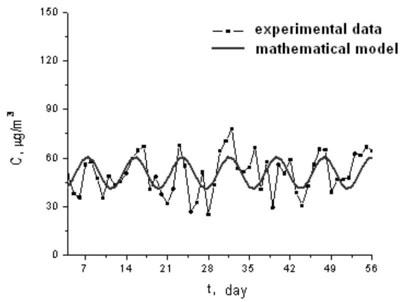

Figure 9. Comparison between the sine wave model data and smoothed data of average daily NO_2 concentration in the air in Bucharest, Mihai Bravu intersection during March - April 2009

In diagram from figure 11 the TS data show a seasonal periodicity. In this case, the deviations of experimental data from the smoothed data are still significant but quite reduced relative to the cases presented in figures 8 and 9. This demonstrates once again that by averaging the influence of random factors is diminished, while the periodical character becomes more evident.

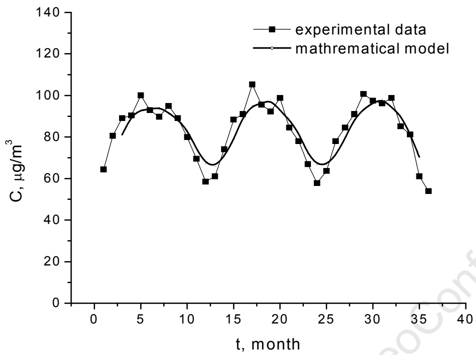

Figure 10. Comparison between the sine wave model data and smoothed data of monthly average NO_2 concentration in the air in Bucharest, Mihai Bravu intersection during January 2006 and June 2008

The result of data correlation from figure 11 was the following equation:

$$C = 81.5+19,61 \sin(2\pi t/12 -0,8) \tag{4}$$

The equation (4) reveals the seasonal variation of NO_2 concentration in the air. In urban areas, the main source of NO_2 pollution is the vehicular traffic producing emissions that are distributed all the year. The vehicles fuel consumption increases in cold weather, sometimes to 40% and the pollution outputs are much higher in the first minutes after a cold start of vehicles engines. The catalytic converter does not work when it is cold and the engine emissions pass through the exhaust untreated until the converter warms up and so results the monthly average variation of NO_2 concentration that can be correlated with a wave sin time model with a period equal to 12.

The NO_2 concentration in air will be dependent on the road traffic intensity (daily and weekly variations), technical state of vehicles, quality of the commercial fuels, but also the average month temperature during cold season and its duration (seasonal variation). The mathematical models obtained by nonlinear regression can provide the time evolution of a pollutant as long as the process is stationary.

3. CONCLUSION

The paper demonstrated that, in a mathematical approach, the experimental data obtained on monitoring the pollutant concentration can be considered as a time series. The application of time series properties to a set of experimental data obtained on monitoring NO_2 concentration in air over a four years period in Bucharest Mihai Bravu intersection highlights the peculiarities of the time evolution of the monitored variable and provide useful information for further predictions of the running process. Statistical processing of TS elements requires validating the existence of the following properties:

variability, homogeneity, periodicity, interdependence and stationary. The first stage in Box - Jenkins methodology put in evidence these properties.

In the second stage, the TS data are smoothed in order to reduce the random fluctuations and put in evidence the trend of collected data. The correlation of smoothed data with a wave sine model represented the third stage. The models reveal the daily, weekly, and seasonal periodicity of NO_2 concentration in air.

REFERENCES

[1] Barbalace N. & Giannetto L. Modeling of atmospheric pollutants in petrochemical refineries, BGS Proceedings 12, GBP 2005, pp. 23-31, 2005.
[2] de Brauwere A. & de Ridder F. & Pintelon R. & Meersmans J. & Schoukens J. & Dehairs F. Identification of a periodic time series from an environmental proxy record, Computers & Geosciences, 34, pp. 1781-1790, 2008.
[3] Hipel K. & Mcleod A. I. Time series modeling of water resources and environmental systems, Ed. Elsevier, The Netherlands, 1994.
[4] Meghea I. & Lacatusu I. & Mihai M. & Popa I. Air pollution. Monitoring and statistics of air pollutants, Ed. POLITEHNICA PRESS, Bucharest, Romania, 2010.
[5] Meghea I. & Mihai M. & Lacatusu I, & Apostol T. Environmental monitoring of CO emissions: statistical character of acquired data, EEMJ, vol.8, nr.3, pp. 575-582, 2009.
[6] Meghea I. & Mihai M. & Craciun E. Monitoring and statistics of heavy metals daily data in surface water, SGEM 2010, vol. II, pp. 677 - 683, 2010.
[7] Meghea I. & Mihai M. & Craciun E. Statistical control of mercury in surface water of Bucharest, JEPEE, 2012 (in print).
[8] Meghea I. & Mihai M. & Lacatusu I. & Iosub I. Evaluation of monitoring of lead emissions in Bucharest by statistical processing, JEPEE, 2012 (in print).
[9] Meghea I. & Mihai M. & Lacatusu I. & Apostol T. Time series model applied to environmental monitoring data analysis, JEPEE, 2012 (in print).
[10] Meghea I. & Mihai M. & Popa I. & Ganatios S. Statistical analysis of hourly ground level of primary pollutants concentrations in Bucharest, Proceedings of RICCCCE XVI; 2009, pp. 7-16.
[11] Mihai M. & Meghea I. & Necsoiu T. & Meghea A. Effect of thermal inversion on Bucharest air pollution, Proceedings of RICCCCE XVI; 2009, pp. 17-26.
[12] Meghea I. & Mihai M. & Popa I. & Ganatiou M. E. Modelling study for forecasting of urban air pollution, Proceedings of International Symposium SIMI 2009 - "ENVIRONMENT AND INDUSTRY"; 2009, pp. 31-43.
[13] Sakalauskiene G. The Hurst Phenomenon in Hydrology, Environmental research, engineering and management, 3 (25), 16-20, 2003.
[14] Shrihari Sridharan, Statistical properties of hyperbolic Julie sets, DGDS, vol. 11, pp. 175-184, 2009.
[15] Tarcolea C. & Paris A. & Dumitrescu-Tarcolea A. Statistical methods applied for materials selection, APPS, vol.11, pp.145-150, 2009.
[16] Zaldivar J. M. & Strozzi F. & Dueri S. & Marinov D. & Zbilut J. P. Characterization of regime shifts in environmental time series with recurrence quantification analysis, Ecological modelling 210, pp. 58-70, 2008.

BUILDING MORPHOLOGY IN TERMS OF ENERGY PERFORMANCE

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ABSTRACT

In accordance with the long-term strategic objectives for reducing emissions and improving energy efficiency, adopted by the European Parliament on May 18, 2010 and the subsequent adoption of the 2010/31/EU resolution which increases the level of commitment by 2020 to reduce total greenhouse gas emissions by at least 20%, the directive requires Member states design all new buildings with near zero net energy consumptions by December 31, 2020. The aims of the directive can be enforced as a result of the optimization of a building´s geometrical shape and orientation in conjunction with excellent building envelope parameters which are currently available. The geometry of the building plays a fundamental role in optimizing energy efficiency for a given building, i.e. compact shape and surface topography. The geometrical shape of a building generally proposed in the conception stage of architectural design, which undergoes relatively few changes throughout the life of the building.

In this paper, the impact some input parameters have on the architectural and constructional design of the most frequently applied shapes of residential housing in Slovakia, are presented. By combining input parameters, a regression equation can be used to predict annual heating demand during the initial stage of building design.

Keywords: Building shape, window to wall ratio, parameters, heating load

INTRODUCTION

The shape factor *FT* of a building is represented by its surface-area-to-volume ratio and is a measure of a building´s compactness. Buildings with a higher *FT* are less compact and therefore have a larger surface area for a given volume. The surface area of the building is the boundary that separates heated spaces and unheated spaces, and accounts for a large percentage of heat losses in buildings. Some guidance for architects are available for predicting annual energy performances and as these case studies [1],[2] have shown, the building´s shape can have a profound impact on energy performance.

Depecker et al. [3] showed that in colder climates, there is a strong correlation between final energy use and *FT*. Buildings with a higher *FT* have a higher final energy use. China has integrated the *FT* of buildings into its design standard for energy efficiency, which apply stricter values for newly constructed public buildings in colder climates [4]. Slovakia is located in a temperate climatic zone, and the impact that the shape factor has on the energy use is significant.

Quantification of geometric solutions for the buildings envelope area

Generally, from the effect that geometry solution has on the size of a buildings envelope area according to [5], it is possible to compare the difference FT obtained for different rectangular objects. The following than applies:

$$FT = \frac{2}{H} \cdot g \tag{1}$$

Where: $g = \frac{1+b}{ab} + 1$,

$a = B/H$, B is the depth of the building, H is represents height of the building, $B = a*H$

b = A/H , A is match of the building, $A = b*B = a*b*H$

Factor g on Fig.1 depending on the relative numbers a, b. From equation (1) it is obvious that with increasing height the building A/V ratio decreases [5].

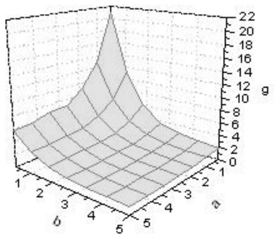

Fig.1 Factor g depending on the relative numbers a, b [5]

Methodology for determining energy performance

Standard heating requirements in Slovakia, depending on the shape factor *FT* use STN 73 0540[6] as the energy criterion. Residential buildings are distinguished mainly by the shape, size and number of floors, these differences can be expressed by the shape factor FT of the building. Heating is considered continuous with a standardized degree days 3422K.day. Rising heat transfer coefficient values affect the heat reduction capacity. Buildings meet requirements if the shape factor fulfils the condition $E \leq E_N$ (need for heating must be equal or less than heating loads determined by regulations) Fig.2. This standard specifies the maximum heat transfer coefficient U for a building envelope construction. Thermo-technical qualities of building envelope structures are defined by the mean heat transfer coefficient U_{em}.

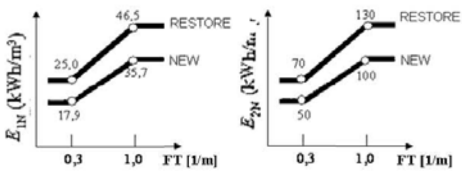

Fig. 2 Normalized heating load according to standard STN 73 0540, left: use per unit cubic meter, right: use per unit of floor area.

Heating load per unit floor area, is used to compare final energy use in buildings with differing shapes and sizes. The area definition according to the Slovak standard is equivalent to the overall external dimension. Heating load are determined by calculating the thermal properties of building elements. These do not include properties of the heat source and heating system. Additionally, it is necessary to calculate the specific heat loss by the transition and ventilation. This specific heat loss is reduced by heat gain from internal sources and passive solar heat gain which depend on the size of transparent surfaces and cardinal orientation.

Case study

Residential buildings in Slovakia differ mainly in shape and by the number of floors. These differences can be determined by the shape factor *FT* of the building. Accordingly, the need for heating demand varies. A review was conducted regarding the impact a common rectangular building has on its annual heat energy demand as can be found amongst the vernacular architecture of residential buildings in Slovakia illustrated in Fig.3.

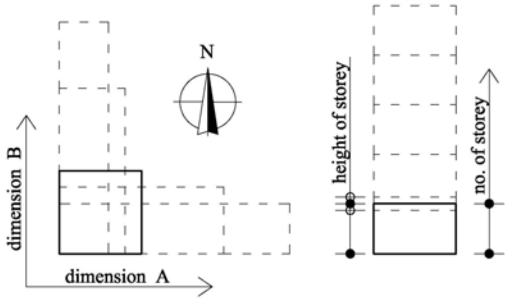

Fig. 3 Rectangular shape of typical apartment buildings considered in the calculation, left: floor plan, right: section

Input parameters and subsequent ranges are depicted in Tab.1.

Tab.1 Input parameters and ranges of values considered in the energy performance calculation of apartment buildings.

PARAMETER			MED.	MIN.	MAX.
INDEX	**NAME**	**UNIT**			
A	Match	[m]	10	2	18
B	Depth	[m]	10	2	18
KV	Height of storey	[m]	3,5	2,2	4,2
n	Number of storrey	[-]	4	1	8
%win -N	% of window to wall - N	[%]	50	10	90
%win -S	% of window to wall – S	[%]	50	10	90
%win -E	% of window to wall – E	[%]	50	10	90
%win -W	% of window to wall - W	[%]	50	10	90
U_{floor}	Heat tr. coeff. of floor	[W/m^2.K]	0.25	0,1	0,45
U_{wall}	Heat tr. coeff. of wall	[W/m^2.K]	0.2	0,1	0,4
U_{roof}	Heat tr. coeff. of roof	[W/m^2.K]	0.2	0,1	0,4
U_w	Heat tr. coeff. of window	[W/m^2.K]	1.0	0,6	1,4
g win	Solar transmittance of window	[-]	0,5	0,1	0,8

Computing methodology

The Monte Carlo optimization method was used to facilitate the calculation of different combinations of input parameters based on stochastic random selection of input parameters. The Monte Carlo analysis is based on repeated simulations, the outputs are evaluated for each element of the sample matrix. Simulación 4.0 [7] was used to generate a combination of input parameters. Annual heating requirements were calculated utilizing above mentioned quasi-stationary seasonal method in compliance with standard STN 73 0540 [6]. The inputs for the optimization model are the dimension of building sides, the buildings envelope construction U – value, % of window to wall area, solar properties of window etc. All input parameters meet the criteria of minimum thermal properties according to standard [6].

Results of parametric analysis

Shape solution of buildings are illustrated (expressed through the shape factor FT [1/m]) depending on the thermal quality of building envelope constructions (using the average heat transfer coefficient U_{em} [W/m2.K]) shown in Fig.4. As seen in Fig.4, these two variables may range relatively widely range, and heat loss may exhibit different values. With adding heat gain throughout the transparent construction, the need for heating in the interval as shown Fig.5 is expressed by mean values and standard deviation.

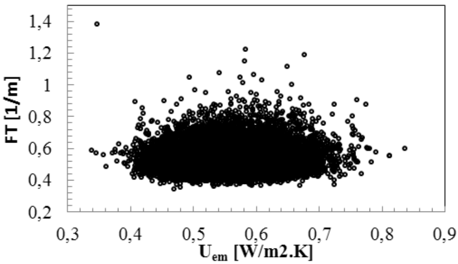

Fig. 4 Thermal-technic quality of building construction through average heat transfer coefficient U_{em} [W/m^2.K]

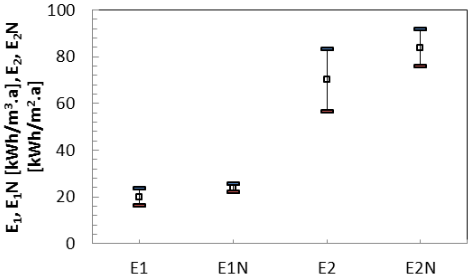

Fig. 5 Mean and standard deviation of energy needs for heating expressed per cubic meter – E1[kWh/m^3.a], or per floor area E2 [kWh/m^2.a]

From the parametric study, the above mentioned parameters and their combination (in this case 20000 combinations for the highest coverage of the distribution function of input parameters) have developed several regression equations. Generally, the regression equation (1) is used to heating loads. This equation consists of equation (2) and equation (3). Equation (2): architectural impact – contains parameters of shape solution (suitable for the first stage of building design to optimize the shape of buildings and size of transparent constructions based on cardinal orientation). Equation (3): construction impact – contains thermal parameters of envelope constructions. This equation is appropriate for later stages of building design. The regression constants of input parameters for this equations are located the Tab.2 and Tab.3. Tab.2 expresses architectural effects and corresponding dimensions and the percentage of transparent construction.

$$y = \alpha + y_{AI} + y_{CI} \tag{1}$$

$$y_{AI} = \sum_{i=1}^{4} \beta_i + \sum_{i=1}^{4} \gamma_i \tag{2}$$

$$y_{CI} = \sum_{i=1}^{4} \delta_i + \varepsilon . U_{win} \tag{3}$$

Table 2: Regression coefficient of input parameters. Architectural impact AI* expressed by a buildings dimension.

Regression constant			E_1 [kWh/m³.a]	E_1N [kWh/m³.a]	E_2 [kWh/m².a]	E_2N [kWh/m².a]
α	--		17,07882	17,07882	-10,2465	63,17681
β_1	**A**	**AI***	-0,68534	-0,68534	-2,39752	-2,06546
β_2	**B**		-0,64281	-0,64281	-2,24834	-2,02084
β_3	**KV**		0,852708	0,852708	22,97558	20,94526
β_4	**n**		-0,54178	-0,54178	-1,88244	-2,34714
γ_1	**%win -E**		0,01903	0,01903	0,066965	0,000693
γ_2	**%win -N**		0,043612	0,043612	0,153086	0,000123
γ_3	**%win -S**		-0,01036	-0,01036	-0,03653	0,001785
γ_4	**%win -W**		0,018695	0,018695	0,064966	-0,00183
δ_1	**g win**	**CI***	-20,4467	-20,4467	-71,4724	-0,0625
δ_2	**U_{floor}**		4,723929	4,723929	16,33154	-0,55822
δ_3	**U_{roof}**		5,148134	5,148134	17,87576	0,235518
δ_4	**U_{wall}**		17,32994	17,32994	60,53296	0,281753
ε	**U_{window}**		17,17717	17,17717	60,16134	-0,04119
R^2			0,967243	0,938832	0,969792	0,955684
AI* - architectural impact of a building´s design parameters on energy performance **CI*** - constructional impact of building design parameters on energy performance						

Table 3: Regression coefficient of input parameters. Architectural impact AI* expressed by a ratio of a building´s side.

Regression constant			**E_1 [kWh/m^3.a]**	**E_1N [kWh/m^3.a]**	**E_2 [kWh/m^2.a]**	**E_2N [kWh/m^2.a]**
α	--		18,8347	37,72531	59,13655	124,0655
β_1	**a**	**AI***	0,15584	0,226469	1,393336	1,769964
β_2	**b**		-13,2702	-11,3805	-46,0176	-39,4372
β_3	**c**		3,667114	3,28114	12,9918	11,70482
β_4	**H**		-0,61631	-0,60294	-1,82115	-1,71528
γ_1	**%win -N**		0,02048	0,001619	0,06916	0,002209
γ_2	**%win -S**		0,044497	0,000985	0,154867	0,001479
γ_3	**%win -E**		-0,01092	0,000265	-0,04174	-0,00317
γ_4	**%win -W**		0,020012	0,000533	0,071791	0,004343
δ_1	**U_{floor}**	**CI***	-20,4044	-6E-05	-71,221	0,162473
δ_2	**U_{roof}**		4,518503	-0,2478	14,56397	-2,18412
δ_3	**U_{wall}**		4,758142	-0,24439	16,17166	-1,24673
δ_4	**U_{window}**		17,35043	0,098641	60,89532	0,626037
ε	**g win**		17,16846	-0,04691	60,62143	0,419282
R^2			0,906694	0,75242	0,839206	0,561712

AI* - architectural impact of a building´s design parameters on energy performance
CI* - constructional impact of building design parameters on energy performance

Conclusion

Architectural design considerably influences heating needs, making it necessary to optimize the energy efficiency already in the preliminary phase of building design.

This methodology and developed regression equation of input parameters can be a good tool to optimize the need for heating rectangular apartment buildings. The egression equation can be used in a multi-criterion decision analysis as a tool to predict annual heating demands in the initial stages of residential design in Slovakia.

Additional work is needed to further validate, refine and expand the proposed method for dealing with a building´s shape and determining regression coefficient for parameters of dynamic variables and for each climatic zone.

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REFERENCES

[1] OURGHI R, AL-ANZI A, KRARTI M. A Simplified Analysis Method To Predict The Impact Of Shape On Annual Energy Use For Office Buildings. Energy Convers Manage J 2007;48:300–5.

[2] ALANZI, A., SEO, D., KRARTI, M., Impact of building shape on thermal performance of office buildings in Kuwait. Energy Conversion and Management J, 2009; no 50, p. 822-828.

[3] Depecker P,. Menezo C., Virgone j., and Lepers S., "Design of Buildings´ Shape and Energetic Consumption", Building and Environment, Vol. 30, No.2, 201-222,2001.

[4 Pessenlehner, W and Mahdavi, A, "Building Morphology, transparency, and energy performance", Eighth International IBPSA Conference Proceedings, Eindhoven, Netherlands.

[5] Řehánek, J, "Tepelně-technické a energetické vlastnosti budov. Praha 2002, 248 strán, ISBN 80-7169-582-3.

[6] STN 73 0540 1 and 4 Thermal properties of buildings and constructions. Thermal protection of buildings, 2002

[7] Simulación 4.0, available online:
< http://www.ucema.edu.ar/u/jvarela/index_eng.htm>

CHEMICAL AND BIOLOGICAL METHODS OF SORBENTS REGENERATION

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ABSTRACT

Natural montmorillonite and composite based on clay and iron oxide were used for Cu(II) adsorption. The sorbents regeneration after their usage was studied by chemical and biological methods. Treating of the sorbents with organic acids led to partial Cu(II) dissolution. When the hydrochloric acid was used for the composite regeneration, almost 95 % of Cu(II) was released after 2 days, but also high amount of Fe ions was dissolved. For the bacterial regeneration, the sorbents used for the Cu(II) adsorption were inoculated with heterotrophic indigenous bacteria isolated from locality polluted by copper. The activity of the bacteria was monitored and the content of Cu(II) dissolution was evaluated after 3, 7 and 10 days of bioregeneration and compared with abiotic control. It was found, that bacteria in medium did not only release, but also adsorbed the dissolved Cu(II), therefore, lower amount of Cu(II) was extracted by bioregeneration than during the abiotic control, where chelating reagent was used. Next experiments showed that chemical method using the Na_2EDTA is cheap, fast and convenient way of sorbents regeneration. On the other hand, the possibility using the heterothrophic indigenous bacteria in sorption processes seems to be inetersting, especially in combination with other sorbents.

Keywords: sorbents, Cu(II) adsorption, chemical regeneration, bacteria, bioregeneration

INTRODUCTION

Due to the rapid increase in global industrial activities, heavy metal pollution became serious. Naturally occurring clays and clay minerals are of paramount importance in the field of environmental and waste management [1]. Bentonites are a group of natural nanomaterials composed predominantly from crystalline mineral particles from the group of dioctahedral smectites – montmorillonite. The adsorption properties of bentonites are determined by their chemical and mineralogical composition, also, various ways of modifications and treatments for enhancement of their properties were performed [2-9].

But, problems of sorbents cumulation after their use have occurred. The question of their regeneration became very important. The adsorbed ions can be removed by conventional methods [10-11], what are usually non economical processes, or processes cause the sorbents destruction.

In this paper the authors compare the classical chemical methods of sorbents regeneration used for the Cu(II) adsorption with the introductory experiments of bioregeneration.

MATERIALS AND METHODS

Sorbents and adsorptive

Bentonite, containing the calcium – magnesium montmorillonite with crystalochemical formula: $[Si_{7.95}\ Al_{0.05}]\ [Al_{3.03}\ Fe_{0.22}\ Mg_{0.75}]\ O_{20}\ (OH)_4\ (Ca_{0.42}Mg_{0.04}Na_{0.01}K_{0.01})$, originated from the Slovak deposit Jelšový potok [12]. The sample used for the investigation was isolated from the 4 % water suspension of bentonite and treated by sedimentation method with the aim to obtain the monomineral fraction with the particle size below 20 μm [13]. The composite material was prepared by the method of precipitation from the solution of $FeSO_4.7H_2O$ and $FeCl_3.6H_2O$ (with ratio of $Fe^{3+}/Fe^{2+} = 2$), according to the method described for magnetic fluids preparation [14]. The bentonite was mixed into the solution of iron cations prior to the reaction with NH_4OH. Its amount was adjusted in order to obtain the material with the equal content of bentonite to iron oxide. Then the dark brown suspension was stirred for half an hour. The final product was washed with de-ionized water, filtrated and dried at 70 °C.

Analytical grade metal salt ($Cu(NO_3)_2.\ 3H_2O$) was used without further purification. Stock solutions (1000 mg L^{-1} and 100 mg L^{-1}) of Cu(II) were prepared by dissolving the appropriate amounts of nitrate in de-ionized water. The stock solutions were diluted to obtain standard solutions containing 10 – 500 mg Cu(II) L^{-1}.

Sorption experiments

The adsorption measurements were made by a batch technique at room temperature using the rotary shaker. The pH of the dispersions was adjusted to the desired value by diluted solutions of NaOH and HCl added dropwise. The suspensions were shaken for 24 hours to reach equilibrium and then consequently filtered using the filter paper. The supernantant solutions were analyzed by the atomic absorption spectroscopy (AAS, Varian 240 RS/2400). Through the study, the pH was varied from 2 to 9, initial Cu(II) concentration from 10 to 500 mg L^{-1} and two selected sorbent masses were tested: 1 and 10 g L^{-1}. From the equilibrium adsorption isotherms the efficiency of the sorbents was calculated. For subsequent bioremedation the sorbents mass 10 g L^{-1}, pH 5 and initial concentration 100 mg Cu(II) L^{-1} were selected for the adsorption experiments.

Chemical regeneration of sorbent

The classical methods of metal dissolution enable the using of organic acids, as oxalic and citric, as well as the inorganic hydrochloric acid. Their efficiency in regeneration of composite sample was studied and compared with bacterial regeneration.

Bacterial regeneration of the sorbent

The montmorillonite and composite sample after the Cu(II) adsorption were inoculated with heterotrophic indigenous bacteria isolated from the contaminated soil near the factory Kovohuty Krompachy, which effectively recovers the copper from the secondary scrap materials. The experiments were realized in test tubes containing the same ratio of powdered sample and the liquid medium as during the Cu(II) adsorption. The medium consisted of 0.05 g L^{-1} of yeast extract, 0.5 g L^{-1} $MgSO_4$, 1 g L^{-1} $(NH_4)_2SO_4$, 2 g L^{-1} K_2HPO_4, 0.1 g L^{-1} $CaCl_2$, 0.075 g L^{-1} NaCl, 0.4 g L^{-1} of urea, 0.085 g L^{-1} $NaNO_3$ and chelating reagent. The tubes were incubated under static conditions for 10 days. The liquid supernatant was collected after 3, 7 and 10 days and the changes of the desorbed metal content were evaluated. The bioregeneration experiments were conducted three times. The abiotic control using the same medium as for the bacterial regeneration, but without the bacteria was performed to compare the results, too.

RESULTS AND DISCUSSION

Effect of pH and amount of sorbent

The pH of the metal ions solution influences their adsorption by sorbent. The metal ion uptake slightly increased in the pH range from 3 to 6, higher adsorbed amounts was observed for the adsorption on montmorillonite (not shown here). In solutions with pH 8 and 9, the adsorption capacity of both sorbents increased, due to the precipitation of $Cu(OH)_2$. Dissolution of Fe^{3+} from the composite was also studied. It was shown, that iron oxide was stable in the solution with pH > 4. For the next adsorption experiments pH equal 5 was selected.

The Cu(II) removal increased with the increasing initial metal ion concentration. No saturation was reached in the studied concentration range using both amounts of sorbents. The higher was the sorbent dose, the higher was the sorption efficiency, Fig. 1. For the regeneration purposes, 10 grams of sorbents were used for Cu(II) adsorption from the solution with initial metal ions concentration 100 mg Cu(II) L^{-1}, where montmorillonite and composite removed 71 % and 90 % of Cu(II), respectively.

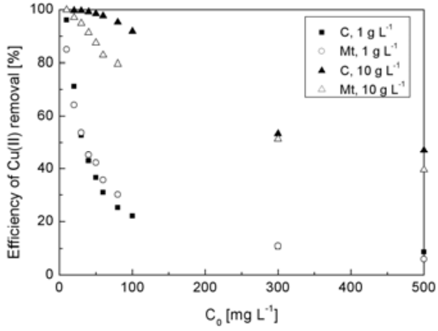

Fig. 1 Effect of the sorbent mass on the Cu(II) adsorption (C – composite, Mt – montmorillonite)

Chemical regeneration of the composite

The treating of the composite with organic acids led to partial Cu(II) dissolution already after 2 days. The oxalic acid dissolved 24 % of adsorbed Cu(II) and the citric acid 34 %, Fig. 2. Except the Cu(II), the oxalic and citric acids dissolved in two days also 253 mg Fe(III) L^{-1} and 81 mg Fe(III) L^{-1} from the composite, respectively. When the hydrochloric acid was used for sorbent regeneration, 95 % of Cu(II) was released after 2 days. Unfortunately, together with Cu(II) also 333 mg Fe(III) L^{-1} was dissolved.

From the above mentioned reasons the using of hydrochloric acid, as well as oxalic and citric acids are unappropriate for sorbents regeneration.

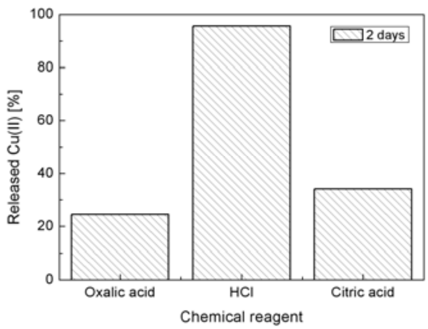

Fig. 2 Effect of chemical leaching after 2 days of regeneration

Bacterial regeneration of the sorbents

Already after 3 days of bioleaching bacteria dissolved 71 % of Cu(II) from the montmorillonite and 67 % Cu(II) from the composite. After 10 days of regeneration, the bacteria released 81 % and 83 % Cu(II), respectively, Fig. 3, leaving the sorbent stable. Monitoring the Fe(III) dissolution from the composite with adsorbed Cu(II), the concentration of dissolved iron ions was low, especially in first 2 days, Fig. 4, in comparison with dissolution from the as-prepared composite. Higher Fe(III) dissolution was observed in the 9th day of bioleaching. From these results can be concluded, that the dissolution of Fe ions is restricted by the presence of Cu(II), what means, that the Cu(II) cations were adsorbed preferentially by maghemite particles precipitated on the montmorillonite surface of the composite.

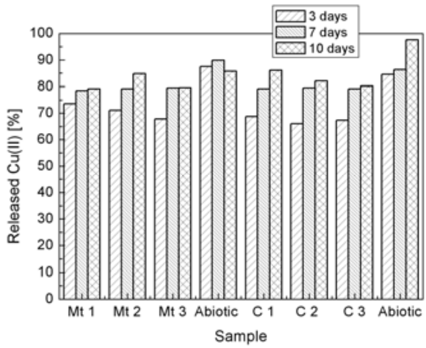

Fig. 3 Effect of bacterial regeneration of sorbents during the selected days in comparison with abiotic control (Mt – montmorillonite, C – composite)

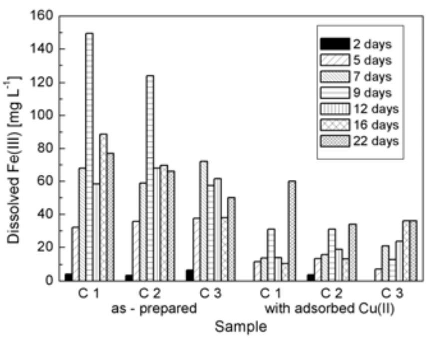

Fig. 4 Effect of bacteria on Fe(III) dissolution from the as-prepared composite and composite with adsorbed Cu (II) during selected days

The regenerated composite material, after 5 day of bioleaching, was repeatedly used for adsorption, where almost 72 % Cu(II) was removed from the model solution. After the bioregeneration the adsorption capacity of the sorbent a little bit decreased in comparison to as-prepared, but bacteria did not influence its structural changes, leaving it stable after the process.

During the control experiments (abiotic control) the sorbents with the adsorbed Cu(II) were treated by medium used for the bioregeneration, without the bacteria. Interesting results were obtained from these experiments. Comparing the Cu(II) release, higher amounts were obtained by abiotic treatment, Fig. 3. The used medium contained the chelating reagent Na_2EDTA, accelerating the bacterial processes. Therefore, pure, less concentrated reagent was also tested in the process of regeneration. After 2 days, almost 100 % of adsorbed Cu(II) was dissolved from the montmorillonite and more than 80 % from the composite. As followed from the results, this kind of regeneration is more appropriate for the natural montmorillonite, while for the composite, combination of medium with chelating reagent used for the abiotic control seems to be more effective.

Also, the influence of bacteria on the Cu(II) release without Na_2EDTA in the medium was studied after 2 and 5 days of bioleaching. Approximately 9 % and 8 % of adsorbed Cu(II) was dissolved from the montmorillonite and composite, respectively. For both sorbents, the bacterial efficiency decreased after 5th day of bioleaching. Lower dissolved amounts of Cu(II) in comparison with abiotic control, as well as decrease in releasing during the bacterial treating without Na_2EDTA in the medium could be caused by reverse adsorption of dissolved Cu(II) by bacteria. From these results it can be stated that heterothrophic indigenous bacteria could be used preferentially as sorbents or components of materials for heavy metals cations adsorption.

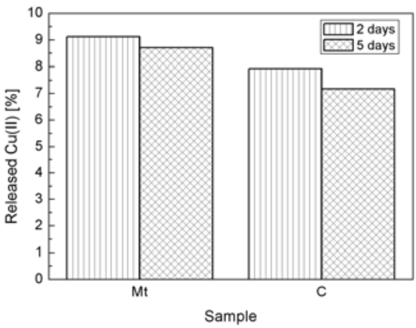

Fig. 5 Effect of bacterial regeneration of sorbents during two selected days using medium without Na_2EDTA (Mt – montmorillonite, C – composite)

CONCLUSION

Initial experiments of sorbents regeneration by heterothrophic indigenous bacteria as well as by inorganic and organic acids were performed in this study. The natural montmorillonite and composite prepared by precipitation of maghemite on the montmorillonite surface were used as Cu(II) sorbents. Treating by inorganic and organic acid is not appropriate for their regeneration; except of Cu(II), high amount of Fe(III) was also dissolved from the composite surface in short time period. During the bacterial treatment almost 82 % Cu(II) was released from the montmorillonite and 78 % from the composite, what was lower amount than was obtained from the abiotic control (83 % and 98 %, respectively), due to adsorption of dissolved Cu(II) by bacteria. The sorbents treatment by Na_2EDTA without the components in medium dissolved almost whole adsorbed Cu(II) amount from the montmorillonite and approximately 80 % from the composite. Regeneration by bacteria without Na_2EDTA in the medium was very slow and not so efficient, decrease in dissolved amount of Cu(II) was observed due to the reverse Cu(II) adsorption by bacteria. These experiments showed that chemical method using the chelating reagent is cheap, fast and convenient way of sorbents regeneration. On the other hand, usage of heterothrophic indigenous bacteria in combination with other sorbents seems to be effective for waste waters treatment.

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REFERENCES

[1] M. Galamboš, O. Rosskopfová, J. Kufčáková & P. Rajec. Utilization of Slovak bentonites in deposition of high-level radioactive waste and spent nuclear fuel. Journal of Radioanalytical and Nuclear Chemistry, Slovak Republic, vol. 288, pp 765-777, 2011.

[2] V. Copcia, C. Hristodor, C. Luchian, N. Bilba & I. Sandu. Ammonium nitrogen removal from aqueous solution by natural clay. Revista de Chímíe, Romania, vol. 61,pp. 1192-1196, 2010.

[3] G.N. Pshinko, S.A. Kobets, A.A. Bogolepov & V.V. Goncharuk. Treatment of waters containing uranium with saponite clay. Journal of Water Chemistry and Technology, Ukraine, vol. 32, pp. 10-16, 2010.

[4] Ch. Wang, L.C. Juang, C.K. Lee, T.C. Hsu, J.F. Lee, H.P. Chao, Effects of exchanged surfactant cations on the pore structure and adsorption characteristics of montmorillonite, J. Colloid Interfac., China, vol. 280, pp. 27-35, 2008.

[5] Y. Chen, B. Zhu, D. Wu, O. Wang, Y. Yang, W. Ye & J. Guo. Eu(III) adsorption using di(2-thylhexly) phosphoric acid-immobilized magnetic GMZ bentonite. Chemical Engineering Journal, China, vol. 181 -182, pp. 387-396, 2012.

[6] V. Copcia, C. Hristodor, N. Bilba, E & Popovici. Use of natural and modified clay for Zn^{2+} removal. Revista de Chímíe, Romania, vol. 62, pp. 195-198, 2011.

[7] G. Wang, K. Chen, W. Li, T. Liu, L. Qi, X. Zhang, Y. Zhang, L. Jiang, H. Zhu, Y. Zhu & J. Wang. Preparation of nano magnetic modified bentonite materials for reclamation of coking wastewater. ICMREE2011 – Proceedings 2011 International Conference on Materials for Renewable Energy and Environment, China, vol. 1, pp.1027-1030, 2011.

[8] W.Q. Wang, Q.M. Feng, F. Dong, H. Li & X. Zhao. Preparation and properties of Fe3O4/clinoptilolite magnetic composite. Wuji Cailiao Xuebao/Journal of Inorganic Materials, China, vol. 25, pp. 401-405, 2010.

[9] W. Wenjuan, Ch. Changwei, W. Xin & S. Li. Effect of the structure and acidic property of activated bentonite on removal of olefin aromatics. China Petroleum Processing and Petrochemical Technology, China, vol. 4, pp. 23-26, 2009.

[10] E. Katsou, S. Malamis, M. Tzanoudaki, K.J. Haralambous & M. Loizidou. Regeneration of natural zeolite polluted by lead and zinc in wastewater treatment systems. Journal of Hazardous Materials, Greece, vol. 189, p. 773-786, 2011.

[11] K. Gedik & I. Imamoglu. Removal of cadmium from aqueous solutions using clinoptilolite: Influence of pretreatment and regeneration. Journal of Hazardous Materials, Turkey, vol. 155, pp.385-392, 2008.

[12] K. Jesenák, Ľ. Kuchta, L. Guller & J. Fúsková. Physico-chemical Properties of Bentonite "Stará Kremnička - Jelšový potok": I. Particle Size Distribution, Mineralia Slovaca, Slovak Republic, vol. 29, pp. 439-442, 1997.

[13] K. Jesenák, V. Hlavatý, Laboratory Device for Sedimentation of Fine Bentonite Fractions, Scripta Fac.Sci.Nat.Univ.Masarik. Brun. Geology, Slovak Republic, vol. 28-29, pp. 33 – 36, 2000.

[14] Š. Jakabský, M. Lovás & F. Blaško. Ussing of the ferromagnetic fluids in mineral processing. Vojenská letecká akadémia gen. Milana Rastislava Štefánika, Košice, Slovak Republic, 2004, p.22.

CLEANING METHOD OF CERTEJ MINE WATERS, IN ORDER TO DISCHARGE THEM IN EFFLUENTS

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ABSTRACT

Mining activities for underground and surface extraction of useful minerals generate a change in local hydrostatic levels, requiring the drainage of the resulted water.
Owing to water contact with the existing mineralization, mine waters are generally loaded with suspended material and heavy metal ions and have an acid pH.
The mine waters continue to be polluting factors for that area and for water courses, even if the mining activity is closed.
Therefore is particularly important to study the limitation of polluting effects of mine waters and if possible, the recovery of useful metals from them. The paper goal is to present the characteristics of mine waters from Certej mining area, the suitable techniques for mine water cleaning and finally, some results of a first research stage, applying a method of mine water treatment based on the co-precipitation of heavy metal ions with lime.
The research has revealed the conditions in which heavy metal ion content decrease can be realized in order to meet the quality conditions for waters discharged in natural receptors. Except the lead ions (that have the content within the allowed limits) the efficiency of heavy metal ion content reduction was of over 93%, in the determined working conditions.
It has been established the requirement for the flocculent dosage and consumption in the precipitate decantation phase and the aeration of clean water, to reduce its alkalinity under the allowed limit (pH=8.5).
Keywords: mine water, pH, metal ions, pollution, treatment, lime, precipitation

INTRODUCTION

Mining activity in underground and surface exploitations is associated with significant local changes in the patterns of land cover, affecting both qualitative and especially quantitative the regional hydrological regime. They generate significant quantities of dissolved mineral substances that are driven to the receiving water accumulations even after the mining activity is ended.

In Certej mining perimeter are located the following deposits: Coranda, Baiaga, Săcărâmb and Bocşa – Săcărâmb, fields in which, according to the existing techno – economic context at a given moment the exploiting activity has taken place.
Certej Valley is the main collector from the central area of the studied perimeter. After crossing the mountain area with a large catchment supplied by a high torrential network

Certej Valley incorporates rainwaters, minewaters and technological waters bearing pollutants. The presented analysis concerning the activities carried out during the objective conservation leads to the following sources of water pollution:

- Rainwaters percolating the sterile and ore layers in micro quarry and mine galleries areas;
- Appearance of water bogging from seepages in pond bottom
- Polluted water seepage in underground waters;
- Sterile bearing from the pond, by the rainwater on neighboring land
- Sewage

Analysis results for water samples from this perimeter, presented in table 1, showed overcomes for main contaminant concentrations (Mn, Zn, Fe) of ten even hundred times compared with the allowed values foreseen in regulations for discharge of waste water in natural receivers [1] and for surface waters [2]. The concentration values for the other heavy metal ions (Cu,Cd, Ni), exceed by several, even ten times the allowed limits while the sulphate values exceed the limit by 19 times. High water acidity can also be remarked (pH between 2.54 and 5.83)

Table 1 Characteristics of water from Certej perimeter

Water	pH	Concentration, mg/L										
		SO_4^{2-}	Cu	Pb	Zn	Cd	Fe	Mn	Ni	Cr	Ca	Mg
Băiaga	2,54	11630	14,1	0,32	919,2	9,77	2726	861	7,82	0,16	312	129
Coranda + Băiaga	3,30	787	1,01	0,05	37,12	0,32	40,8	59,1	0,55	0,02	124	61
Coranda	2,95	1648	1,43	0,12	75,65	0,67	68,4	114	0,95	0,02	232	68
Mina Certej,	5,83	1145	0,17	0,06	7,57	0,05	0,29	87,7	0,06	sld	312	109
Hondol stream	3,20	1095	1,19	0,08	49,37	0,44	48,6	78,7	0,72	0,01	156	68

From the analyzed waters, the most polluted is the one from Băiaga mine, with a flow of 260 m^3/day, representing 20% of the total water flow from the whole perimeter.

An effective treatment involves the generation of water with neutral pH, low acidity and decreasing the zinc, iron and other metal content below the admissible values from environment legislation. To be attractive, this process must be low cost, easy to install, maintain and generate limited quantities of solid wastes.

Given that water flows resulted from the ore exploitation from the Certej area are hundreds of cubic meters per day and that contamination contents are high, these waters being discharged directly into the nearby emissaries, lead to quality degradation. So, the paper goal is to study the mine water characteristics in Certej area and to present the research for pollution level reducing of this water, because now, the main receiver – Hondol stream – in which these waters flow, is strongly contaminated, relative to the characteristic parameter values imposed for waters discharged in natural receptors [1] and to those imposed for surface waters [2].

During the years, many treatment attempts have been made on the waters from the mines with several technologies, common precipitation with various chemical reagents and through ionic exchange, with synthetic resins or with ion exchange membranes.

Following these experiments it has been established that the best way, economically speaking, is to co-precipitate heavy metal ions with lime.
The neutralization of acid mine waters is done by adding an alkaline substance to raise the pH level, which reduces the solubility of metal ions. The necessary pH for minimum solubility varies with the metal type, but most neutralization installations work with a pH between 9 and 12. Several neutralization agents can be used: lime, which is the most commonly used because of its availability, low cost and high efficiency, sodium hydroxide, magnesium hydroxide, chalk, sodium sulfide and ammonia [3, 4].
The most used is the lime, which forms calcium hydroxide in the presence of water [5]:

$$CaO + H_2O \rightarrow Ca(OH)_2 \quad (1)$$

$$Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^- \quad (2)$$

Following the dissolution of the hydrated lime, the pH rises and the metal ions precipitate as hydroxides. For example:

$$Cu^{2+} + 2OH^- \rightarrow Cu(OH)_2 \quad (3)$$

There for the water treatment experimentations made on samples collected from each water, followed the optimum conditions that lead to an advanced neutralization of waters, using hydrated lime.

WATERS TREATMENT EXPERIMENATIONS

The first research stage aimed on the establishment of lime dosage that can reduce water acidity and its ion contents. Depending on the water quality from the 4 sampling points, the lime dosage varied between 0.4 and 8 g/l for the Băiaga water, the most unpurified and between 0,2 and 1 g/l for the other samples.

The neutralization conditions were: reaction (conditioning) time: 20 minutes; decantation time after conditioning: 30 minutes.
The quality of the hydrated lime used for experimentations was 86,2% active substance (CaO). After the decantation of the resulted precipitate, the samples were filtrated, and the filtrate was analyzed through atomic absorption. The obtained results, pH values and treatment efficiency (the percentage ratio between the content obtained after treatment and the one before treatment), are presented in table 2.
As it can be seen, for Băiaga water, the heavy metal ion removal yields are over 95 % when the lime dose was increased at 7 g/L, without decreasing the Zn, Cd, Fe, Mn ion content to admissible values from environment legislation.
Increasing the lime dose to 8g/L, residual heavy metals ion contents fall below the admissible values but the water alkalinity increases over the admissible value (9.9).
It must be noted the fact that by increasing the pH value appears the possibility of dissolving heavy metals hydroxides with amphoteric character.
For the water sample resulted after mixing the Coranda quarry sample with the Băiaga mine water, the efficiency of ion content reduction reaches values of over 94% when the lime dose increased to 1 g/l, except the one realized for lead ions that instead are in concentrations under the allowed values foreseen in regulations even without water treatment and for cooper ion content that reaches a maximum of 87% for 0.6 g/l lime dose.
Manganese ion content reduction under the minimum allowed value is obtained only with a 1 g/l lime dose, but a very high pH value increase, up to 11.93, is detected.

Table 2 The results of treatment with lime for different specific doses

Water	Lime g/L	pH	Treatment efficiency, %						
			Cu	Pb	Zn	Cd	Fe	Mn	Ni
Băiaga	0	2.54	-	-	-	-	-	-	-
	0.4	2.70	17.73	3.12	10.17	3.38	32.94	9.00	6.26
	0.6	2.86	19.15	4.06	14.52	13.20	46.98	24.44	9.21
	2.0	3.74	26.60	34.37	28.13	15.56	59.23	36.63	11.38
	4.0	4.10	34.75	40.00	31.93	35.52	62.85	38.44	16.88
	4.5	4.85	44.33	46.87	65.06	45.85	82.62	46.12	20.33
	5.0	5.30	82.06	56.25	75.68	56.50	89.58	55.80	58.06
	6.0	6.55	99.61	64.06	99.64	74.41	95.33	78.71	72.50
	6.5	8.65	99.87	68.75	99.80	88.99	99.62	87.76	85.04
	7.0	9.60	99.85	97.81	99.82	98.92	99.87	95.16	95.91
	8.0	9.90	99.57	100	100	99.42	99.95	99.90	97.95
Coranda + Băiaga	0	3.3	-	-	-	-	-	-	-
	0.2	5.45	21.78	4.00	3.02	9.68	16.11	3.30	12.73
	0.4	7.02	83.17	4.00	60.00	45.16	96.62	5.27	53.64
	0.6	8.73	87.13	8.00	95.29	93.23	97.06	74.88	80.55
	1.0	11.93	72.28	20.00	98.76	98.39	94.19	99.52	97.27
Coranda	0	2.95	-	-	-	-	-	-	-
	0.2	4.35	70.13	16.88	86.23	22.97	25.14	8.38	18.56
	0.4	6.98	87.41	27.50	91.62	37.91	86.46	14.02	51.78
	0.6	8.90	95.10	54.17	96.19	95.67	93.80	77.23	97.68
	1.0	10.85	93.71	65.00	98.97	99.40	95.32	99.26	97.89
Hondol stream	0	3.20	-	-	-	-	-	-	-
	0.2	6.95	52.10	12.50	45.51	36.94	70.39	5.40	59.72
	0.4	8.50	92.44	12.50	93.62	87.61	90.88	84.25	91.53
	0.6	9.60	97.73	25,00	99.65	95.75	99.36	97.93	91.81
	1.0	11.85	91.00	37.50	94.02	98.20	95.34	99.68	94.58

The major alkalinity increase for lime doses of over 0.6 g/t also determine the decrease of the treatment efficiency for cooper and iron ions, due to the dissolution of formed precipitates. As a consequence, for this water, we can consider the most indicated lime dose to be of 0.6 g/l.

For the water sample from Coranda quarry, the efficiency of ion content reduction is over 94% at a specific lime dose of 0.6 g/l, except the one obtained for lead ions (with contents under the allowed values foreseen in regulations) and for manganese ions that, at an efficiency value of only 77.23% records a remnant content of 26.1 mg/l, way over the allowed limit.

In this case the lime dose increase to 1 g/l is benefic for the ion content reduction under the allowed values foreseen in regulations, but the pH value increases very much (10.85), thus we appreciate that the lime dose should remain at 0.6 g/l.

The most important results are the ones obtained for the sample from Hondol creek, after it receives the waters from Băiaga mine and Coranda quarry. It can be observed that in this case also, the efficiency of ion content reduction is high (over 97.7%) for all metals, except lead; the lime dose increase to 1 g/l determines a decrease of manganese ions to a content that is within the allowed values foreseen in regulations for surface waters (0.248 mg/l). In this case also, we remark the increase in water alkalinity (pH = 11.85), thus imposing its reduction.

TREATMENT OF HONDOL STREAM WATER

On the basis of the obtained results, in the next research phase we aimed to establish the conditions that allow the most complete treatment of the Hondol creek water, this being the main objective of the research. We had in view a more precise determination of the specific lime dose, reaction time strictly necessary, precipitate decantation conditions and clean water aeration.

The determination of specific lime dose for the Hondol creek water sample was realized through a new set of attempts, at specific dosages of 0.6, 0.75 and 0.8 g/l, with a conditioning time of 15 minutes. The best results were obtained at a dosage of 0.75 g/l, as the data from table 3 indicate. These data show the heavy metal content obtained after water treatment in relation to the limits imposed in Romania for the three surface water quality categories. The contents are under the allowed limits, except for the lead and cadmium ion contents, where we have a slight overcome. A higher than the maximum allowed alkalinity is recorded for all lime dosages (pH > 8.5). We appreciate that the best specific dose is 0.75 g/l.

Table 3 The ion content reduction with the lime dose variation

Specification	Lime g/L	pH	Concentration, mg/L						
			Cu	Pb	Zn	Cd	Fe	Mn	Ni
Water from Hondol stream	0	3.20	1.19	0.08	49.37	0.44	48.64	78.75	0.72
	0.60	9.40	0.028	0.068	0.178	0.010	0.320	1.70	0.059
	0.75	9.50	0.026	0.066	0.125	0.005	0.455	0.985	0.055
	0.80	10.27	0.055	0.050	0.160	0.006	0.520	0.720	0.047
Surface waters quality	I class	6.5 - 8.5	0,030	0,010	0,200	0,001	0,500	0,100	0,025
	II class		0,050	0,025	0,500	0,002	1,000	0,300	0,050
	III class		0,100	0,050	1,000	0,005	2,000	1,000	0,100

The conditioning time determination was realized through its variation from 10 to 30 minutes, at a specific lime dose of 0.75 g/l. The obtained results are presented in table 4. It is found that prolonging the conditioning time over 15 minutes doesn't lead to significant reductions in ion contents, a slight increase of iron and cadmium ion contents being recorded, with the water alkalinity increase. As a consequence, we established as necessary and sufficiently the conditioning time of 15 minutes.

Table 4 The ions content reduction at different reaction times

Specification	Reaction times	pH	Concentration, mg/L						
			Cu	Pb	Zn	Cd	Fe	Mn	Ni
Water from Hondol stream	0	3.20	1.19	0.08	49.37	0.44	48.64	78.75	0.72
	10	9.48	0.028	0.069	0.131	0.005	0,462	0.996	0.056
	15	9.50	0.026	0.066	0.125	0.005	0.455	0.985	0.055
	20	9.53	0.025	0.067	0.107	0.006	0.471	0.792	0.055
	30	9.80	0.026	0.053	0.105	0.008	0.480	0.784	0.050
Surface waters quality	I class	6.5 - 8.5	0,030	0,010	0,200	0,001	0,500	0,100	0,025
	II class		0,050	0,025	0,500	0,002	1,000	0,300	0,050
	III class		0,100	0,050	1,000	0,005	2,000	1,000	0,100

The precipitate settling was the next step in establishing the water treatment technology that had in view the determination of precipitate settling conditions. For this purpose precipitate settling tests were made by dosing 0.75 g/l lime, with a conditioning time of 15 minutes. Settling tests were made without and with adding flocculent, several substances were tested. Among them, the most efficient – correlated with a reasonable price – proved to be polyacrylamide P 2300, dosed in 0.001 g/l solution (0.1%), at consumption of 1 ml/l and 2 ml/l. The obtained sedimentation curves are presented in figure 1.

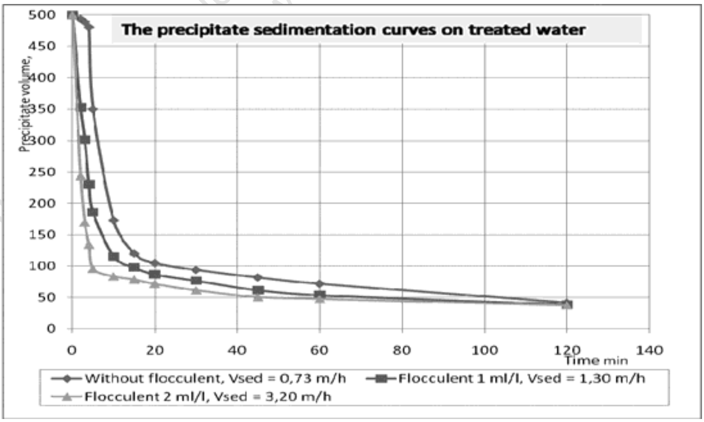

Figure 1. The precipitate sedimentation curves for Certej perimeter waters

The determined sedimentation rates are as follows:
- without flocculent: 0.73 m/h;
- with 0.001 g/l flocculent: 1.3 m/h;
- with 0.002 g/l flocculent: 3.2 m/h.

Analyzing the results, we find it necessary to dose flocculent in order to increase the sedimentation rate, but we feel that with a specific dose of 0.001 g/l the sedimentation occurs satisfactory to ensure a continuous water treatment flow.

Decreasing alkalinity through the aeration of clean water. As we mentioned, at a specific lime dose of 0.75 g/l established as the recommended dose for heavy metal ion precipitation, the water alkalinity considerably exceeds the maximum allowed limit. In order to correct this characteristic, we can use aeration while conditioning with lime, or in the clean water. We choose the second option, which we consider to be easier to realize from a technical point of view. Thus, on samples of water obtained after removing the sediment obtained by dosing flocculent (1 ml/l) and after 15 minutes settling time, the aeration process took place at variable air flows between 1.5 and 3 l/h per liter of water. The injection time was of 60 minutes. The pH values obtained after aeration at various flows are presented in figure 2 and point out that a 2 m^3/h aeration flow for 1 m^3 of water is sufficient to reduce the pH value under the allowed limit for surface waters. The increase of air flow over this value determines an insignificant decrease of pH.

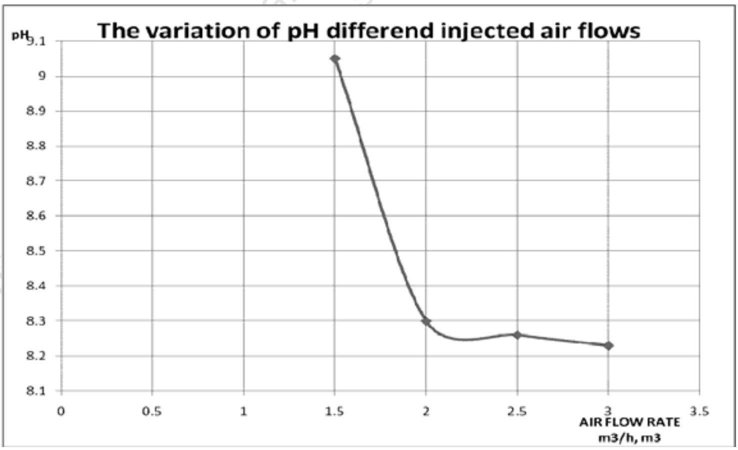

Figure 2. The variation of pH at different injected air flows

CONCLUSIONS

1. Analysis results for mine waters and the one from Hondol creek collector proved a strong pollution, imposing the establishment and application of a heavy metal ion content decrease treatment.
2. Among the analyzed methods, the most convenient both in terms of technological efficiency and economic ratability has proven to be lime treatment, followed by precipitation, clean solution separation and its aeration.
3. Research showed the conditions in which a heavy metal ion content reduction can be realized to meet the quality conditions for waters discharged in natural receptors. Except lead ions, the efficiency of content reduction was, for all the elements, over 93%, in stable working conditions.
4. It has been established the necessity of a flocculent dose of 0.001 g/l in the precipitate settling phase and the aeration at a flow of 2 m^3/h, m^3 clean water, to reduce its alkalinity under the accepted limit (pH=8.5).
5. Based on the obtained results, the treatment plant will be designed for the main natural receptor of the mine waters for Certej area.

REFERENCES

[1] *** NTPA 001, Load limit values for polluants in waste water discharged in natural receivers, published in Oficial Monitor no.187, Romania, 2002;

[2] *** Governent Order No.161, Norms on surface water quality classification in order to establish the ecological status of water bodies, Elements and quality standards for physical and chemical characteristics of waters, published in Oficial Monitor no.511, Romania, 2006;

[3] Kalin M., The chemistry of conventional and alternative treatment systems for the neutralisation of acid mine drainage, Science for total environment, No.366, Netherlands, 2006, p.395-408;

[4] Johnson D.B., Hallberg B.K., Acid mine drainage remediation options: a review, Science for total environment, No.338, Netherlands, 2005, p.3-14;

[5] Negulescu M., Waste water treatment, vol. II, 1989, Romania, 1980, p.214-220

MICROCLIMATE INFLUENCE ON THE DYNAMICS OF EDIBLE LAND SNAIL HELIX POMATIA POPULATIONS IN THE CONTEXT OF ITS SUSTAINABLE USE. STUDY CASE SOUTHERN TRANSYLVANIA

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ABSTRACT

The dynamics of four population of *Helix pomatia* was analyzed in southern Transylvania, with respect to regional climate and microclimatic conditions. Populations were selected from the most representative habitat types for the species' presence. Mathematic models were described by factorial analysis, in order to frame the evolution of population dynamics function the biotope factors. The considered variables were the abundance (in terms of number and biomass) and on the other hand the air and soil temperature, soil relative humidity (all recorded during the sampling), and also the mean monthly values of air temperature and precipitations. In the analyzed populations the density values decreased significantly troughout the research period, between 1997 and 2000. The most significant correlations were found between the number of individuals and the soil temperature, number and soil humidity, and biomass and soil humidity. Based on the analysis of vegetation for two counties from southern Transylvania, the area with favorable habitat for *H. pomatia* was assessed at about 6% of the entire surface. This value, associated with data on population density, allows an estimation of the exploitable amount of snails.

Keywords: climate variability, *Helix pomatia*, edible, land snail, Transylvania

INTRODUCTION

Land snails were appreciated from ancient times, as a primary or complementary source of accessible animal protein. Several archaeological findings had proved the importance of these animals in the human diet in Europe (Lubell, 2004, 2004a, Lubell and Barton, 2011). Over time, the status of land snails has evolved in relation with the economic, social and cultural conditions. Some European cultures are even today closely related to this tradition. Among the European land snails consumers the most important are France, Spain, Italy, Greece, and Portugal.

One of the most appreciated edible terrestrial gastropod species is *Helix pomatia*, the Roman snail, often considered the true escargot. Its distribution includes south-eastern and Central Europe, southern England (most probably introduced), from central France to Sweden, Norway, eastern Finland, Estonia, Belarus, Hungary, Romania, Western Ukraine, Moldova, Bulgaria and northern Italy (Kerney and Cameron, 1979, Welter-Schultes, 2012).

The interest in this species is not confined to its use as food, one of the most important no alimentary use is in medicine and pharmacy, documented from antiquity, and continued today (Cranga and Cranga, 1991; Bonnenheim, 2005). The lectine Helix pomatia aglutinin (HPA), used in the past decades, as marker in several forms of cancer, is an additional reason that increased even more the interest in this species (Brooks and Leathem, 1991, Pons et al, 1998, Mitchell and Schumacher, 1999).

While several edible land snail species, introduced accidentally or on purpose, due to their appreciation, have become invasive in different areas, having a major impact on agriculture, natural communities, economic trade, human health (Sanderson and Sirgel, 2002), the distribution of *H. pomatia* has not changed considerably, evidence of its low adaptive capacity. The interest for edible land snails' natural populations' conservation, had experienced during the last years an increase, as the international demand for escargot augmented. Currently, in most western European countries, *H. pomatia* is vulnerable or even endangered, due to habitat destruction, pesticide use, and especially to overexploitation. This has led to the species' inclusion in the red lists of several countries and by default, the interdiction of its collection from the wild. The species is on the list of the Berne Convention, Annex III, and is also included in Annex V of Directive 92/43/EEC on the conservation of natural habitats, fauna and flora (Habitats Directive). Both annexes include vulnerable animal species whose exploitation must be object of management. As the species has suffered an accentuated decline during the last decades in the west European countries, the collecting practice moved towards the eastern Europe, were the species is still widely distributed. The sustainable use of this species requires a real knowledge of its status and of the way the changing climatic conditions and the exploitation may interfere to affect the species' surviving capacity. The past decades have experienced an increased interest concerning the climatic changes, the global warming, and their effect on biodiversity. The climatic changes are long term irreversible phenomena, induced by a complex of natural and anthropogenic causes (Bălteanu, Şerban, 2005; Bogdan, Marinică, 2007). This paper aims to identify the interrelation between the dynamics of *H. pomatia* populations and microclimatic conditions in southern Transylvania, one of the most intensely exploited regions of Romania, in terms of edible land snails.

MATERIAL AND METHODS

Populations were selected from the most representative habitat types for the species' presence, and the species dynamics was followed by quantitative monthly sampling (25 sampling plots of $1m^2$, each month in every station) during three years, in the active period, beginning with May (in order to allow all the snails to emerge) and ending with September, in the years 1997, 1999, and 2000. The analyzed interval was selected in order to include a year with extreme meteorological conditions. Microclimatic conditions were also recorded: air and soil humidity and temperature. The sampling points' characteristics are presented in table 1. Regression models were used in order to frame the evolution of population dynamics function the biotope factors. The considered variables were the abundance (in terms of number and biomass) and on the other hand the air and soil temperature, soil relative humidity (all recorded during the sampling), and also the mean of monthly values of air temperature and precipitations.

An analysis of the climatic parameters for the interval 1970 -2006 was accomplished for the research area. In order to highlight the great fluctuation of the regional climate and its variation trend, the sliding mean, computed on successive intervals of five years, offset a year, was calculated. This method was used to show temperature and precipitation fluctuations and their variation tendency for the warm months. Intensity of climatic phenomena was estimated by deviation from the mean.

Table 1. Characteristics of sampling sites: climatic parameters: the mean values of air temperature (Tam), soil temperature (Tsm), soil relative humidity (URm); soil properties; vegetation (vegetal association, tree and herbaceous cover). Station abbreviation: S1 – Tocile, S2 – Dumbrava , S3 – Avrig, S4 – Sâmbata.

station	**year**	**Tam (°C)**	**Tsm (°C)**	**URm (%)**	**soil**	**vegetation**
S1	1997	22.76	14.86	20.8	luvisoils, phaeosioms, with gleic properties, high water content, increased compactibility and impermeability	*Salicetum albae-fragilis* next to an abandoned orchard tree cover – 27.5% herbaceous cover-41.5%
	1999	22.64	14.92	20.6		
	2000	23.6	16.44	14.6		
	mean	**23**	**15.40**	**18.66**		
S2	1997	21.14	14.52	22.8		*Quercetum roburi* tree cover -52% herbaceous cover -36.5%
	1999	22.5	15.42	24		
	2000	23.4	16.6	15.2		
	mean	**22.34**	**15.51**	**20.66**		
S3	1997	22.5	14.36	20.2	cambisoils luvisoils, aluvialsoils high porosity and permeability, due to the presence of sands and gravels	*Salicetum albae-fragilis* tree cover -22.5% herbaceous cover -48%
	1999	22.36	14.4	20		
	2000	23.8	17.52	13.6		
	mean	**22.88**	**15.42**	**17.93**		
S4	1997	22.72	14.64	21		*Aegopodio-Alnetum glutinosae* tree cover -30.5% herbaceous cover -32%
	1999	21.54	11.74	18.8		
	2000	23.84	16.3	12.4		
	mean	**22.7**	**14.22**	**17.4**		

RESULTS AND DISCUSSIONS

The selected populations have experienced an important decrease during the research period, both in terms of number and biomass. During the study the abundance of the analyzed populations ranged between 1.55 ind./m^2 and 0.13 ind./m^2, in terms of specimens number and between 12.7 g/m^2 and 0.47 g/m^2 in terms of biomass (table 2, figures 1, 2). The highest values were recorded in 1997 in Dumbrava Forest, while the year 2000 was characterized by the lowest values recorded in two different sampling points on alluvial soil (Avrig and Sambata). Regarding the mean values of abundance, the numeric density ranged between 0.318±0.186 ind./m^2 (in 2000) and 0.836±0.495 ind./m^2 (in 1997). The U Mann – Whitney test used to compare the values recorded during the three years, show a statistic difference ($p \leq 0,05$) between 1999 and 2000 both for number and biomass, except Sambata station were, a statistically significant difference was found only between 1997 and 2000. In all stations the snails were active during May, the months June and July being characterized by a constant and approximately equal activity. The numeric increase registered in August and September is consecutive to hatching. As a result, the biomass, although having the same tendency, is not proportional with the numeric increase. The biomass reduction in September is due to the fact that adult snails enter earlier in hibernation, especially when the climatic conditions are inappropriate, while the juveniles, and particularly the hatchlings, need to get sufficient reserves before wintering, so they will take advantage on the available vegetation as long as possible. The regression analyze shows significant correlations between the following parameters: N and Ts, (r^2= 0,82), N and UR (r^2= 0,82), B and UR (r^2= 0,841).

Table 2. The abundance (number – N and biomass - B) of the four populations of *Helix pomatia* (average ± SD - standard deviation of the monthly values in 1997, 1999 and 2000, as well as minimum and maximum values).

	TOCILE			DUMBRAVA		
	1997	**1999**	**2000**	**1997**	**1999**	**2000**
N	0.684 ±0.363 min=0.41 max=1.25	0.65 ±0.271 min=0,40 max=1,04	0.358 ±0.0732 min=0,27 max=0,46	**0.836** **±0.495** min=0.44 **max=1.55**	0.6 ±0.211 min=0.40 max=0.90	0.49 ±0.153 min=0.33 max=0.73
B	5.762 ±2.304 min=2.88 max=9.23	5.738 ±1.539 min=3.76 max=7.48	2.774 ±1.280 min=1.25 max=4.12	**8.238** **±3.184** min=4.51 **max=12.7**	6.512 ±2.626 min=3.90 max=10	4.994 ±0.812 min=3.93 max=5.73
	AVRIG			**SAMBATA**		
	1997	**1999**	**2000**	**1997**	**1999**	**2000**
N	0.768 ±0.148 min=0.56 max=0.96	0.76 ±0.156 min=0.60 max=0.97	**0.318** **±0.186** **min=0.13** max=0.60	0.82 ±0.231 min=0.52 max=1.04	0.58 ±0.269 min=0.33 max=1.03	0.344 ±0.155 min=0.14 max=0.53
B	7.08 ±1.584 min=7.31 max=10.2	7.222 ±2.307 min=3.90 max=10.3	3.692 ±2.567 min=0.61 max=6.91	7.172 ±2.292 min=5.81 max=10.6	4.692 ±1.482 min=2.29 max=6.03	**2.69** **±2.680** **min=0.47** max=6.52

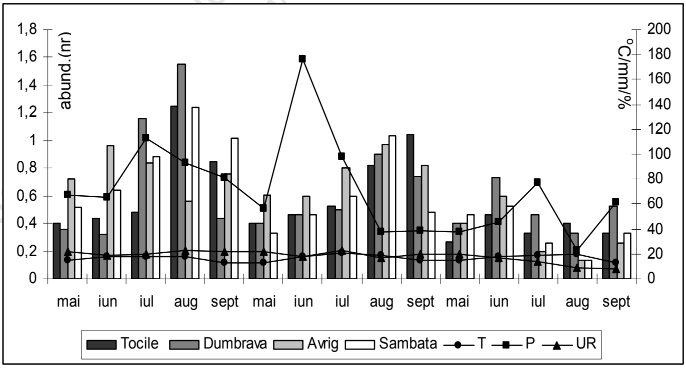

Figure 1. Numerical abundance dynamics of the *Helix pomatia* populations in the sampling months (May-September), during the three years of study (1997, 1999, 2000), plotted against the dynamics of climatic conditions: (temperature (°C), precipitations (mm) and soil relative humidity (UR %).

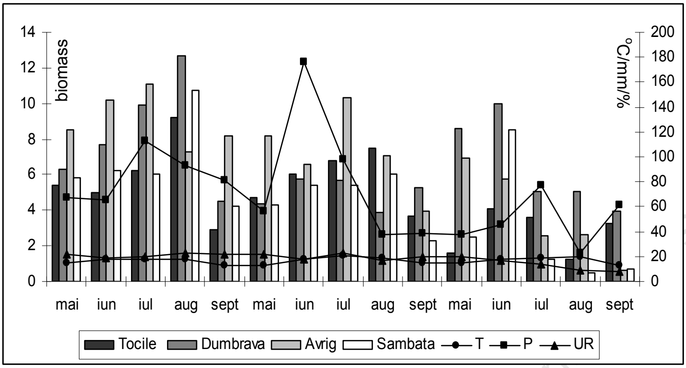

Figure 2. Biomass dynamics of the researched *Helix pomatia* populations in the sampling months (May-September), for the three years of study (1997, 1999, 2000), plotted against the dynamics of climatic conditions (temperature (^{o}C), precipitations (mm) and soil relative humidity (UR %).

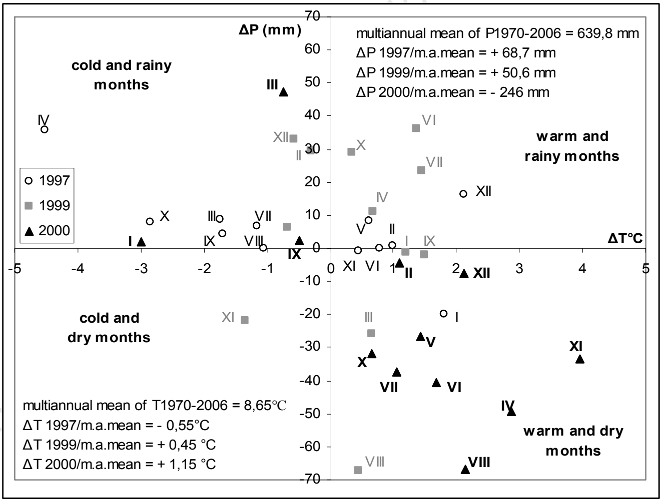

Figure 3. Deviations climographs (for 1997, 1999, and 2000) of the monthly regime from the multiannual mean recorded at Sibiu meteorological station

The significant decrease, both in terms of specimens' number and biomass, as represented in the figures 2 and 3, is more important for the year 2000, an especially warm and dry year. The regression analysis underlines the fact that the small amount of precipitations and the high temperatures recorded in 2000 (as represented in figures 4 and 5), are correlated with the populations' parameters (number and biomass) not directly, but through soil temperature and humidity. The climatologic analysis shows that in 2000 the monthly multiannual mean of air temperature in summer have been exceeded by 1-2° C, and monthly maximums were 28.7°C in May, 34.5°C in June, 36.6°C in July and 36.2°C in August, with a 3-10 tropical days (T > 30°C) in every month, leading to the loss of moisture from the air and soil. The pedological drought was exacerbated by the scarcity of rainfall in all months, especially in the warm seasons of the year. The deviations climograph indicates for almost all months of 2000 a warm and dry regime, except for March, when rainfall exceeded twice the monthly multiannual mean. Very high negative deviations (–26 to –66 mm) recorded between April and August (fig. 3) could not be compensated by positive deviations from March (47.3 mm) and September (2.4 mm). This has severe consequences on snails population.

The monthly values of climatic parameters during the warm season indicate the occurrence of warming or cooling phenomena, the precipitation deficit or surplus, produced suddenly and with extreme intensity. The sliding mean of the monthly temperature values for the interval 1970-2006 indicate a slight upward trend. The largest positive deviation was recorded in the last decade (+2.3°C in April 2000; +2.7 °C in May 2003; +2.5 °C in June 2003). There is also a continuity of these deviations in the same year in two to four consecutive months (April-July in 2000; May-July in 2002; May-June in 2003). For the precipitations, the sliding mean indicates a downward trend for May and June, and a slide increase in July. The largest negative deviations were recorded throughout the last decade (May 2000 – 43 mm; May 2002 – 45 mm; June 2000 – 70 mm; June 2003 – 95 mm). In 2003, the monthly amount of rainfall in June, normally the rainiest month of the year, was only 2.5 mm. The precipitation deficit has a continuity of two to five months (April-August in 2000; April-July in 2002; April-August in 2003). This overlap between positive deviations of temperature and negative deviation of rainfall is recorded with the highest intensity of phenomena, especially in 2000-2003; afterwards, their intensity decreases.

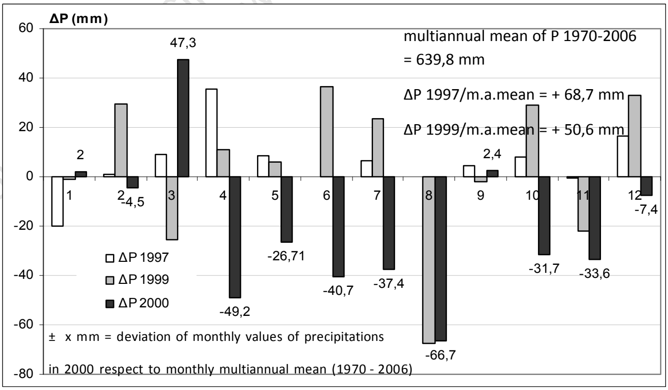

Figure 4. Deviation of monthly precipitation amounts of the years 1997, 1999, 2000 with respect to monthly multiannual mean of 1970- 2006 period (data from Sibiu climatologic station).

It can be observed a simultaneous association of phenomena that occur in opposite sense (increase of temperature and decrease of precipitation), as well as a sequence of thermal and pluvial phenomena occurring in opposite sense (deficit followed by exceeding precipitations). In addition, for the rainfall were recorded maximum values in a very short time (24 hours), and the concentration in a single month of the interval April – August. Rainfall in 24 hours represents frequently 70-90% of the monthly multiannual mean.

As demonstrated by the populations' dynamics, the preservation of an optimal microclimate for the development of *Helix pomatia* is influenced by different factors, as the soil properties and vegetation. A soil with high permeability can not retain enough water, a property which influences land snails, both directly, because of their water dependence, and indirectly, through vegetation quantity and quality. Also, a reduced tree and herbaceous vegetation cover can have a detrimental effect on microclimatic conditions, by allowing a fast evaporation. The fact that the most significant decrease of population was recorded in the sampling stations Avrig and Sambata, both with alluvial soils and a reduced retention capacity (as presented in table 1), underlines the importance of soil properties for the maintenance of ecosystems' homeostasis, and consequently for the equilibrium of populations' parameters in species with low adaptive capacity, as is the case of *Helix pomatia.* This effect is accentuated by a reduced tree cover (table 1), which can not prevent the water loss by evaporation.

CONCLUSIONS

The Roman snail is collected for commercial purposes in Romania, starting the fifties, but this practice was more significant during the last two decades, due to the growing demand on European market. Although this species' collection is regulated and is allowed only with an authorization, frequently the terms of collection are violated concerning the collected quantities and snails dimensions. Habitat degradation, especially due to the development of agriculture and deforestation (and we underline in this context especially the unauthorized cuts of wood from meadows, which represent the most appreciated habitat not just by *Helix pomatia,* but also by many other land snail species), can also imperil *H. pomatia* populations. At this moment, an analysis of southern Transylvania, based on vegetation maps, reveals an amount of 6% of total area, favorable for this species' development, area which is in decrease. In addition, random phenomena such as anomalous weather conditions, becoming more common in the last years, can unbalance the population. In order to perform a sustainable use of the edible land snails, multiple elements have to be considered. Regional climate variability, associated with changes of microhabitat conditions as soil texture and vegetation coverage can affect the annual and multiannual dynamics of *H. pomatia*, an effect which, uncorrelated with an appropriate approach of the harvest, can cause a decline of this species in Romania.

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biotehnology based on the eco-economy and the bioeconomy required by eco-san-genesys”

REFERENCES

[1] Balteanu, D. & Serban, M., Modificari globale ale mediului. O evaluare interdisciplinară a incertitudinilor. Ed Corresi Bucuresti,.231 pp. 2005.

[2] Bogdan O. & Marinica I., Hazarde meteo-climatice din zona temperata, geneza si vulnerabilitate, cu aplicatii la Romania. Ed. ULBS, 422 pp. 2007.

[3] Bonnemain, B., Helix and Drugs: Snails for Western Health Care From Antiquity to the Present, Evid Based Complement Alternat Med; Vol 2 /Issue 1, pp 25–28, 2005.

[4] Brooks SA, & Leathem AJ. Prediction of lymph node involvement in breast cancer by detection of altered glycosylation in the primary tumour. Lancet; 38:71–4, 1991.

[5] Cranga, F., Cranga Y. L’escargot. Zoologie, symbolique, imaginaire, médecine, gastronomie, Dijon, Ed. du Bien Public, 83 pp. 1991.

[6] Kerney, M.P. & Cameron, R.A.D. A Field Guide to the Land Snails of Britain and NW Europe. London, William Collins Sons & Co. Ltd., 288 pp. 1979.

[7] Lubell, D., Prehistoric edible land snails in the circum-Mediterranean: the archaeological evidence, *J.-P. Brugal & J. Desse* (dir.), Petits animaux et sociétés humaines. Du complément alimentaire aux ressources utilitaires. XXIV rencontres internationales d’archéologie et d’histoire d’Antibes, Antibes, APDCA, 2004a: pp.77-98.

[8] Lubell, D, Are land snails a signature for the Mesolithic-Neolithic transition?, Documenta Praehistorica: 31, pp 1-24, 2004b.

[9] Lubell D & N. Barton. Gastropods and Humans in the Late Palaeolithic and Mesolithic of the Western Mediterranean Basin. *Quaternary International* vol. 244, Issue 1, pp 1-5, 2011.

[10] Mitchell B.S. & U. Schumacher, The use of the lectin Helix pomatia agglutinin (HPA) as a prognostic indicator and as a tool in cancer research, *Histol. Histopathol.* 14: pp 217-226, 1999.

[11] Pons, F., Konig M., Michelot R, Meyer M. The bronchorelaxant effect of thee helicidine, a Helix pomatia extract, involves prostaglandin E2 release. Pharmaceutical Biology, Vol. 36, No. 1, pp 13–19, 1998.

[12] Sanderson, G. and W. Sirgel. Helicidae as pests in Australian and South African grapevines, pp. 255-270. In G.M. Barker, editor. Molluscs as crop CABI Publishing, New York, NY. 468 pp 2002.

[13] Welter-Schultes, F. Species summary for Helix pomatia - www.animalbase.uni-goettingen.de (version 12-03-2012).

CLUSTER ANALYSIS OF WATER QUALITY FOR SMOLNIK CREEK, SLOVAKIA

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ABSTRACT

Water quality monitoring has one of the highest priorities in environmental protection policy. The main objectives are to control and minimise the incidence of pollutant-oriented problems, and to provide water of appropriate quality to serve various purposes such as drinking water supply, irrigation water, etc. Multivariate statistical methods including cluster analysis have been used successfully in hydrochemistry for many years. Surface water, groundwater quality assessment and environmental research employing multi-component techniques are well described in the literature. Multivariate statistical approaches allow deriving hidden information from the data set about the possible influences of the environment on water quality. Cluster analysis attempts to explain the correlations between the observations in terms of the underlying clusters, which are not directly observable.

In the present study, cluster analysis is applied to physico-chemical parameters of Smolnik creek, Slovakia, with the aim to classify and summarize data as well as segmentation of large heterogeneous data sets into smaller homogeneous subsets that can be easily managed, separately modelled and analysed. Twelve parameters (pH, Ca, Mg, Fe, Mn, Al, Cu, Zn, As, Cd, Pb) were measured. Samples were collected from five sampling locations. This paper illustrates the usefulness of using statistical techniques in analysing environmental data for better understanding of the behaviour of different parameters.

Keywords: acid mine drainage, heavy metals, cluster analysis

INTRODUCTION

Acid mine drainage (AMD) is considered as one of the worst environmental problems associated with mining activity. Overflowed mine Smolnik produces AMD with high metal concentrations and low value of the pH (about 3-4) as a result of chemical oxidation of sulphides and other chemical processes. Runoff from mining operations can have negative impacts on the surrounding aquatic environment including heavy loads of suspended solids, decreased pH levels and increased levels of heavy metals.

In Slovak republic there are some localities with existing AMD generation conditions. The most critical values were observed in the abandoned deposit Smolnik [1]. This was the reason for starting a systematic monitoring of geochemical development in acid mine drainage in 2004 in order to prepare a prognosis in terms of environmental risk and use of these waters as an atypical source of a wide range of elements [2]. Multivariate statistical methods including factor analysis, cluster analysis, principal components method etc., have been used successfully in hydrochemistry for many years. Surface water, groundwater quality assessment and environmental research employing multi-component techniques are well described in the literature. Multivariate statistical approaches allow deriving hidden information from the data set about the possible influences of the environment on water quality.

MATERIALS AND METHODS

Smolnik is situated in the southeastern Slovakia between villages Smolnik and Smolnicka Huta in the valley of Smolnik creek (fig. 1), 11 km south–west of the village Mnisek nad Hnilcom. Geomorphologically, the locality is situated in the area of Slovenske Rudohorie (Slovak Ore Mountains - West Carpathians).

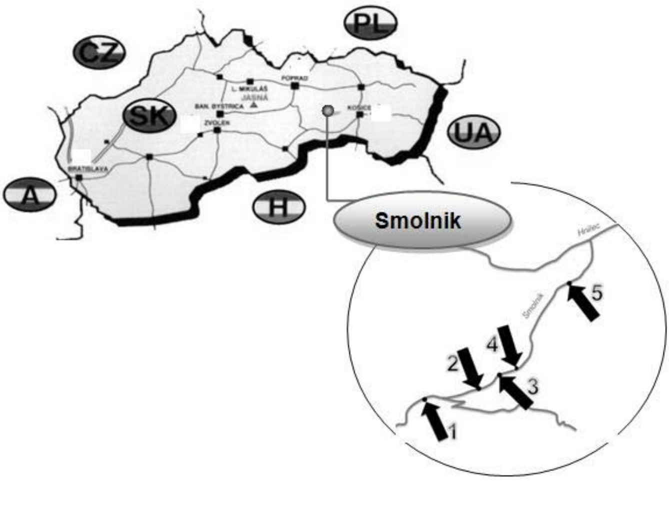

Figure 1 Location Smolnik creek on the map of the Slovak Republic and sampling localities

Water sampling localities are shown in Figure 1. Two localities were in the upper part of the Smolnik creek without contamination by acid mine waters from shaft Pech (1 – outside the Smolnik village, 2 - small bridge - crossing to the shaft Pech) and another two sampling localities were located under the shaft (4 - 200 m under the shaft Pech, 5 – inflow to the Hnilec river). The outflow of AMD from shaft Pech (Smolnik mine) has number 3.

Twenty water samples – surface water were collected from Smolnik creek during years 2006-2011. The chosen physical and chemical parameters were determined by multifunctional equipment METTLER TOLEDO in situ and chemical analyses of water samples were realized in accredited laboratory of State Geological Institute of Dionyz Stur Spišská Nová Ves. The results of chemical analysis of water samples in the Smolnik creek in 2006 - 2011 are presented in Table 1.

Table 1 Mean concentration of results of chemical analyses of water from the Smolnik creek and AMD from the shaft Pech in 2006 – 2011

	pH	Ca	Mg	Fe	Mn	Al	Cu	Zn	As	Cd	Pb
	-	[mg/L]					[µg/L]				
S1	5,69	10,44	3,60	0,16	0,01	0,05	2,75	4,2	1,5	<0,3	<5
S2	5,81	13,10	5,62	1,30	0,19	0,24	15,33	64,83	<1	0,4	<5
S3	3,98	166,17	278	373,67	28,98	75,55	1839,17	8536,5	29	18,37	59,17
S4	5,20	23,83	20,17	33,35	1,58	2,07	152	477,5	1,5	1,02	5,5
S5	5,37	22,18	34,21	8,19	1,22	0,62	70,17	353,5	1	0,7	5

DATA MANAGEMENT AND MULTIVARIATE STATISTICAL TECHNIQUES

Statistical techniques, such as cluster analysis, can provide a powerful tool for analysing water-chemistry data. These methods can be used to test water quality data and determine if samples can be grouped into distinct populations (hydrochemical groups) that may be significant in the geologic context, as well as from a statistical point of view. Cluster analysis was successfully used, for instance, to classify lake samples into geochemical faces [3, 4, 5, 6] also applied cluster analysis to classify water-chemistry data. The assumptions of cluster analysis techniques include homoscedasticity (equal variance) and normal distribution of the variables [4]. Equal weighing of all variables requires the log-transformation and standardization (*z*-scores) of the data, as discussed above. Comparisons based on multiple parameters from different samples are made and the samples grouped according to their "similarity" to each other. The classification of samples according to their parameters is termed Q-mode classification. This approach is commonly applied to water- chemistry investigations in order to define groups of samples that have similar chemical and physical characteristics because rarely is a single parameter sufficient to distinguish between different water types.

Cluster analysis comprises a series of multivariate methods that are used to find true groups of data. In clustering, the objects are grouped such that similar objects fall into the same class [7]. Hierarchical cluster analysis is the most widely applied techniques in the earth sciences and is used in this study. Hierarchical clustering joins the most similar observations, and then successively the next most similar observations. The levels of similarity at which observations are merged are used to construct a dendrogram. Some measure of similarity must be computed between every pair of objects. In this study, a standardized m-space Euclidian distance [8]. Cluster analysis groups variables into clusters on the basis of similarities (or dissimilarities) such that each cluster represents a specific process in a system [9]. For cluster analysis single linkage method was used. In this method the distance between the clusters was determined by the distance of the nearest neighbour in the different cluster (Systat Software Incorporated), as shown in Table 2.

Table 2 Euclidean distance between variables

	pH	Ca	Mg	Fe	Mn	Al	Cu	Zn	As	Cd	Pb
pH	0										
Ca	404	0									
Mg	687	302	0								
Fe	925	539	299	0							
Mn	67	348	629	864	0						
Al	181	242	516	749	118	0					
Cu	4803	4425	4154	3931	4744	4628	0				
Zn	21498	21105	20824	20588	21437	21320	16796	0			
As	76	349	633	869	46	135	4752	21444	0		
Cd	44	374	655	891	30	146	4773	21465	53	0	
Pb	136	271	555	792	78	56	4673	21364	86	105	0

RESULTS AND DISCUSSION

Hierarchical cluster analysis was used to classify the samples into distinct hydochemical groups based on their similarity. In order to determine the relation between groups, the *rxc* data matrix (r samples with c variables) is imported into statistical package. The Statistica (Statsoft, Inc. 2010) has seven similarity/dissimilarity measurements and seven linkage methods and supports up to 300 cases for the amalgamation process in the cluster analysis. Individual samples are compared with the specified similarity/dissimilarity and linkage methods and then grouped into cluster [10].

Hierarchical cluster analysis the data in a relatively simple and direct manner with the results being presented as a dendogram. In the present case, we selected the number of groups based on visual examination of the dendogram (Figure 2). The resulting dendrogram was interpreted to have classified the 330 water samples into five major groups using 11 variables; this however is a subject evaluation. Greater or fewer groups could be defined by moving dashed horizontal line up or down. In addition, the dendogram does not give information about the distribution of the chemical constituents that form each group: a distinct limitation when compared with the graphical techniques. The table 3 shows the groups for each of the parameters produced by the cluster analysis.

Table 3 Groups with variables produce by cluster analysis

Group	Variables
A	pH, Mn, As, Cd, Pb, Al
B	Ca
C	Fe, Mg
D	Cu
E	Zn

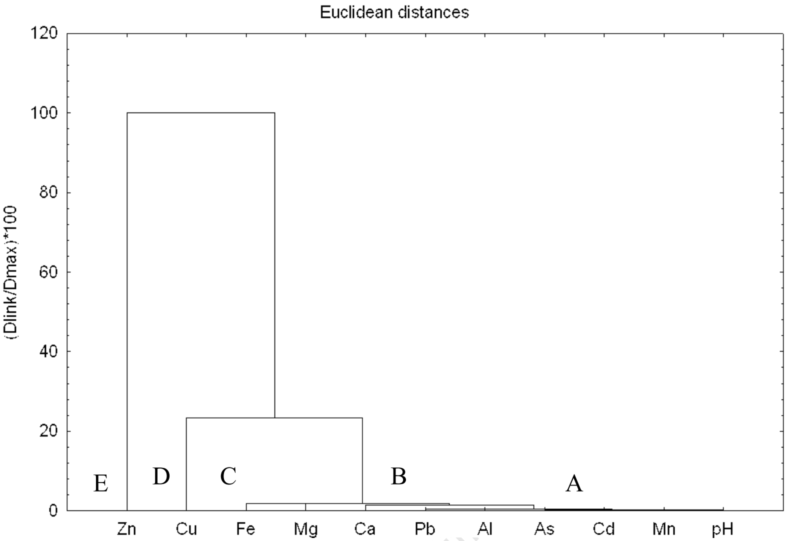

Figure 2: Dendogram

Cluster analysis yielded a dendrogram in which all parameters were grouped into two significant clusters (A,C) and groups that contain only one element (group B, D, E) can be characterized as the typological anomalies or the parameters independent on the ones included into groups A and C. Dendogram in its "A" cluster shows that pH effect on the level of heavy metals in the studied area as they are linked to Ca (cluster "B"). In cluster "C" shows that Fe and Mg derived from mining activity in the area carried out in the past. C cluster linked with clusters "D" and "E" at a very insignificant similarity coefficient.

CONCLUSION

A robust classification scheme for partitioning water chemistry samples into homogeneous groups is an important tool for the characterization of hydrologic systems. The use of graphical techniques proved to have limitations compared with the multivariate methods for large data sets. The most efficient grouping was achieved by statistical clustering techniques. However, these techniques do not provide information on the chemistry of the statistical groups. The combination of graphical and statistical techniques provides a consistent and objective means to classify large numbers of samples while retaining the ease of classic graphical presentations [10].

The results of cluster analysis show two significant groups and three insignificant groups. This clusters can describe impact of heavy metals in the area where past mining activity was carried out

ACKNOWLEDGEMENTS

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REFERENCES

[1] Petriláková, A., and Bálintová, M.: Utilization of Sorbents for Heavy Metals Removal from Acid Mine Drainage.Chemical Engineering Transactions.p. 339-344, 2011.

[2] Šlesárová A., Zeman J. and Kušnierová M.: Geochemical characteristics of acid mine drainage at the Smolník deposit (Slovak republic). IMWA Symposium 2007: Water in Mining Environments, R. Cidu & F. Frau (Eds), Cagliari, Italy, 467-371, 2007.

[3] Jaquet JM, Froidevoux R, Verned JP.: Comparison of automatic classification methods applied to lake geochemical samples. Math Geol 7. p. 237–265. 1975.

[4] Alther GA.: A simplified statistical sequence applied to routine water quality analysis: a case history. Ground Water 17. p. 556–561, 1979.

[5] Williams RE.:Statistical identification of hydraulic connections between the surface of a mountain and internal mineralized zones. Ground Water 20. p. 466–478, 1982

[6] Farnham IM, Stetzenbach KJ, Singh AK, Johannesson KH.: Deciphering groundwater flow systems in Oasis Valley, Nevada, using trace element geochemistry, multivariate statistics, and geographical information system. Math Geol 32. p. 943–968, 2000.

[7] Danielsson, A., Cato, I., Carman, R. and Rahm, L.: Spatial clustering of metals in the sediments of the Skagerrak/Kattegat. Applied Geochemistry, 14: p. 689-706, 1999.

[8] Davis, J.C.: Statistics and Data Analysis in Geology, 2nd ed., p. 563 – 565, 1986

[9] Yidana, S.M., Ophori, D. and Yakubo, B.B.: A multivariate statistical analysis of surface water chemistry data - The Ankobra Baisn, Ghana. Jour. Environ. Management, 86: p. 80-87, 2008

[10] Guler, C.; Thyne, G.D.; McCray, J.E., and Turner, A.K.: Evaluation of graphical and multivariate statistical methods for classification of water chemistry data. Hydrogeology Journal, 10, p. 455–474, 2002

COMPARATIVE ANALYSIS OF TWO CHIRONOMID SPECIES FOUND IN DIFFERENT HABITATS OF LAKE SIUTGHIOL, ROMANIA

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ABSTRACT

Family Chironomidae (Diptera, Nematocera), by the number of species, but especially by population density, occupies the first place among invertebrate communities that inhabit inland waters. Freshwater populations of many species play an important role, both by trophic base offered to different consumers groups, and by involvement in organic matter flow, implicitly in water self-purification processes. In addition, the ability of many species to adapt to varying conditions of inland waters allows them to be good biological indicators for assessing the health status of the aquatic ecosystems they inhabit[1]. Lake Siutghiol is a strong anthropised limnetic system; the western and southern extremities are highly urbanized, cities of Constanta and Ovidiu recording significant expansion in recent years; the eastern extremity of the lake is marked by the summer resort of Mamaia. The lake is characterized by the presence of several types of habitat, among sedimentary ones predominant being the habitats with muddy fractions. Analyzed chironomid species that make the subject of this paper may be encountered in different habitats[2] and have a specific food regime; the type and availability of trophic resources in occupied habitats led to differentiations of the buccal apparatus of each species. This paper aims to emphasize and correlate adaptations of bucal apparatus in two species of chironomids: a sedimentophyl one, with detritivorous trophic regime and the other one associated to phytal substrate (reeds) and with vegetal-detritivorous trophic regime.

Keywords: head capsules, comparative analysis, freshwater phytophyl and sedimentophyli chironomids

INTRODUCTION

Chironomidae (Diptera, Nematocera) family, or non-biting midges, occupies the first place among invertebrate communities encountered in continental waters, both by the number of species, but especially by population density.

Taking into account large numeric and gravimetric densities realized by chironomid larvae populations in many aquatic ecosystems, becomes clear their important role in material and energy transfer, so in developing biological production. The real values of this role are highlighted by the establishment of population energetic budget. Populating in large numbers, practically all inland waters, chironomid larva represent an important component for many fish species trophic regime, with industrial value. Biomass production with high nutritional value accomplished by larvae is considerable. In this way, chironomids are the essential link in the transfer of primary production directed in benthos towards their customers, primarily fish.

By nutrition activity of larvae, their populations contribute substantially to the processes of mineralization, thus to the recycling of substances in ecosystems and thus to self-purification of water[1].

Di Giovani *et al.*(1996)[3] reported that the Chironomidae populations are almost always found to be numerically predominant, both in lotic and lentic environments, due to their tolerance of extreme conditions. Moreover, Merritt and Cummins[4] (1996) indicated that the range of conditions under which chironomids are found is more extensive than that of any other group of aquatic insects, and their wide ecological amplitude is related to their very extensive array of morphological, physiological and behavioural adaptations.

The ability of many species to adapt to various conditions of inland aquatic ecosystems, their presence in all classes of substrate, resulted in their inclusion in saprobes system; these can be used to assess the ecological status of different water bodies[5]. Some groups of generating and/or species are known to inhabit water of high quality; others are well known dwellers in water of poor quality. Unfortunately, many of the larvae have been (and some still are) very difficult to identify, and much of the literature is burdened with studies done with Chironomidae that were misidentified.

In spite of the importance of Chironomidae, the taxonomy of the family has remained very confused[7],[8]. Some of the confusion is due to the complexity of the taxonomy of the family. Most of the species have been described only from adults and, frequently, the generic concept as applied to adults does not correspond with that for the immature stages. These taxonomic problems arose during the first half of the last century, because the German school (inspired by A. Thienemman) focused mainly on the immature stages while other researchers (notably F. W. Edwards in England, M. Goetghebuer in Belgium and J. J. Kieffer in France) worked almost exclusively with adults. Thus, two taxonomic schemes have been developed simultaneously, with generic limits being frequently much narrower for immatures than for adults. In recent years, some attempts have been carried out to reconcile the two systems[9],[10] and this by the only efficient method – obtaining adults by growing larvae[1]. A comprehensive update of the knowledge of the biology and ecology of the Chironomidae has been published[11]. Identifications of chironomid larvae became much more realistic in 1983 when the first volume of the Entomologica Scandinavica “Holarctic Keys”, dealing with larvae, was published (Wiederholm 1983). A pupal volume was produced three years later (Wiederholm 1986), followed by the adult volume (Wiederholm 1989)[7].

In our country, in “Fauna Romaniei” (Romanian fauna) series there is to be found the determination key for Chironominae subfamily[12], focusing on adult phases and containing in the general part the adults, as well as larvae and pupae characterization. In 1999 N. Botnariuc and Victoria Cure published a determination key, based on enormous experience of the authors and on modern literature.

It is generally agreed upon the fact that Chironomidae family is divided into 11 subfamilies[7], six of which occur in our country: Telmatogetoninae, Tanypodinae, Diamesinae, Prodiamesinae, Orthocladiinae and Chironominae[1],[13]. Tatole (2000) presents a list of Chironomidae (Diptera) of Romania and specifies eight species belonging to subgenus *Chironomus* (Meigen, 1803).

Lake Siutghiol is a strongly urbanized system, its eastern shore being parallel to Mamaia summer resort, while the eastern shore hosts 2 localities: Palazu and Ovidiu.In

Lake Siutghiol chironomid species belong mostly to Chironominae subfamily, Chironimini tribe, genus Chironomus. They inhabit different types of habitat, from sedimentary to phytall substrate. Sedimentary habitats have the largest expansion and consist from sand, mostly found on the eastern side of the lake, where there is very little belt-vegetation, sand and silt in the south-eastern area, sand with mud fractions and dominantly mud in the north-eastern side of the lake[2]. Rocky and phytall substrate biotopes are mostly found on the lake shoreline and on the shoreline of Ovidiu Island.

The aim of this paper is to make a comparative analysis of two chironomid species, encountered on different substrates and with specific food regime, using drawings of head capsules obtained from microscopic images of organisms.

EXPERIMENTAL

Sampling of benthos was conducted on different types of substrate: phytal (especially reeds), and sedimentary (mostly dominated by the clay fraction and only occasionally sediments with a sandy matrix were encountered – on the eastern shore of the lake).

Samples consisting of substrate and biological material were taken using a Van Veen type bodengreifer. Fixation of the biological material was performed immediately after collection with 4% formaldehyde and stored in plastic bags (to have no loss of volume), labeled and transported to the laboratory. Samples processing involves separating biological material from the substrate, operation performed using a set of sieves with mesh size of 1 mm and 0.250 mm; in the same way the separation of mature chironomids was performed using the first sieve retaining macrofauna, and the second one retained the juveniles, which fall into the meiofauna (depending as well on the size of individuals). Plant material was collected just below the water surface, stored in plastic bags, labeled and transported to the laboratory where organisms where separated by thorough washing and the vegetal material was weighted. All types of samples were conserved with formaldehyde and processed in the laboratory.

In order to describe the organisms, body characteristics and head capsules of the larvae were studied under the microscope. Measurements of length, first thoracic segment, telson parameters (posterior parapods and ventral tubules) were done and cephalic index was calculated. Furthermore, hand drawings have been made for most of the key characteristics such as mandibles, mentum for the freshwater chironomids inhabiting two types of habitats: phytal (Fig. 1) and sedimentary (Fig. 2).

Species determination was done using different keys: Botnariuc, Cure, 1999; Epler, 1995, Epler, 2001[1],[6],[7].

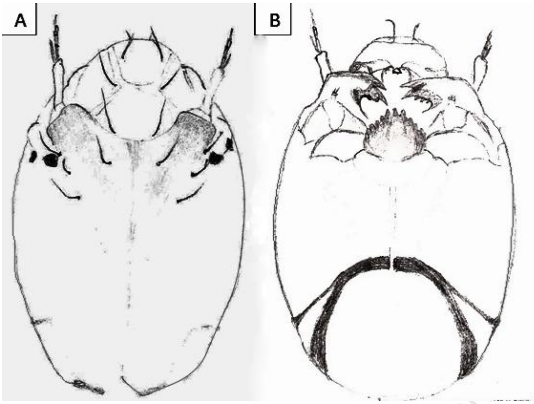

Figure 1: Hand drawing for phytophil species: A - dorsal view; B - ventral view

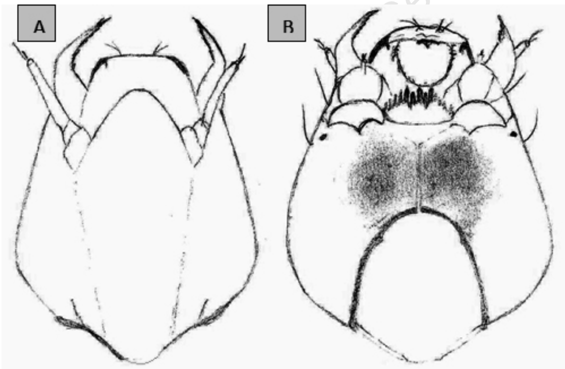

Figure 2: Species associated to sedimentary substrate: A dorsal view; B ventral view

RESULTS AND DISCUSSIONS

This paper focuses on two chironomid species encountered in Siutghiol Lake: one species found on sedimentary substrate and the other one from the phytal substrate, both belonging to Chironominae subfamily.

Specimens encountered on the soft substrate had a cherry-red color before conservation with formaldehyde, due to the hemoglobin in the haemolymph, which allows them to live in low oxygen conditions. The length of the larvae had an average of 23 mm and the cephalic index recorded 1.26 μm average. Larvae present long ventral tubules. Moving on to head capsule analysis, the mandibles have all black teeth. The ventromental plates are striated separated medially and as wide as the mentum. Mentum has a central trifid tooth and the lateral teeth decrease uniformly. Pecten epipharyngis looks like a toothed plate, with the central teeth longer that the oters. Antennae are penta-articulated. It presents two eyespots, separated and arranged one obove other. All these aspects led to the conclusion that the encountered genus was *Chironomus plumosus* (L., 1758) (Fig. no.2).

The color of the body for the organisms found on the plant substratum was whitish-yellow or greenish. The length of the larvae had an average of 10 mm, respectively 1.64 μm for the cephalic index. Mandibles have black teeth, except for the proximal one, which has a lighter, yellowish color. The mentum with trifid tooth was quite convex and inclined forward, a characteristic that most probably helps in scraping plant material. As well as for the other species, the antennae were penta-articulated. According to sources this is *Chironomus* sp. affinis *Ch. annularius* (Fig. 1).

These species have specific trophic regime. The type and availability of trophic resources in occupied habitats led to differentiations of the buccal apparatus of each species. The soft substrate contains large amounts of detritus, a characteristic of this eutrophic ecosystem, while in some parts of the littoral area of the lake predominant are the reeds, which represent the physical and feeding substrate for other chironomid species adapted to this specific conditions (*Ch.* sp. affinis *Ch. annularius*), having a vegetal-detritivorous feeding regime.

Chironomids represent indeed a great support for the trophic network, representing a base for the upper levels. One of our objectives was to see which of the two species have a greater role for the organism that feed on chironomids (fish, amphibians). The ration between the numerical mass of the two species favors the one encountered on the phytal substrate. From this stand point, the vegetation has a great role. Unfortunately, Siutghiol Lake is urbanized, and especially the eastern shore is modified, made of concrete, with only little vegetation, represented by reed wisps. Only the northern extremity of the lake kept on a larger surface the natural conditions, with a large and thick reed belt, as well as Ovidiu Island, which represents an oasis for the benthic organisms, compared to the other parts of the lake.

From another point of view, *Chironomus plumosus* presents importance to be used to establish the lake typology, as it represents a dominant component of the profundal species community [15].

CONCLUSION

Both species represent indicators for poor water quality condition because their distribution is closely related to the different degrees of water depth, dissolved oxygen, organic matters and temperature. These larvae play an important role in the degradation of food materials and nutrition cycle. However, in most studies the importance of the group has been ignored due to taxonomic problems related to their identification[16]. Their presence in different habitats can be used for lake status characterization (water quality, lake classification). The low number of species and the great abundance shows the bad ecological status of the lake.

Although the habitat conditions differ, the similarities found in the two species *Chironomus plumosus* and *Ch.* affinis *annularius*, made us conclude that the structures used for feeding are adapted for detritus-based feeding, either from the sedimentary deposits, or from the vegetal substrate. The interesting difference between mentum (inclined forward and convex) and larvae behavior shows the adaptation to scraping vegetal material. Both species form the base for the trophic system and have a role in the mineralization process, contributing in this way to the water purification.

REFERENCES

[1] Botnariuc, N., Cure, Victoria, *Determinator al larvelor de chironomide (Diptera) din fauna Romaniei*. Editura Academiei Romane, 1999.

[2] Paraschiv, Gabriela-Mihaela, Ehlinger, T.J., Tofan, Lucica, Bucur, Mirela, Vasile Daniela, Slabu A., Scorțea Ramona, Hennessy, J., Benthic invertebrates species as indicators of benthic habitats health from Siutghiol Lake, Romania – paper presented at Urban Environmental Pollution - Overcoming Obstacles to Sustainability and Quality of Life, Boston, USA. 2010.

[3] Di Giovani M.V., Goretti E., Tamanti V., *Macrobenthos in Montedoglio Reservoir, central Italy*. Hydrobiologia, *321*, 17–28, 1996.

[4] Merritt, R.W., Cummins K.W., *Aquatic insects of the North America, Dubuque*: Kendall/Hunt Publishing Company, 1996.

[5] Zinchenko, T. D., *The bioindicative role of chironomids (Diptera, Chironomidae) in aquatic ecosystems: problems and perspectives*, Journal Uspekhi Sovremennoĭ Biologii Vol. 129, No. 3, pp. 257-270, 2009.

[6] Epler, J.H., *Identification manual for the larval Chironomidae (Diptera) of Florida*. Final Report. Florida Dept. of Environment Protection, 1995.

[7] Epler, J.H., *Identification manual for the larval Chironomidae (Diptera) of North and South Carolina*, 2001- http://www.esb.enr.state.nc.us/BAUwww/Chironomid.htm

[8] Da Silva Correia, Leny Célia, Trivinho-Strixino, Susana, *New records of Chironomus Meigen (Diptera, Chironomidae) in the State of São Paulo, Brazil*. Rev. Bras. entomol., vol.49, no.3, 2005.

[9] Oliver, D. R., Life history of the Chironomidae. *Ann. Rev. Entomol* , pp 211-230, 1971.

[10] Pinder, L.C.V., Observations on the life-cycles of some Chironomidae in southern England. Memoirs of the American Entomological Society, 1983.

[11] Armitage, P.D., Symes, K.L., Blackburn, J.H., Environmental quality assessment of the Win Stream (Dorset) using macroinvertebrate data. *Proceedings of the Dorset Natural History and Archaeological Society*, pp. 105-110, 1995.

[12] Albu, Paula, *Diptera: Chironomidae, Subfam. Chironominae, Fauna R.S.R., Insecta (Diptera)*, XI, 13:3-32-, 1980.

[13] Tatole, Victoria, Checklist of Chironomidae (Diptera) of Romania, Travaux du Museum National d'Histoire Naturelle "Grigore Antipa", pp. 117-132, 2000.

[14] Wiederholm, T., Chironomidae of Holarctic region. Keys and diagnosis, Part I. Larvae, Entomologica Scandinavica, Suppl., pp. 1-457, 1983.

[15] Brundin, L., Chironomiden und andere Bodentiered es siidschwedischen Urgebirgsseen. Ein Beitrag zur Kenntnis der bodenfaunistischen Charakterziige schwedischen oligotropher Seen. - Rep. Inst. Freshwater Res. Drottningsholm 30: 1-914, 1949.

[16] Ebrahimnezhad, M., Fakhri, F., Taxonomic study of Chironomidae (Diptera) larvae of Zayandehrood river, Iran, and effects of selected ecological factors on their abundance snd distribution, Iranian journal of science & technology, vol. 29, no. A1, 2005.

COMPARATIVE MICROBIOLOGICAL CHARACTERIZATION OF THE URBAN SEWAGE SLUDGE AND RESIDUAL MARINE BIOMASS ALONG ROMANIAN BLACK SEA COAST

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ABSTRACT

Pathogenic microorganisms can contaminate the environment. The role of these factors in producing transmissible diseases was proven by a number of authors long before the discovery of pathogenic microbial agents. Accepting the notion of bacterial contamination indicator of environmental, the necessity to establish when a non-pathogen or conditionally pathogen germ can be indicator appeared. If for pathogen germs their mere presence in the environment may be enough to consider the researched factor as dangerous, in reality the true is represented also by the number of present pathogens. For indicators germs establishing the number through quantitative and qualitative bacteriological examinations are necessary. In this aim, a comparative study of two residual biomass microbial charges (sewage sludge and marine biomass) was realized in order to assess the possibilities of combining them and identifying the optimal level of participation of each component for achieving a potential biocomposite fertilizer formula. The microbial loading problem has been the priority of our study because this is the most important factor involved in improvement of two biological wastes for agriculture purpose. Marine biomass (macroalgae and zoobenthos) along the seashore from Cap Singol of Constanta to the southern extremity of the Romanian Black Sea Coast consist of green, brown and red macroalgae, raw plant material Danube river origin, benthic marine organisms as crustacean decapods, bivalves and gastropods (mussels and *Rapana* sp.), shell material and the sewage sludge coming from urban wastewater treatment plants, were collected monthly in the last two years. Analysis methodology applied to residual marine biomass and sewage sludge has been based on aqueous extracts from dried samples. The follows physical-chemical parameters for the biomass extracts have been studied: moisture, ash, total nitrogen, total protein, total lipids and carbohydrates. For the microbial charge determination, the serial dilutions method has been applied and the qualitative and quantitative identification by the colony forming units reported to the volume unit (total coliforms, fecal coliforms, total streptococcus, fecal streptococcus, *Shigella*, *Salmonella* sp., *Staphylococcus aureus, Campylobacter* spp.), was realized. The comparative microbiological characterization assessed that the two residual biomasses could be successfully recovered as separately

or mixed in the aim to obtain a new biocomposite fertilizer with decreased bacterial charge.

Keywords: residual marine biomass, urban sewage sludge, microbial charge, biocomposite fertilizer

INTRODUCTION

The diversity of Black Sea phytoplankton and zooplankton represent an enormous and unique source for the natural products with potential in the development of the biodiesel, pharmaceutical industry, cosmetics and nutritive supplements industries, medicine, agro-chemicals industry, sustainable agriculture. The variation of the macro – algae diversity in the past three years, due to the climatic changes, a proliferation of algal blooms occurred and shows a clear dominance of the green algae (*Chlorophyta* sp.) closely followed by red algae (*Rhodophyta* sp.), these groups being represented by nine and respectively seven species in average. The most frequently found species belong to Phylum *Chlorophyta* and *Rhodophyta*, so they realize significant biomass at depths between 0 and 5 meters: *Chladophora sericea, Enteromorpha intestinalis, Ulva lactuca, Cystoseira barbata* and *Ceramium rubrum*. The total length of the Romanian Black Sea coast is 245 km. Of this, only the southern part between Midia - Navodari and Vama Veche – 2 Mai form the touristic Romanian Seaside. Only on these beaches are collected during the summer season from June to August algae coming ashore. This is how in 2006 there have been collected 23,500 tons of algae and in 2007, almost 40.00 tons. We can imagine how easy to lose huge quantities of marine biomass which daily remains unused and thousand of tones of algae are collected and stored as wastes. In addition, marine biomass is not so convenient in use and fossil fuel. We study the possibility to use the marine residual biomass of the Romanian Black Sea coast in agriculture purpose, for a sustainable exploitation of soil and especially bonitation of the soils that are now unsuitable for agriculture. The usage of algae in agriculture contributes to sustainable development which integrates an environmental, an economic and a social dimension and the negative impact that the dumps of algae (e.g. soil infiltrations) have over the environment will be reduced. To comply with the principles to prevent soil application of harmful substances, it will study the microbiological parameters of residual marine biomass [1, 2].

Sewage sludge from Romanian wastewater treatment plant is the results of human activity. Many years the incomplete wastewater treatments lead to marine ecosystem pollution, eutrophycation, algae bloom and tourism problems. Sewage sludge is the organic by-product of the waste water treatment process and an important source of essential plant nutrients with applications of organic matter to soils. Sludge characteristics vary depending on each treatment facility's waste stream and the processes that are used. Sludge that meets the relevant standards for land application, which include reduction or elimination of pathogens and very low limits for heavy metals, are referred to as biosolids [3 - 8]. The aim of the study is to issue a disposal concept as a basis for excess sludge disposal, but under consideration that the effects of sludge on groundwater, soils and agriculture are to be avoided. The agricultural use of sludge is the preferably solution; however it must be stated that earlier attempts for an implementation in agriculture have failed [9 - 11]. In respect to the environment protection, especially sludge parameters and their limits, in the last decade national and international environmental initiatives have tried to remedy the environmental degradation of the Black Sea [12, 13]. In this paper are present new data regarding the microbiological parameters of the sewage sludge from WWTP in Constanta County, Romania and in addition effects on soil quality, as a new possibility to obtain an innovative compound formed by a mixture from marine biomass and sewage sludge. The purpose of microbiological investigation was to determined the microbial charge of sewage sludge and notice if further is necessary the process of sanitation to use this biomass in agriculture. The aim of this study is to find opportunities for the residual marine biomass and sewage sludge exploitation, regarding the amount collected in different periods of time, because represents an important soils nutrient which can be used in order to improve as bio-composite, fertilizer for eroded soils and for agriculture purpose. A set of representative samples of marine biomass (macroalgal and marine invertebrates organisms) along Romanian Black Sea Coast and sewage sludge samples from Constanta conty wastewater treatment plant has been analyzed during 2010 - 2011 period, for the presence of pathogens strains TNG, Total coliforms, *Fecal Coliforms*, *Total Streptococcus*, *Fecal Streptococcus*, presence or absence of enteric pathogenic agents: *Shigella* spp., *Salmonela* spp., *Campylobacter* sp., etc. and different fungi species. The two residual biomasses have been monitored for the microbial charge [3]. The comparative microbiological characterization assessed that the two residual biomasses could be successfully recovered as separately or mixed in the aim to obtain a new biofertilizer with decreased bacterial charge, for agricultural purpose.

MATERIAL AND METHODS

A. Microbiological analysis of the residual marine biomass from shallow area

Residual marine biomass samples have been collected from four locations: Midia - Navodari, Cap Singol - Constanta, Eforie Sud – Capul Turcului Gulf and Vama Veche - 2 Mai Gulf, in the period May 2010 – April 2011, following the standard methodology for sampling the marine biomass, 2 samples/month, in total 24 samples processed as mixture of residual macrophytobenthos and marine fauna. Sampling frequency was dictated by weather conditions and the biological cycle of the species, especially for macroalgae. The comparative characterization of the marine biomass was performed both on fresh and on dry powder marine biomass (drying at 37°C). The microbiological analysis consists in methods for determining the bacteriological level of pollution and for constituting the potential risk for the health of humane and animal collectivity. It were used standardized procedures [14, 15] for determination the level of contamination based on specific microbiological indicators: TNG, Total Coliforms, *Fecal streptococcus, Escherichia coli*, *Salmonella sp.*, *Staphylococcus sp.*, *Shigella* spp., *Yersinia enterocolitica, Campylobacter, Vibrio cholere, Pseudomonas aeruginosa, Citrobacter* spp., *Enterobacter* spp., *Klebsiella* spp., *Proteus* spp., *Candida* sp.

B. Microbiological analysis of the sewage sludge from WWTP of Constanta County

The study of the level of bacteriological contamination of sewage sludge resulted from wastewater treatment plant of Constanta County, Romania, in the period September 2010- April 2011, based on specific microbiological indicators MPN/g (most probable number of germs) of: TC (Total coliforms); FC (Fecal coliforms); TS (Total streptococcus); *E. coli (Escherichia coli*); FS (Fecal streptococcus); TS gr.D (Total streptococcus group D).

The complementary methods of analysis were used for establishing the bacteriologic level of pollution with reference to pathogenic agents/25g: the presence of bacteria and fungi from the type *Shigella* spp., *Salmonella* spp., *Vibrio cholerare*, *Staphylococcus aureus*, *Camphylobacter* spp., the presence of bacteria from the family Enterobacteriaceae (incriminated types in the component of coliform germs) and *Candida albicans*. The methods of current analysis were compulsory. The specific procedures had at their basis the bacteriological approaching of the standardized methods [3, 14, 15]. The biological experiment included a number of 8 samples of active sludge in 2 replicates mounted in parallel; the first sample was taken from the superficial layer by razing with a help of a spatula and the second sample was taken from the whole column of sludge (Figure 1); the sludge samples were introduced in the culture environment (glycerin and water in rapport 1:8). The sludge samples were mounted in distillate water, thus the organisms that could have appeared through the exit from the resistance forms and than could develop to use only the food resources existent in the sample, following their evolution after 3, 5, 7, 10 days/month along the experiment. The total number of sewage sludge samples analyzed was of 62 and the values average was registered.

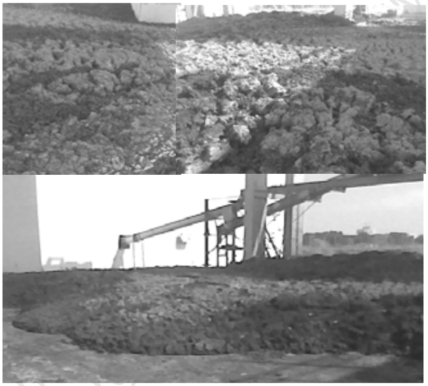

Figure 1. Temporary dump of sewage sluge

RESULTS AND DISCUSSIONS

A. Microbiological characterization of the residual marine biomass

In the January – April 2011, due to prolonged freezing phenomena and the presence of a snow layer for a significant period, typical season bioforms began to appear. Rarely some reduced in size, individual green algae appear on the beach (*Ulva rigida* Ag., *Enteromorpha* sp.); most of them are fixed on the mussel shells; some very small talus pieces of *Porphyra leucosticta* (Thur in Le lolis, RHODOPHYTA) rarely appear. In the period May – September, it was observed in addition to development of the macroalgal forms, a diversification of the communities: *Bangia*, *Ceramium*, *Phylophora* RHODOPHYTA and *Cystoseira barbata* (Good et Wood) Ag-PHAEOPHYTA. The most abundant fauna were mollusks species, especially bivalves: (*Cardium*, *Cerastiderma*, *Mytilus*, *Scapharca* (*Anadara*), *Venus* (*Camellaea*), *Donax*) and a few gastropods (quantitative, (*Rapana*); have revealed numerous fragments but also whole individuals crab (Decapoda): *Carcinus*, *Eriphia*, *Pachygrapsus*, *Xantho* (Figure 2).

Figure 2. Algae species and invertebrates organisms present in residual marine biomass along Romanian Black Sea Coast

The mussels are most abundant in marine biomass samples and this situation is frequent along all the year. As there are a great number of mussels and decapods in the Romanian coastal area of the Black Sea, their microbial charge analysis is absolutely necessary, in order to anticipate their future utilization. The comparative microbial charge of the residual marine biomass (algae and invertebrates organisms) was performed both on fresh and on dry powder marine biomass and the average of the registered values (MPN/g) is presented in the Tables 1 and 2. From the total of 24 samples, the average of the registered values for *fresh residual marine biomass* is as follows: TNG 10^3/g-10^5germs/g, total coliforms bacteria 20 –100 germs/g, *fecal streptococcus* 6 –30 germs/g and the others microbiological indicators are absents. From the total of 24 samples, the average of the registered values for *dry powder residual marine biomass* is as follows: TNG 10^2/g –10^3germs/g, total coliforms 5 –20 germs/g, *fecal streptococcus* 5 -10 germs/g and the others microbiological indicators are absents. The microbial load recorded in residual marine biomass from the southern sector of the Romanian seaside is explained by tourist activities and the large number of tourists who prefer camping on the beach (especially at Vama Veche) that we are entitled to consider that in this case - the values of the order of 10^3 – 10^5 are explained also by the presence of chemical compounds from the green algae, which favors the development of colony-forming units. The marine biomass collected from the Black Sea costal area is not contaminated with enteric pathogenic agents: *Shigella spp., Salmonela spp., Campylobacter jejuni*, etc. We noticed the absence of the pathogen strains *Pseudomonas aeruginosa* and *Candida albicans*. The comparative analyses of fresh marine biomass (algae and invertebrates organisms) and dry form, present an insignificant microbial charge that does not cause sanitary or environmental problems.

Table 1. Comparative average of the values for the microbiological charge of fresh residual marine biomass (algae and invertebrates organisms) on collection stations (MPN/g)

MPN	Collection station for fresh residual marine biomass			
	Midia-Navodari	**Cap Singol - Constanţa**	**Eforie Sud -Capul Turcului Gulf**	**Vama Veche - 2 Mai Gulf**
TNG	$8 \cdot 10^3$	$6 \cdot 10^4$	$3 \cdot 10^5$	$4 \cdot 10^5$
Total Coliforms	20	20	50	100
Fecal Streptococcus	6	10	10	30
Escherichia coli	Absent	Absent	Absent	Absent
Salmonella spp.	Absent	Absent	Absent	Absent
Coagulaso-positive Staphylococcus	Absent	Absent	Absent	Absent
Shigella spp.	Absent	Absent	Absent	Absent
Yersinia enterocolitica	Absent	Absent	Absent	Absent
Campylobacter	Absent	Absent	Absent	Absent
Vibrio cholere	Absent	Absent	Absent	Absent
Pseudomonas aeruginosa	Absent	Absent	Absent	Absent
Citrobacter spp	Absent	Absent	Absent	Absent
Enterobacter spp.	Absent	Absent	Absent	Absent
Klebsiella spp	Absent	Absent	Absent	Absent
Proteus spp	Absent	Absent	Absent	Absent
Candida spp.	Absent	Absent	Absent	Absent

Table 2. Comparative average of the values for the microbiological charge of dry powder of residual marine biomass (algae and invertebrates organisms) on collection stations (MPN/g)

MPN	Collection station for dry powder residual marine biomass			
	Midia-Navodari	**Cap Singol-Constanţa**	**Eforie Sud-Capul Turcului Gulf**	**Vama Veche - 2 Mai Gulf**
TNG	$5 \cdot 10^2$	$3 \cdot 10^2$	$2 \cdot 10^3$	$3 \cdot 10^3$
Total Coliforms	5	10	20	20
Fecal Streptococcus	Absent	Absent	5	10
Escherichia coli	Absent	Absent	Absent	Absent
Salmonella spp.	Absent	Absent	Absent	Absent
Coagulaso-positive Staphylococcus	Absent	Absent	Absent	Absent
Shigella spp.	Absent	Absent	Absent	Absent
Yersinia enterocolitica	Absent	Absent	Absent	Absent
Campylobacter	Absent	Absent	Absent	Absent
Vibrio cholere	Absent	Absent	Absent	Absent
Pseudomonas aeruginosa	Absent	Absent	Absent	Absent
Citrobacter spp	Absent	Absent	Absent	Absent
Enterobacter spp.	Absent	Absent	Absent	Absent
Klebsiella spp	Absent	Absent	Absent	Absent
Proteus spp	Absent	Absent	Absent	Absent
Candida spp.	Absent	Absent	Absent	Absent

B. Microbiological characterization of the sewage sludge

The results regarding the level of contamination of sewage sludge from wastewater treatment plant, based on average of the microbiological indicators values are presented in Table 3.

Table 3. Average of the values for microbiological charge of sewage sludge in the period September 2010 – April 2011 (MPN/g)

Germs type	Sept.	Oct.	Nov.	Dec.	Jan.	Febr.	March	April
TC	7,9 x 10^6	3,1 x 10^6	3,3 x 10^6	3,3 x 10^6	3,4 x 10^6	3,3 x 10^6	1,7 x 10^5	2,6 x 10^5
FC	4,9 x 10^6	2,8 x 10^6	2,7 x 10^6	2,6 x 10^6	2,2 x 10^6	2,7 x 10^6	1,3 x 10^5	1,1 x 10^5
E. coli	3,3 x 10^6	3,3 x 10^6	2,6 x 10^6	2,6 x 10^6	2,7 x 10^6	2,2 x 10^6	2,3 x 10^5	2,8 x 10^5
TS	9,4 x 10^6	4,3 x 10^6	2,6 x 10^6	2,6 x 10^6	2,1 x 10^6	2,7 x 10^6	2,2 x 10^5	2,3 x 10^5
FS	2,6 x 10^6	3,1 x 10^6	1,7 x 10^6	1,7 x 10^6	1,7 x 10^6	2,7 x 10^6	2,2 x 10^5	1,2 x 10^5
TS gr. D	2,6 x 10^6	3,1 x 10^6	1,7 x 10^6	1,7 x 10^6	1,7 x 10^6	2,7 x 10^6	2,2 x 10^5	1,3 x 10^5

The pathogenic agents survive in the sewage sludge for a limited time based on the microbial species but also in the conditions that it offers. Our studies made confirmed that the sewage sludge can be contaminated without being a carrier of pathogenic germs. The study relieved that the microbiological indicators present the follows MPN/g average values: TC between 1,7 x10^5 – 7,9 x10^6; FC between 1,1 x10^5 – 4,9 x10^6; *E.coli* between 2,2 x10^5 – 3,3 x10^6; TS between 2,1 x10^5 - 9,4 x10^6; FS between 1,2 x10^5 - 3,1 x10^6; TS gr.D between 1,3 x10^5 – 3,1 x10^6, the increased values in September and October 2010 (MPN/g x10^6) and the decreased values in March and April 2011 (MPN/g x10^5) were registered. The germs presence indicate that the sewage sludge analyzed present normal limits of pathogen agents for this type of biological samples and exist the possibility to use it as biosolid fertilizer.

CONCLUSIONS

- The fresh residual marine biomass was most influenced by particular meteorological conditions from the analyzed period; Specifics algae species point out are relative abundant were red species *Ceramium*, *Porphyra leucosticta* and *Phylophora*; brown species *Cystoseira barbata*; green macroalgae *Ulva lactuca* and species from *Enteromorpha* genus were observed;
- The qualitative structure of invertebrates fauna observed included four species of mollusks (bivalves and gastropods: *Anadara*, *Mytilus*, *Cerasoderma*, *Rapana*) and four crustacean decapods;
- The marine biomass (Total Number of Germs between 10^2 - 10^3 MPN/g) and sewage sludge (microbial charge between 10^5 - 10^6 MPN/g) does not cause environmental or sanitary problems regarding the bacteriological pollution level and not constituting potential risk for the health of human and animal collectivity;
- This new proposal dimension by using the residual marine biomass mixed with sewage

sludge in an innovative biocomposite fertilizer, can be considered as a key element for sustainable development and improve the environment because it uses "eco-efficiency", that can enable us to use nature for economic activities (agriculture) required to meet human needs and maintaining the capacity and support to ensure equitable access to environmental use by present and future generations.

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Sustainable Development in Bulgaria and Romania", Project no. KNRIN 2008/115241.

REFERENCES

[1] Nastac, M., Resteanu, A., Negreanu-Pirjol, T., Negreanu-Pirjol, B., Liao, Z., *Unconventional non-food resources from Romanian Black sea Coast*, AAPG European Region Annual Conference, Paris-Malmaison, France, 23-24 November 2009

[2] Negreanu-Pîrjol, T., Negreanu-Pîrjol, B., Paraschiv, G.M., Meghea, I., Niţu, B., *Potential improvment of the residual marine biomass as nutrient for eroded soils and agriculture purpose*, 11th International Multidisciplinary Scientific GeoConference – SGEM 2011, 20 – 25 June 2011, Albena, Bulgaria, Conference Proceedings, Volume III, Section „Ecology and Environmental protection", pp. 553 – 565

[3] Paraschiv, G.M., Negreanu-Pîrjol, T., Negreanu-Pîrjol, B., Meghea, I., Gorun, E., *Organisms and microorganisms communities analysis in sewage sludge before and after the sanitation procedure*, 11th International Multidisciplinary Scientific GeoConference – SGEM 2011, 20 – 25 June 2011, Albena, Bulgaria, Conference Proceedings, Volume III, Section „Ecology and Environmental protection", pp. 523 – 535

[4] Bohm, R., *Hygienic aspects of sludge reuse*, EU Report – Pollutants and nutrients in sludge and their effects over the soil, vegetation and fauna, 2002

[5] Dakes, G., Cheremisinoff, P.N., *Land application of the urban sludge, water and sewage works*, 1977

[6] Dudley, D.L., Guentzel, M.N., Ibarra, M.J., Moore, B.E. and Sagik, B.P., *Enumeration of Potentially Pathogenic Bacteria from Sewage Sludges*, Applied and Environmental Microbiology, 39(1), pp. 118-126, 1980

[7] Hyde, C.H., *Utilization of Wastewater Sludge for Agricultural Soil Enrichment*, Journal of Water Pollution Control Federation, 48(1), pp. 77-90, 1976

[8] Jones, D.L., *Potential Health Risks Associated with the Persistence of Escherichia coli O157:H7 in Agricultural Environments*, Soil Use and Management, 15, pp. 76-83, 1999

[9] Juang, D.F., Morgan, J.M., *The Applicability of the API 20E and API Rapid NFT Systems for the Identification of Bacteria from Activated Sludge*, Electronic Journal of Biotechnology, 4(1), pp. 18-24, 2001

[10] Kelly, W.D., Martenrns, D.C., Reneau, Jr. R.B., Simpson, T.W., *Agricultural Use Of Sewage Sludge: A Literature Review*, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University Bulletin, 143, pp. 46, 1984

[11] Legeas, M., *Pros- and cons- of the use of sludge in agriculture as compared to the animal manure, mineral fertilizers and other wastes*, EU Report. Pollutants and nutrients in sludge and their effects on soil, vegetation and fauna, 2002

[12] Spinosa, L., *EU Strategy and practice for sludge utilization in agriculture, disposal and landfilling*, 2001

[13] Veronica, A., *Proper Sanitization of Sewage Sludge: A Critical Issue for a Sustainable Society*, Applied and environmental microbiology, pp. 5267-5275, 2008

[14] Buiuc, D., Neguţ, M., *Clinical Microbiology Monography*, Second Ed., edited by Medical Publishing House, Bucureşti, 2008

[15] ISO 4832 – 92; SR ISO 7251-96; SR ISO 6579-97; SR ISO 6579-97; STAS 6888-92; SR ISO 6340-2000; STAS 3001-91; SR EN ISO15189: 2007.

CONCEPT OF RECLAMATION MANAGEMENT OF THE ASH POND TŘINEC (THE CZECH REPUBLIC)

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ABSTRACT

The presented contribution deals with the former ash pond study in the Třinec city, which is one of the most important industrial cities in the Czech Republic. The study was focused on the research of spontaneous succession ongoing in the study area almost 50 years and also focused on the evaluation of success in realized reclamation. There was designed a reclamation management based on the obtained information about the study area. The management was prepared according to the methodological procedures of directed succession. Individual management measures for the future care of the area were designed sensitively according to the locality integration in the surrounding landscape without disturbance of current spontaneous succession. Scientific benefit of the contribution is to draw attention to the possibility using methods of conducted succession for designing reclamation of former industrial sites, ash ponds or other non-functional and unused Brownfield sites.

Keywords: brownfields, reclamation, restoration ecology, spontaneous succession, ash pond, Třinec,

INTRODUCTION

Today, many authors have devoted their work to restoration of damaged sites by industry and their reintegration into the landscape.e.g. [1], [2], [5], [8], [9].

In recent years, restoration ecology become a relatively new concept - from the English expression “restoration ecology". The description of this sub-discipline of ecology, which was developing from the 80ths of the 20 century, was handled e.g. [6]. The method of restoration ecology is controlled succession, which was described by many authors, such as [3]. Controlled succession process in the restoration is based on the use of higher natural successional stages corresponding to the sequence of successive ecotopes. Controlled succession process includes spontaneously arising vegetation support, its tuning and reinforcement, especially by native plants substitution. Than the communities arise, that exhibit different, but for the purpose for which it was founded more favorable characteristics, than communities that would be developed completely by spontaneous succession. It is used for environmental restoration of sites affected by mining activities, or other industrial activities. There are many of these damaged sites in the Czech Republic. Large amount of literature can be found in the field of the landscape restoration in after mining and quarry mining in the Ostrava-Karvina district or reclamation of spoil heaps and heaps in Ostrava. This topic is dedicated to authors such as [4], [7].

MATERIAL AND METHODS

Storage of energy waste (slag, cinder, fly ash) Energetika Třinec, a.s. is located in the Třinec – Dolní Líštná cadastral area in Moravian-Silesian Region in the northeastern part of the Czech Republic. Storage was established in the valley of Dolní Líštná in 1962 by the construction of the first dam at an altitude of 356 m. Storage activity was terminated in 1998. During the storage of waste the dike system was increased, which currently consists of 13 terraces, with the last edge of the terrace at an altitude of 403 m. The terraces are 5-7 meters wide and 3 meters high, see Figure 1. The total area of the dam with plain ponds is 26.87 hectares, interest area of the reclamation management refers only to terraces system with an area of 11.8 hectares, as it was necessary to leave the plateau without reclamation because of possible further use of power plant waste storage in the future. Barrier system of the storage is relatively densely covered with vegetation. The largest representation of mixed stands of trees and shrubs is in the oldest terraces, the middle part consists of the same-aged white birch culture (*Betula pendula*) and willow willow (*Salix caprea*). There is sporadic vegetation comprising self-seeded tree species, shrubs and grasses in the youngest terraces dam system. The vegetation is gradually spreading in response to a newly built dam even during the storage activities.

Ash pond Třinec

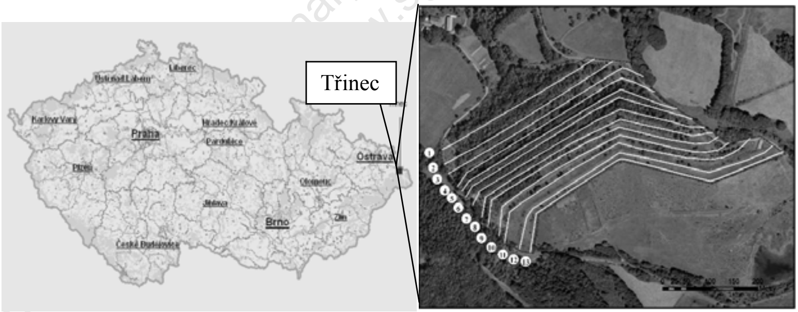

Fig. 1 Study area localization and individual terraces of repository

During the raising of the dam occurred on the lower terraces the spontaneous succession especially pioneer trees such as silver birch (*Betula pendula*), aspen poplar (*Populus tremula*), willow willow (*Salix caprea*), the mosses, grasses, higher plants took root. Some terraces were planted with amelioration trees, especially birch (*Betula pendula*), sycamore (*Acer pseudoplatanus*), willow willow (*Salix caprea*) and aspen (*Populus tremula*), then spruce spruce (*Picea abies*). Thanks to the nearby suburban forest, composed mainly of coniferous species such as spruce (*Picea abies*), larch (*Larix* *decidua*), but also deciduous species such as beech forest (*Fagus sylvatica*), sycamore, milk (*Acer pseudoplatanus, A. campestre, A. platanouides*), winter oak (*Quercus petraea*) heart-shaped linden (*Tilia cordata*), these trees could successfully spread on the terraces.

On the barrier system, there are probably due to changes in habitat conditions drying out timbers that are naturally linked to wetter habitats. The fungal disease (*Rhytisma* family) on maples often appears. In some tree species there are snakes on the trunk, probably caused by spring frosts. In terms of successive stages, the braking element of natural regeneration is considerably dominant shrub layer on older terraces, composed essentially of the following species: dogwood (*Cornus sanguinea*), dog rose (*Rosa canina*), hawthorn (*Crataegus monogyna*), general chokecherry (*Prunus padus*), viburnum general (*Viburnum opulus*), hazel (*Corylus avellana*), blackberry (*Rubus sp.*). Significant risk for the entire area represents spread of alien species, particularly Japanese knotweed, Canadian goldenrod, black locust from the timbers. Potential threats are overthinned silver birch stands, willow willow and poplar aspen, that make up a third of the territory and are associated with the risk of fractures and fallen trees due to storms. For these nearly monocultural forests also represents a serious risk of fungal pathogen occurance (*Piptoporus betulinus*). In terms of the content of humic substances can be individual terraces evaluated as humic, but the three youngest terraces, with very sporadic vegetation as a slightly humic. The content of humus is due to the age of individual terraces downward trend. Its quantity is directly proportional to the time when there was organic matter to accumulate and thus the state of vegetation. From the crowns of previous dams, the vegetation was removed, and therefore could vegetation develop particular in parts of the slope terraces. These interventions are most evident in the middle terraces where slopes parts are formed by stands ofoverthinned birch woods, birch country lines and willow willows, while on the crown, there is only herbaceous vegetation. With the gradual increase of the dam modifications crowns were shifted to younger terraces. On the lower terraces, this effect is also evident. The slopes of the terraces are covered with full-grown trees and edges are after removing vegetation overgrowned by weeds. These parts of the terraces are absolutely impenetrable.

Metodology

Reclamation management issues were addressed by the managed succession using underplanting, removing unwanted trees, shrubs and herbs. This procedure was modified and supplemented as follows: 1) Site Preparation (weeding, disposal of some species), 2) Care of the existing vegetation (underplanting, establishment of vegetation), 3) planting trees (selection of species composition, selection of planting material, the technique of planting); 4) Care of introduced species (multi-plan care), 5) land use proposal in terms of socio-ecological view.

Reclamation Management has been designed with regard to: maintain the natural development of the site, promoting natural regeneration and advance growth of air raids, a gradual transition preparatory to the target species of trees, a nature-like sites with nearly identical ecological characteristics for the development of vegetation and animal life, which are secured in the near surroundings and to meet the social needs of the individual entities that are directly or indirectly linked to this site. Reclamation management proposal and actions aimed at creating a stable ecosystem, multifunctional and environmentally sustainable landscape vegetation in the reclaimed area, which will perform a multi-function term remediation, reclamation, biological and recreational or educational production in the future will require the least inputs and energy supplements. To improve awareness of local citizens, it was proposed to expand the route or trail that is located in a nearby building and information boards about the history repository, the current vegetation management planning and communities recovery. The resulting terraces -formed field has considerable aesthetic value, which will be underpinned by appropriate planting of trees or groups of individuals with diverse species composition. Part of the site will be left to natural development of vegetation for the possibility of examining and comparing the current course of succession in this area with other similar store in the Czech Republic or in other countries and the possibility of applying the proposed management area similar to human nature. This area is not in any way will be interfered with silvicultural, only in exceptional cases (calamity, harmful pests and invasive plants). For these purposes has been designed a segment called *silent area*. In the context of closer multifunctional ecosystem is to be expected timeline for decades, the primary function of the individual will fall into different periods having its main task and a different management, but they overlap and complement is absolutely crucial. The interweaving of functions and their importance varies in a given period are shown schematically in Figure 2

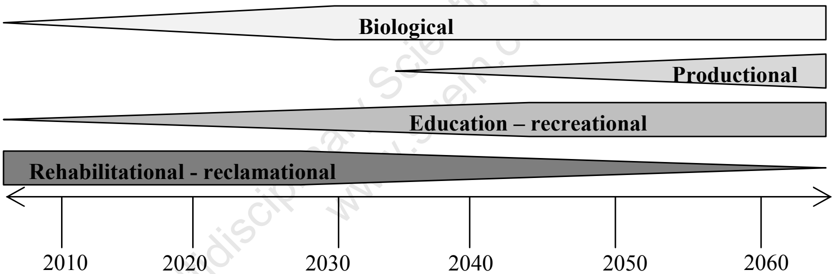

Fig. 2. Illustration of the changes in the importance of each function in the time frame out-forrest green terraces at the store.

RECLAMATION MANAGEMENT

Selecting the planting material, site preparation

For planting is proposed to use transplants coverroots seedlings preferably from nurseries with similar ecological conditions. Preparatory stands of the silver birch will be based by sieving the seeds. Site preparation will be raking off sward using hand hoes or spades. Silent boundary areas are planted with shrubs to prevent the access. For sprouts and improvements will be used strong half-grows up. The list of species is given in the Table 1. Shrub layer is constructed of species: *Rhamnus catharticus*, *Euonymus europaeus*, *Cornus mas*, *Padus avium* and *Cornus sanguinea*.

Formation of new plantations, planting individuals

Mixed stands of deciduous trees will be established and planted will be individuals primarily in underplanting. Planting stock of root ball is the best planted in the fall or early spring. Planting hole will be dug by hands with hoes and spades with the size of min. 3 times larger than the root system, or root ball. As needed, there will be added to the planting pit the manure (eg NPK, Cererit) or a layer of topsoil. Surface planting will be implemented with minimal numbers per hectare refer to Table 1 and in groups in a square buckle, min. seedling length 1 m, or individually. After planting, apply a dressing and checked regularly.

Liquidation of invasive plant species and regular site mowing

Dispose of weeds and invasive species, particularly the Canadian goldenrod carried out mechanically or by wheeled trimmer mower, term in late May and late August Reynoutria should be liquidate in August and September with the herbicide, withered biomass discarded. Treeless meadows and left lea sites mow mower regularly 2 times a year.

Care of air raids, periphyton and based vegetation mats

Protection against animals (feel, exfoliation) - protective netting, tubes around the trunk, to protect the culture with repellent coatings (e.g. Morsuvin, Aversol). Mechanical protection of wire or plastic with a minimum lifecycle of 2 years. It is also necessary to be aware of not damaging trees or also to prevent them from poor measures resulting in suspension of growth. Planted areas should be protected with the fencing. Removal of weed-best should be done by hand sickle, 2-times in the first 2 years followed by once another 3 years after establishment, removed biomass should be left in the place.

Vegetation upbringing

During the trees thinning up to support the natural composition and natural structure (in groups and clusters) of the growth. When there is the thinning treatment species composition should be also adjusted (the release the target species by liquidation birch - willow stands). The pursuit of natural vertical and horizontal differentiation stands. Damaged implement health choices of individuals. Removal of trees carried out by the choice way (individually and in groups). Thinning, release and removal of undesirable trees perform mechanically using power saws, thin stems or shrubs remove with brush cutter. Hazel acacias and stumps treated with herbicide (Roundop). When the release of the stands, using directional felling and provide gentle clearing of timber with tractors.

Measures to meet the educational and recreational functions

Building on the existing route or nature trail, access path field, build a bench with 3 interceptions and a nature trail signs giving information about the area, its history, management, or the near future. Close to terrace 7 solidify existing parking with grass panels. The edges 7 and 12 f the terraces not to afforest, leave for potential rollers, after the industrial activity on the plain storage. Further, it is necessary to exclude inappropriate technologies to interfere with the soil surface and subsequently causing erosion. At the appropriate places to leave old trees in the physical decay and decompose min. 5 m^3/ha (volume of large) deciduous trees due to direct binding of some animals, especially insects, the dying trunks and thick branches.

The use of introduced species to the establishment cannot be permitted. All interventions carried out at designated places, particularly important omission is any interference (unless otherwise specified) and possible damage to the segment of non-intervention area, which is designed as a research area of natural succession. In any segment not to allow clear-way renewal. Maintaining the existing intersection for later use as a processing line. For this purpose, leave without woody vegetation edge of the terrace No. 12.

Table 1. Minimal numbers of planting stock for whole locality (generally)

Timber	**Aim state (%)**	**Planting stock (st/ha)**	**Amount of use covered-roots material (st/ha)**	**Result number of planting material (st/ha)**
Fagus sylvatica	20	9 000	7 200	1 440
Quercus petraea	15	10 000	8 000	1 200
Acer pseudoplatanus, A. platanoides	20	6 000	4 800	960
Tilia cordata	30	6 000	4 800	1 440

DISCUSSION

Industrial landscape renewal can be done through traditional technical and biological reclamation through forestry plantations such as [5], but also more and more controversy develops degraded areas to maintain natural succession and their own development. As a compromise in recent years, the method of the restoration of degraded land through controlled succession is considered [3]. This is precisely the less expensive way, for many owners of degraded areas and brownfields, it is the opportunity to transform these sites to ecologically stable ecosystems, and socially exploited new areas. This method was used in the design of fly ash storage reclamation management in Třinec, where the goal was to transform the vegetation dam resulting from spontaneous succession on species-rich structured forest ecosystem that is both functionally and continuously building on nearby suburban forest.

CONCLUSION

Whole area can be evaluate such a reclaimed area of anthropogenic origin, left to their own development. Open Aires are covered by spontaneous vegetation. Species timber composition is in most cases equal to preparatory growths, which are very overthinned or vice versa. Despite considerable anthropogenic influence, locality has a relatively large self-renewal capacity, but the lack of a systematic care plan of for this area has resulted in very intense damage to individuals from natural regeneration particularly hoofed animals, uncontrollable spread of invasive species and also absolute dominance of shrub layer in some parts of the site. In this paper proposal for reclamation management is presented, which was created for the owner of the site.

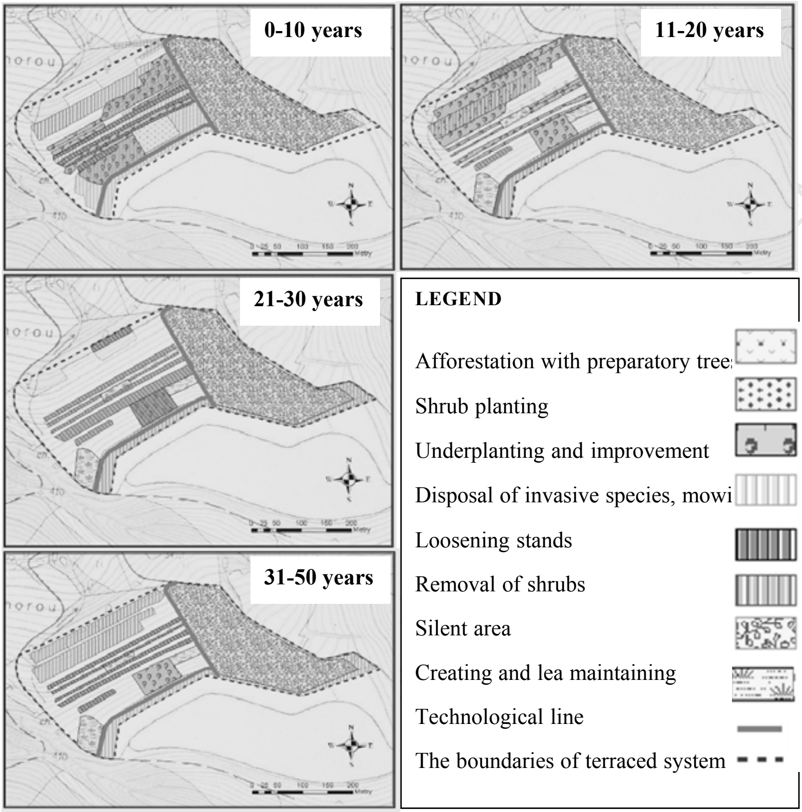

Fig. 3 The proposal of reclamation management for next 50 years.

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REFERENCES

[1] LACKOVÁ, E. & ŽAMPACHOVÁ, D. & ČMIELOVÁ, L. & POLANSKÁ, J. & STALMACHOVÁ, B. Effect of Forest Reclamation on the Křivý Důl Spoil Heap

(Upper Silesia, Czech Republic.) Carpathian Journal of Earth and Environmental Sciences ,2012; 7(1):205-12.

[2] LACKOVÁ, E. & STALMACHOVÁ, B. & POLANSKÁ, J. & ČMIELOVÁ, L. The functional potential assessment of the landscape affected by the extraction of row materials. 11th International Multidisciplinary Scientific GeoConference, June 20-25, 2011, Vol. 3, 693-700 pp. ISSN 1314-2704, DOI:10.5593/sgem, 2011

[3] SÁDLO, J. & TICHÝ, L. Sanace a rekultivace po lomové a důlní těžbě: Tržné rány v krajině a jak je léčit. 1. vyd. Brno: ZO ČSOP Pozemkový spolek Hády, 2002. 35 s. ISBN 80-9031-211-X.

[4] STALMACHOVÁ, B. Základy ekologické obnovy průmyslové krajiny. 1. dopl. vyd. Ostrava: Vysoká škola Báňská - Technická univerzita Ostrava, 1996. 155 s. ISBN 80-7078-375-3.

[5] ŠTÝS, S. Návraty vypůjčených krajin. 1. vyd. Praha: Bílý slon, 1998. 47 s. ISBN 80-902063-9-5.

[6] PRACH, K. "Restaurační ekologie", či ekologie obnovy?. Vesmír [online]. 1995 [cit. 2009-02-25]. Available at www: <http://www.vesmir.cz/clanek.php3?stranka=143&cislo=3&rok=1995&pismeno>.

[7] POLANSKÁ, J. & LACKOVÁ, E. & STALMACHOVÁ, B. Evaluation of externalities in the long – time influenced mining area Orlová – Poruba. GeoScience Engineering, Volume LVII, 2011, No.1, p. 22-31, ISSN 1802-5420

[8] SIERKA, E. & SIERKA W. The Effect of Flooded Mine Subsidence on Thrips and Forest Biodiverzity in the Silesian Upland of Southern Poland – A cese study. Acta Phytopathologica et Entomologica Hungarica, 2006, 43 (2). 345 – 353.

[9] LEWIN, I. & SMOLIŃSKI A. Rare and vulnerable species in the mollusc communities in the mining subsidence reservoirs of an industrial area (The Katowicka Upland, Upper Silesia, Southern Poland), 2006. Limnologica 36. 181 – 191.

CONSIDERATIONS REGARDING THE CRIME SCENE INVESTIGATION IN CASE OF INFRINGEMENTS REFERRING TO THE REGIME OF THE EXPLOSIVE, NUCLEAR AND OTHER RADIOACTIVE SUBSTANCES

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ABSTRACT

In the present paper my aim is to present the characteristics of the crime scene in the case of lawbreaking regarding nuclear materials and other radioactive matters and the nuclear weapons regime in Romania. The research at the crime scene is a highly technical activity with tactic components, underdone by experts in criminal prosecution who immediately perceive the event’s crime scene. Most of the times these refer to infringements of the law, determination of the circumstances and evidence take-off in order to evaluate and explain them. Here, the main purpose to identify the criminal and his/her guilt. Inobservance of the nuclear materials or any other radioactive materials regime and inobservance of the explosive matters are crimes described by the Romanian Criminal Code in art 279^1 and art 280. Forensic investigation of the two above-mentioned crimes in general and crime scene in particular are highly complex and intricate. The activities specific for the crime scene investigation are the photography and video-recording of the crime scene as a whole, the explosive matters, the nuclear materials or radioactive materials; air evidence take off with recently used explosives, investigation of the human odor with the help of trained dogs, taking into account both the field characteristics and the atmospheric conditions.

Keywords: crime scene investigation, crimes, traces, evidence, Romanian Criminal Code

INTRODUCTION

The evidence course called crime scene investigation in The Romanian Criminal Procedure Code – art 129, represents the beginning of the investigation in cases of highly dangerous deeds. According to the above-mentioned article, crime scene investigation is underdone when it is necessary to observe the crime scene, to rediscover and fix the crime traces, to establish the position and material means for evidence take off and the circumstances under which the crime took place [1].

The infringements described in art. 279^1 of the Romanian Criminal Code – inobservance of the nuclear materials regime or other radioactive materials was introduced in the Law no 140/1996 in order to modify and complete the Criminal Code [2]. It requires that illegal reception, possession, utilization, yielding, modification, alienation, dispersion, exposing, transportation or misappropriation of nuclear materials or other radio active substances, as well as any other operations regarding their circulation are punishable by three to ten years’ imprisonment and denial to exercise certain rights. If the actions provided for in paragraph 1 produced public danger, have been followed by the results prescribed for in Article 181 or 182, or caused material damage, the penalti is from four to twelve year’s imprisonment and the denial to exercise certain rights. Purloining or destroying nuclear or other radioactive substances is punishable from five to fifteen years' imprisonment and the denial to exercise certain rights. If the actions provided in paragraph three produced public danger or have been followed by one of the results provided for in Articles 181 or 182 the penalti is from five to twenty years' imprisonment and denial to exercise certain rights. In case the actions provided for in paragraphs 1 and 3 had been followed by special serious consequences, the penalties are from ten to twenty years' imprisonment and denial to exercise certain rights, and if it has caused death to one and more persons the penalti is life detention or from five to twenty five years' imprisonment and denial to exercise certain rights. Threatening a state, international organizations or a physical or juridical person by using nuclear materials or radioactive substances, with the purpose to provoke bodily injury, death of certain persons, or material damages is punishable from three to twelve years' imprisonment. If the action provided for in paragraph 6 is committed by accomplishing or not accomplishing of an act or when using threat, in a way, under the pretense to give or to deliver of nuclear materials or other radioactive substances the penalti is from five to fifteen years' imprisonment and denial to exercise certain rights. Attempt is punishable.

In art 280 of the Romanian Criminal Code is provided for the infringements referring to the regime of the explosive materials as follows: The illegal manufacture, experimentation, transformation, possession, transportation, utilization of explosive materials, or any other operation concerning those substances are punishable from three to ten years' imprisonment and denial to exercise certain rights. Purloining explosive materials is punishable from five to fifteen years' imprisonment and denial to exercise certain rights. When the actions provided for in paragraphs 1 and 2 concerning a quantity beyond one kg. Equivalent to a triton (trotyl) or when the quantity of explosives together with initiation materials, the penalti is from five to twenty years' imprisonment and denial to exercise certain rights. The actions provided for in paragraphs 1 and 2 if they produced public danger or have caused any results provided for in Articles 181 and 182 is punishable from five to twenty years' imprisonment and denial to exercise certain rights. The same sanction is applied to the action provided for in paragraph 1, i fit caused material damage. In case the actions provided for in the preceding paragraphs resulted in extremely serious consequences, the penalti is from ten to twenty years' imprisonment and denial to exercise certain rights, and if they caused death to one or more persons, the penalti is life detention or from fifteen to twenty five years' imprisonment and the denial to exercise certain rights. Threatening a state, an international organization or a physical or juridical person by using explosive materials or for the purpose to provoke bodily injury or death of certain persons or material damages, is punishable from three to twenty years' imprisonment. Threatening with explosive materials committed under the conditions mentioned in Article 279[1] paragraph 7 is sanctioned with the same penalti provided for in this paragraph. Attempt is punishable.

PAPER CONTENT

The thorough knowledge of the rules related to the norms referring to the above-mentioned crimes ensures the correct judicial categorization and choice of the most adequate methodology for crime investigation, especially the crime scene investigation.

In the case of holding, producing, experimenting, handling or transportation of explosive materials or explosive or possession, alteration and display etc. of nuclear materials and radioactive materials, the crime scene includes [3]:
- the places where explosive, nuclear or other radioactive materials are hidden;
- the places where explosive materials were produced, elaborated and tested;
- the place where the nuclear or other radioactive materials were modified, disparaged, exposed;
- the place where different crimes were committed through the use of explosive materials;
- the places where radioactive waste and other similar legal or illegal imported materials are stored;
- the means used to transport the explosive materials, the nuclear materials and any other radioactive materials etc.

The crime scene refers to the crime place, the area and other surroundings as well as remote areas where there can be found traces related to the preparation, accomplishment and results of the deed, including the criminal's access and escape ways from the crime field.

The crime scene investigation in the case of explosive, nuclear or other radioactive materials regime is characterized by a high degree of difficulty. In case of criminal act resulted in explosions, the research team must dispose of the following: helicopter, magnetic detectors, technical means and instruments necessary for digging or search under debris in order to find the traces. There is also necessary to have the equipments provided by fire-fighters or other experts as well as transceiver boxes.

At the crime scene, first there must enter the intervention teams in order to save the victims and eliminate the possibility for a second explosion. The forensic investigation starts only after the expert's activities of drainage and mine clearing came to an end. Both in the case of explosive matters and nuclear materials, or other radioactive materials the investigation team must wear adequate protecting gear [4].

The specialized literature distinguished between two stages of the crime scene: static and dynamic. In practice, the specialized literature distinguishes between two stages of crime scene investigation: static and dynamic. In practice this separation is conventional; in reality the two stages rigorously overlap, which is excellent if the material evidence is preserved [5]. The static stage represents the first contact with the crime scene, when nothing is touched and observation is the only investigation underdone. The dynamic stage implies the objects movement, observation and examination of all sides in a precautious manner. This is the most complex stage where all the team members are involved.

The actual investigation shall be underdone according to the following tactical rules [6]: the crime scene investigation will be done immediately, avoiding expedition and artificiality; it must be done systematically; it must be objective, complete; the investigation team must be led by a lead investigator who knows all activities and directs the investigation; strict observation of the standing rules; the relation with the mass-media must be correct as well as the analysis of the results obtained.

By observing the succession of the two stages of the crime scene investigation in the case of explosive materials, nuclear materials and radioactive matters, there are underdone the following activities [7]:

1. Fixation of the investigation scene through photography or filming of the discovered explosive materials, nuclear materials and radioactive matters.

In the category of explosive materials we find the proper explosives, explosive, pyrotechnic and simple mixes, and the means of priming, the auxiliary means of conflagration and other substances and mixes of assimilated substances.

According to the legal provisions, and in particular Law no. 126 as of 27 December 1995 regarding the regime of explosive materials, republished in the Official Journal no 660 as of 15 September 2011], the explosive matters are classified as: highly explosive, average and low explosives [8].

By report to the nuisance value and purpose of the handmade and amusement objects, based on pyrotechnic mixes, there are the following classes [9]: class I – very small pyrotechnic objects, such as spark candles, confetti mini squibs etc.; class II – small pyrotechnic amusement objects such as small clacks, squibs etc.; class III – medium amusement pyrotechnic objects – fireworks, clacks; class IV – large pyrotechnic amusement objects; class T1 – technical pyrotechnic objects with technical scopes such as smoke bombs, light signal means, etc.; class T2 – technical pyrotechnic objects with maximum mass of pyrotechnic mix higher than class T1.

In the case of nuclear matters or any other radioactive matters, in order for the crimes to subsist to the regulations, they must be part of the substances previewed by the law such as [10]: nuclear raw material (uranium, thorium and their combinations), diggings with at least 0, 03% uranium, thorium or their combination, special fissile materials, radioactive materials, radioactive materials and nuclear radiations.

2. Recently used explosive air evidence take off.

3. Elaboration of the human trace by trained dogs taking into account the field characteristics and the atmospheric factors.

4. Investigation, discovery, reveal, fixation and take off of different types of traces left on the crime field, such as: papillary traces, burned powder, flue, biologic traces, textile fragments, paint, dirt etc.

5. Take off of the discovered explosive materials in view of laboratory analyses. When assembling and transporting the uncovered explosive materials there must be taken into account their behaviour in the environment conditions.

CONCLUSION

With the exception of the particularities above-mentioned, the development and materialization of the crime scene investigation results are underdone according to general rules. In open places, the investigation of traces and evidence material means usually starts from the center o the explosion towards the periphery in concentric circles or coil. In the case of the explosions produced by the ”explosive atmosphere” there will be searched traces of singeing and fumigation on the walls and objects from the room.

Due to the special characteristics of the crimes in explosive, nuclear materials and other radioactive materials, the collaboration between the judicial organisms and experts present at the crime scene is absolutely necessary and only in this way they establish the circumstances and causes that generated these deeds.

REFERENCES

[1] For more details, see Stancu, E. Criminalistics Treaty, Universul Juridic Printing House, Bucharest, Romania, 2002, pp. 307-310;

[2] Published in the Official Journal no. 289 as of 14 November 1996;

[3] Bercheşan, V. Research at the crime scene as the main mans of evidence in the criminal trial, Little Star Printing House, Bucharest, Romania, 2006, p. 251;

[4] Idem;

[5] Ionescu, L. Criminalistics, Pro Universitaria Printing House, Bucharest, Romania, 2007, p. 29;

[6] For more details, see Cârjan, L. & Chiper, M. Criminalistics. Tradition and modernism, Curtea Veche Printing House, Bucharest, Romania, 2009, p. 280 and the following pages;

[7] For more details, see Bercheşan, V. *cit.,* pp. 253 and next;

[8] For more details, see Bercheşan, V. *cit.,* pp. 253-255;

[9] Ibidem;

[10] Ibidem.

CONTRIBUTION TO INFILTRATION HEAT LOSSES STUDY IN THE EDUCATIONAL FACILITIES OF THE SCHOOL BUILDING

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ABSTRACT

Thermal insulation in construction means, above all, the ability of architectural structures to prevent heat loss from the building in the most appropriate way. Heat losses in buildings occur as a result of heat exchange between internal and external air in winter. At the same time, the size of these losses, among other parameters, depends on heat-protective properties of the building envelope. Given the origins of heat losses, one can differentiate transmission heat losses, through the building envelope, and ventilation and infiltration heat losses, as a result of air infiltration through the joints of building envelope. Appropriate architectural design of educational facilities in school buildings, among other things, should pay special attention to infiltration heat losses. The fact that the nature of activities in school buildings, particularly in educational facilities, points out the great importance of daylight, makes the windows basic details of building volume, and the architecture of school buildings recognizable. Bearing in mind that infiltration heat losses through windows and exterior doors are far greater than other losses, establishing correlation between these losses and certain characteristics of school buildings, educational facilities and the associated windows, as well as location characteristics, is necessary in order to reduce heat losses to minimum.

Keywords: school building, educational facilities, windows, infiltration heat losses

INTRODUCTION

Infiltration heat losses through the building envelope, due to its permeability to air, are caused by air pressure differences between external and internal air in the winter. These heat losses emerge primarily on the surfaces of immobile external walls, joints of prefabricated external walls, air vents, windows and doors. [1] Especially for high performance buildings which go beyond the national requirements, the infiltration losses become a significant factor to the energy performance. [5]

Infiltration heat losses through windows and exterior doors are much larger than others, and can emerge: due to the opening of windows, as a result of air infiltration through the joints of window frame or joints of door and walls as well as by air infiltration through the joints between window sash and frame. [1]

Windows bring air and light into a room and connect the room with the world outside. They introduce different ventilation and lighting requirements for a school, and the choice of a window system has an impact on both the owner and the user. [6]

Ventilation design should first try to use the natural movement of the outside air into the school building by using the rising warm air leaving the classroom, or the prevailing winds, to draw the fresh air into the rooms. [3]

Heat losses due to opening of windows cannot be influenced by design, because they depend on the subjective attitude of users. Infiltration of air through the joints of window frame or joints of door and walls is the result of low quality of these elements. Size of infiltration heat losses through the joints of window and door frames and sashes depends on the particular characteristics of the building and openings, as well as location characteristics of the building. Based on conducted research it was determined that heat losses are higher if following factors are increased: temperature difference between internal and external air, permeability of joints between window and external door sashes and frames, room characteristics, building characteristics, height correction factor depending on the number of building storeys. [1], [7]

DESIGN VENTILATION HEAT LOSS AND SPECIFIC CHARACTERISTICS OF SCHOOL BUILDING

Analysis of infiltration heat losses in the design of school buildings is significant, primarily due to specific requirements in terms of lighting of educational facilities causing certain size, shape and rhythm of windows, because in some cases they proved to be even larger than transmission heat loses. In addition the size of the heat losses in educational facilities can be affected by other factors that depend on specific characteristics of school building, geographic position and characteristics of immediate environment.

Therefore, in the implementation phase it is necessary to correlate these parameters, regarding heat loss through the joints of window and door sash and frame, with characteristics of educational facilities and school building.

According to the new European standard EN 12831 [2], [4], the design ventilation heat loss, $\Phi_{V,i}$, for a heated space (i) is calculated as follows:

$$\Phi_{V,i} = H_{V,i} \cdot \left(\theta_{int,i} - \theta_e\right) \quad [W] \qquad (1)$$

where:

$H_{V,i}$ = design ventilation heat loss coefficient in Watts per Kelvin (W/K);

$\theta_{int,i}$ = internal design temperature of heated space (i) in degrees Celsius (°C);

θ_e = external design temperature in degrees Celsius (°C).

Temperature difference between internal and external air depends on purpose and climate conditions of building site. The selection of external temperature is performed by climate map of certain region or based on accurate ten-year data on temperature. Tangible temperature that takes into account air temperature as well as medium temperature of included surfaces is adopted as standard internal temperature. [7] Standard average internal air temperature in educational facilities in school buildings is 20°C.

The design ventilation heat loss coefficient, $H_{\mathrm{V,i}}$, of a heated space (i) is calculated as follows:

$$H_{\mathrm{V,i}} = \dot{V}_{\mathrm{i}} \cdot \rho \cdot c_{\mathrm{p}} \qquad [\mathrm{W/K}] \qquad (2)$$

where:

$\dot{V}_{\mathrm{i}}$ = air flow rate of heated space (i) in cubic metres per second (m^3/s)

ρ = density of air at $\theta_{\mathrm{int,i}}$ in kilograms per cubic metre (kg/m^3)

c_{p} = specific heat capacity of air at $\theta_{\mathrm{int,i}}$ in kilo Joule per kilogram per Kelvin (kJ/kgK)

Assuming constant ρ and c_{p}, equation is reduced to:

$$H_{\mathrm{V,i}} = 0,34 \cdot \dot{V}_{\mathrm{i}} \qquad [\mathrm{W/K}] \qquad (3)$$

where $\dot{V}_{\mathrm{i}}$ is now expressed in cubic metres per hour (m^3/h).

The calculation procedure for determining the relevant air flow rate, $\dot{V}_{\mathrm{i}}$, depends upon the case considered, i.e. with or without ventilation system.

In the absence of ventilation systems, it is assumed that the supplied air has the thermal characteristics of external air. Therefore, the heat loss is proportional to the difference between internal design temperature and external air temperature.

The value of the air flow rate of heated space (i), which is used for calculating the design ventilation heat loss coefficient, is the maximum of the infiltration air flow rate, $\dot{V}_{\mathrm{inf,i}}$, due to air flow through cracks and joints in the building envelope and the minimum air flow rate, $\dot{V}_{\mathrm{min,i}}$, required for hygienic reasons:

$$\dot{V}_{\mathrm{i}} = \max(\dot{V}_{\mathrm{inf,i}}, \dot{V}_{\mathrm{min,i}}) \qquad \left[\mathrm{m^3/h}\right] \qquad (4)$$

For reasons of hygiene, a minimum air flow rate is required. Where no national information is available, the minimum air flow rate, $\dot{V}_{\mathrm{min,i}}$, of a heated space (i) can be determined as follows:

$$\dot{V}_{\mathrm{min,i}} = n_{\mathrm{min}} \cdot V_{\mathrm{i}} \qquad \left[\mathrm{m^3/h}\right] \qquad (5)$$

where:

n_{min} = minimum external air exchange rate per hour (h^{-1});

V_{i} = volume of heated space (i) in cubic metres (m^3), calculated on the basis of internal dimensions.

Numerous studies have been carried out in order to find the amount of air in the room to be changed per hour. For residential buildings these values range from 0.3 to 1, depending on purpose of room. German standard defines minimal air change values for residential rooms per hour. Average air exchange value per hour is 0.7. [1] However, current European standard EN 12831 defines two changes of air per one hour for school buildings and educational facilities, $n_{\mathrm{min}} = 2,0\ \mathrm{h^{-1}}$. [8]

The infiltration air flow rate, $\dot{V}_{\mathrm{inf,i}}$, of heated space (i), induced by wind and stack effect on the building envelope, can be calculated from:

$$\dot{V}_{\mathrm{inf,i}} = 2 \cdot V_{\mathrm{i}} \cdot n_{50} \cdot e_{\mathrm{i}} \cdot \varepsilon_{\mathrm{i}} \qquad [\mathrm{m^3/h}] \qquad (6)$$

where:

n_{50} = air exchange rate per hour (h^{-1}), resulting from a pressure difference of 50 Pa between the inside and the outside of the building, including the effects of air inlets;

e_{i} = shielding coefficient;

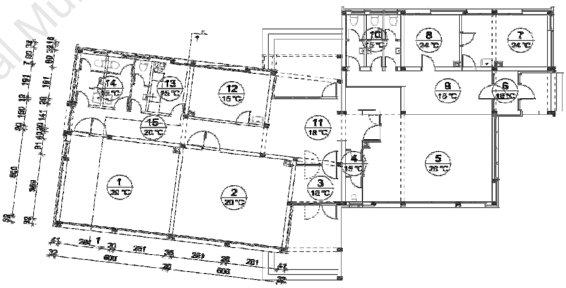
ε_{i} = height correction factor, which takes into account the increase in wind velocity with the height of the space from ground level.

As wind speed is increased at a higher altitude the wind pressure is greater on the high buildings. This influence is defined by *height correction factor* - ε. [1], [7] In terms of number of storeys of school building, current standards define maximal value of ground and two floors.

VALUES OF INFILTRATION HEAT LOSSES IN EDUCATIONAL FACILITIES FOR DIFFERENT CHARACTERISTICS OF IMPACT FACTORS

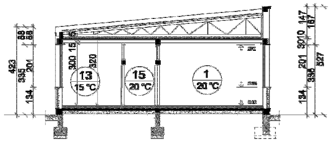
The purpose of evaluation and analysis of certain characteristics of school building and its immediate environment is to come to most appropriate solutions in terms of infiltration heat losses in educational facilities.

Analysis of heat losses on the specific model of a small capacity school building (Fig. 1) is based on characteristic combinations of relevant impact factors: temperature difference between internal and external air, permeability of joints of window and door sashes and frames, room characteristics, building characteristics and height correction factor. Calculation of infiltration heat losses includes parameters that are valid for optimal window constructions. Single glazed windows were not treated as valid.



Ground floor plan

1. classroom 2. classroom 3. entrance 4. toilet 5. sojourn 6. entrance 7. medical doctor 8. nurse 9. waiting room 10. toilet 11. hall 12. teachers 13. kitchen 14. toilet 15. hallway



Section 1-1

Southeast elevation

Fig. 1. Small capacity primary school – ground floor, section and southeast elevation Dašnica, Republic of Serbia, Author: D. Stanković

Constant parameters: room volume – V=90 m^3, standard internal temperature – $\theta_i = 20$°C, minimum external air exchange rate – $n_{min} = 2,0$ h^{-1}.

DESIGN CASE I – CLASSROOM 2 – CURRENT STATE

- climate zone II ($\theta_e = -18$°C)*, - weak winds area, - freestanding position, - single storey building type*

$$\Phi_{V,min,i} = n_{min} \cdot c \cdot \rho \cdot V\left(\theta_{int,i} - \theta_e\right) = 2 \cdot 0,34 \cdot 90 \cdot 38 = 2325,6 \text{ W}$$

$$\dot{V}_{inf,i} = 2 \cdot V_i \cdot n_{50} \cdot e_i \cdot \varepsilon_i = 2 \cdot 90 \cdot 4 \cdot 0,3 \cdot 1,0 = 216,0 \text{ m}^3/\text{h}$$

$$\Phi_{V,inf,i} = \rho \cdot c_p \cdot \dot{V}_{inf,i} \cdot \left(\theta_{int,i} - \theta_e\right) = 0,34 \cdot 216 \cdot 38 = 2790,7 \text{ W}$$

$$\Phi_{V,inf,i} = 2790,7 \text{ W} > \Phi_{V,min,i} = 2325,6 \text{ W}$$

DESIGN CASE II – CLASSROOM 2

- climate zone I ($\theta_e = -12$°C)*, - weak winds area, - normal position, - single storey building type*

$$\Phi_{V,min,i} = n_{min} \cdot c \cdot \rho \cdot V\left(\theta_{int,i} - \theta_e\right) = 2 \cdot 0,34 \cdot 90 \cdot 32 = 1958,4 \text{ W}$$

$$\dot{V}_{inf,i} = 2 \cdot V_i \cdot n_{50} \cdot e_i \cdot \varepsilon_i = 2 \cdot 90 \cdot 2 \cdot 0,1 \cdot 1,0 = 36,0 \text{ m}^3/\text{h}$$

$$\Phi_{\mathrm{V,inf,i}} = \rho \cdot c_{\mathrm{p}} \cdot \dot{V}_{\mathrm{inf,i}} \cdot \left(\theta_{\mathrm{int,i}} - \theta_{\mathrm{e}}\right) = 0,34 \cdot 36 \cdot 32 = 391,7\ \mathrm{W}$$

$$\Phi_{\mathrm{V,inf,i}} = 391,7\ \mathrm{W}\ <\ \Phi_{\mathrm{V,min,i}} = 1958,4\ \mathrm{W}$$

In this case, unlike previous example, minimal heat losses are greater than calculated. Compared to the conditions and design method of the current state, the factors concerning position of the building regarding wind influence, as well as joints sealing were changed. This change caused large decrease in calculated size of infiltration heat losses.

DESIGN CASE III – CLASSROOM 2

- climate zone II ($\theta_{\mathrm{e}} = -18°\mathrm{C}$)*, - weak winds area, - normal position, - single storey building type*

$$\Phi_{\mathrm{V,min,i}} = n_{\min} \cdot c \cdot \rho \cdot V\left(\theta_{\mathrm{int,i}} - \theta_{\mathrm{e}}\right) = 2 \cdot 0,34 \cdot 90 \cdot 38 = 2325,6\ \mathrm{W}$$

$$\dot{V}_{\mathrm{inf,i}} = 2 \cdot V_{\mathrm{i}} \cdot n_{50} \cdot e_{\mathrm{i}} \cdot \varepsilon_{\mathrm{i}} = 2 \cdot 90 \cdot 2 \cdot 0,1 \cdot 1,0 = 36,0\ \mathrm{m^3/h}$$

$$\Phi_{\mathrm{V,inf,i}} = \rho \cdot c_{\mathrm{p}} \cdot \dot{V}_{\mathrm{inf,i}} \cdot \left(\theta_{\mathrm{int,i}} - \theta_{\mathrm{e}}\right) = 0,34 \cdot 36 \cdot 38 = 465,1\ \mathrm{W}$$

$$\Phi_{\mathrm{V,inf,i}} = 465,1\ \mathrm{W}\ <\ \Phi_{\mathrm{V,min,i}} = 2325,6\ \mathrm{W}$$

Compared to the conditions in the design case II the way of lighting the classrooms is different, a two-sided lighting is applied. It can be concluded that with the increase of glazed surfaces, and constant values of other factors, size of infiltration heat losses increases.

If the type of the building is multi-storey, for classroom position on the second floor, z=10m, then:

$$\dot{V}_{\mathrm{inf,i}} = 2 \cdot V_{\mathrm{i}} \cdot n_{50} \cdot e_{\mathrm{i}} \cdot \varepsilon_{\mathrm{i}} = 2 \cdot 90 \cdot 2 \cdot 0,1 \cdot 1,2 = 43,2\ \mathrm{m^3/h}$$

$$\Phi_{\mathrm{V,inf,i}} = \rho \cdot c_{\mathrm{p}} \cdot \dot{V}_{\mathrm{inf,i}} \cdot \left(\theta_{\mathrm{int,i}} - \theta_{\mathrm{e}}\right) = 0,34 \cdot 43,2 \cdot 38 = 558,1\ \mathrm{W}$$

$$\Phi_{\mathrm{V,inf,i}} = 558,1\ \mathrm{W}\ <\ \Phi_{\mathrm{V,min,i}} = 2325,6\ \mathrm{W}$$

In multi-storey building case and position of classroom on the second floor, under identical conditions like in design case III, there is relatively small increase of amount of required heat due to infiltration heat losses, far less than standard values.

DESIGN CASE IV – CLASSROOM 202 – UNFAVORABLE CASE

- climate zone III ($\theta_{\mathrm{e}} = -24°\mathrm{C}$)*, - strong winds area, freestanding position, - multi-storey building type - ground+2 floors (the assumption in case of room No2, 202)*

$$\Phi_{\mathrm{V,min,i}} = n_{\min} \cdot c \cdot \rho \cdot V\left(\theta_{\mathrm{int,i}} - \theta_{\mathrm{e}}\right) = 2 \cdot 0,34 \cdot 90 \cdot 44 = 2692,8\ \mathrm{W}$$

$$\dot{V}_{\mathrm{inf,i}} = 2 \cdot V_{\mathrm{i}} \cdot n_{50} \cdot e_{\mathrm{i}} \cdot \varepsilon_{\mathrm{i}} = 2 \cdot 90 \cdot 4 \cdot 0,5 \cdot 1,2 = 432,0\ \mathrm{m^3/h}$$

$$\Phi_{V,inf,i} = \rho \cdot c_p \cdot \dot{V}_{inf,i} \cdot \left(\theta_{int,i} - \theta_e\right) = 0{,}34 \cdot 432 \cdot 44 = 6462{,}7 \text{ W}$$

$$\Phi_{V,inf,i} = 6462{,}7 \text{ W} > \Phi_{V,min,i} = 2692{,}8 \text{ W}$$

The case of unfavourable site conditions, good sealing of windows, factors related to the way of lighting and number of storeys of school building, multiplies the amount of heat required for heating the air due to its infiltration.

CONCLUSION

The importance of infiltration heat losses in the process of school building design is based on the specific requirements in terms of lighting of educational facilities and site conditions and characteristics of school building and its immediate environment. In order to define guidelines on this issue, an analysis of infiltration heat losses, by combining different relevant impact factors, was conducted on the specific model of small capacity school building. Therefore, following conclusions can be systematized:

- Characteristics of current state of analyzed object point to approximately the same values of calculated infiltration heat losses compared to minimal,

- Building position regarding wind influences is of particular importance because it causes great variations in the size of heat losses. In the case of free exposure of building to strong winds these losses are several times higher, and vice versa,

- In case of multi-storey school building type, for educational facilities on the second floor there is a higher value of infiltration heat losses,

- Unfavourable site characteristics and relatively small windows sealing multiply the amount of heat required for heating the air because of its infiltration.

So, when choosing and planning the location, one should consider protection of the building from strong winds (there must be a possibility of locating educational facilities on the opposite side of strong winds) to reduce infiltration heat losses. The frequency of wind from one direction, if it is strong, requires removal from its impact. By raising protective barriers, planting and appropriately positioning classrooms regarding threatening winds their partial protection is possible. In case of windy locations, it is necessary for windows and doors to be better sealed, especially in higher parts of the building.

Possible large deviations of infiltration heat loss values confirm the need to pay special attention to considered impact factors in the process of construction of new and renovation of existing school buildings. This is very important in order to clearly define optimal framework of energy consumption in school facilities.

REFERENCES

[1] Bogdanović V. Arhitektonsko građevinske konstrukcije – Toplotna zaštita zgrada, Građevinsko-arhitektonski fakultet u Nišu, Niš, pp 56-58, 2000.

[2] BS EN 12831. Heating systems in buildings — Method for calculation of the design heat load, pp 25-28, 2003.

[3] Dudek, M. Schools and Kindergartens: A Design Manual, 1 edition, Birkhäuser Basel, pp 40-41, 2008.

[4] DIN EN 12831. Heizungsanlagen in Gebäuden – Verfahren zur Berechnung der Norm-Heizlast, pp 23-26, 2003.

[5] Erhorn H., Erhorn-Kluttig H. & Carrié, R. Airtightness requirements for high performance buildings. 29th AIVC Conference 2008. Advanced building ventilation and environmental technology for addressing climate change issues, Kyoto, Japan. Proceedings, 2: 25-32, 2008.

[6] Kliment S. A. & Perkins B. Building Type Basics for Elementary and Secondary Schools, John Wiley & Sons Inc., New York, pp 172-174, 2001.

[7] Recknagel H., Sprenger E. & Hönmann W. Taschenbuch für Heizung und Klimatechnik, 63. Auflage, Oldenbourg Verlag GmbH, München, pp 730-743, 1986.

[8] Recknagel H., Sprenger E. & Schramek E. R. Taschenbuch für Heizung und Klimatechnik, 74. Auflage, Oldenbourg Industrieverlag GmbH, München, pp 1088-1100, 2009.

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CORROSION INHIBITION OF ARMCO IRON IN HYDROCHLORIC ACID SOLUTION BY NEW IMIDAZOLE DERIVATIVES

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ABSTRACT

The study of 1-penthyl-3-methyl imidalozium hexafluorophosphate, [C5-mim][PF6], as inhibitors for iron corrosion in 1 M HCl solution at 25 °C was carried out. Potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) techniques were applied to study the metal corrosion behaviour in the absence and presence of different concentrations of this inhibitor under the influence of various experimental conditions. Measurements of open circuit potential (OCP) as a function of time till reaching the steady-state potentials (E_{st}) were also established. The studies have shown that [C5-mim][PF6] was the efficient inhibitor reaching values of inhibition efficiency (IE%) up to 71.5 % at a concentration of 5 x 10^{-3} M. The process of inhibition was attributed to the formation of adsorbed film on the metal surface that protects the metal against corrosive agents. The results of EIS and polarization curves demonstrated that films of the [C5-mim][PF6] were able to protect iron from corrosion effectively. The protection efficiency increased with increase in inhibitor concentration. The potential of zero charge (PZC) of iron in HCl solution as function of pH was determined, and a mechanism of adsorption process was proposed. The effect of chemical structure of the inhibitor was discussed.

Keywords: Armco iron, Hydrochloric acid, Corrosion inhibition, Imidaizole, Electrochemical techniques.

INTRODUCTION

Acid solutions are extensively used in a variety of industrial processes such as oil well acidification, acid pickling and acidic cleaning, which generally lead to serious metallic corrosion. The use of inhibitors is one of the most practical methods for protection against corrosion especially in acidic media [1]. Room temperature ionic liquids (RTILs) possess a series of outstanding advantages as environment-protective electrolytes such as no vapor pressure, high thermal stability, good electrical conductivity, wide range of solubility and wide electrochemical window [2].
Most of the well known acid inhibitors heterocyclic organic compounds containing sulfur, phosphorus, oxygen, nitrogen and aromatic rings are the most effective and efficient inhibitors for the metals in acidic medium due to their special molecular structure [3]. These compounds are adsorbed on the metallic surface block the active corrosion sites. Adsorption behavior of organic molecules on the surface of metals

depends on molecular structure of the organic compounds, surface charge density and zero charge potential (ZCP) of metals [4]. In many factors for the inhibiting effects, the planarity of heterocycles and the presence of lone pair of electrons on heterocyclic atoms are particularly important structure characteristics because they mainly determine the adsorption of inhibitor molecules on metal surface [4-5]. On the other hand, the surface state and excess charge of the metal surface also affect the adsorption behaviour of inhibitor molecule on metal surface. Generally, the tendency to form a stronger coordination bond, and consequently resulting in the high inhibition efficiency, increases in the following order O < N < S < P [6]. The ionics liquids and their derivatives such as triazole, imidazole, oxadiazole, piperidines, indole, pyrazole, pyridazine, pyrrole, schiff base compounds may be applied as potentially efficient corrosion inhibitor for ARMCO iron or mild steel corrosion in acid solutions.

The aim of this work was to study the corrosion inhibition of imidazole derivatives: 1-penthyl-3-methyl imidalozium hexafluorophosphates on iron in borate buffer (pH = 8.47) and 1M HCl solution.

EXPERIMENTAL

The tested inhibitor was 1-penthyl-3-methyl imidalozium hexafluorophosphates (1×10^{-3} and 5×10^{-3} M) and its molecular formulae are shown in Fig. 1. Corrosion tests were performed on the ARMCO iron in 1 M HCl and borate buffer (pH = 8.47) solutions. Solution of 1 M HCl was prepared by analytical grade 37% HCl by diluting with doubly distilled water.

The electrochemical experiments were carried out in a standard three electrode cell with a platinum counter electrode and Ag|AgCl|3 M KCl as reference. The working electrode was a pure iron. The exposed area to corrosive solution was 0.196 cm^2. Prior to each experiment, the working electrode was successively polished with finest grade emery papers, polished with alumina suspension down to 0.05 μm, ultrasonically cleaned in doubly distilled water, degreased in ethanol, rinsed with doubly distilled water, and dried in air. All measurements were carried out at room temperature (25±1 ^oC) in 1M HCl (pH = 0.11) and borate buffer (pH = 8.47) solutions.

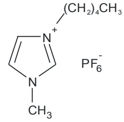

Figure 1. Structure of 1-penthyl-3-methyl imidalozium hexafluorophosphates.

Before each electrochemical impedance spectroscopy (EIS) experiments, the electrode was allowed to corrode freely and its open circuit potential (OCP) for 0.5 h. After this time a steady-state OCP, corresponding to the corrosion potential (E_{corr}) of the working electrode, was obtained. EIS measurements were carried out at the open circuit potential using AC signals of amplitude 5mV peak to peak in the frequency range of 10^5 Hz to 10^{-2} Hz. All voltammetry and impedance measurements were done using a

Solartron SI 1260 HF frequency response analyzer and an SI 1287 electrochemical interface controlled by a personal computer. Each experiment was performed with freshly prepared solution and a newly polished set of electrodes.

RESULT AND DISCUSSION

Potentiodynamic film formation

In the initial investigation, corrosion inhibition of iron in the presence of the ionic liquid was examined using cyclic voltammetry. Fig. 2 shows the influence of [C5-mim][PF6] on the anodic and cathodic potentiodynamic polarization curves of iron in borate buffer (pH = 8.47) solution.

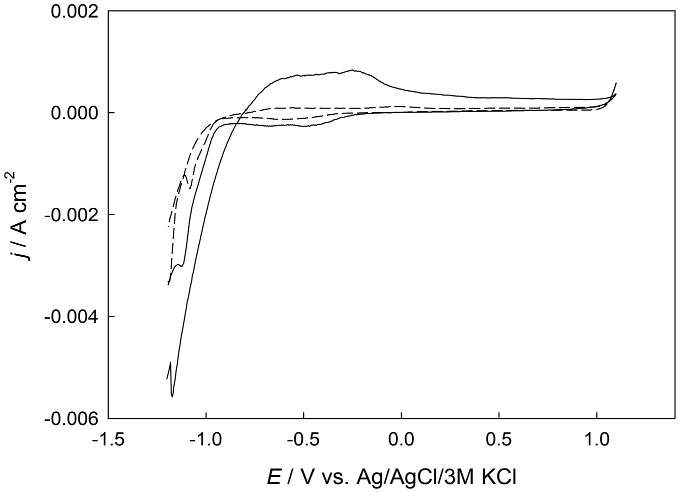

Figure 2. Cyclic voltammograms recorded on Fe in borate puffer solution and in [C5-mim][PF6] in borate puffer solution. Scan rates 1 mV s^{-1}.

Fig. 2 shows the influence of [C5-mim][PF6] on the anodic and cathodic potentiodynamic polarization curves. An addition of 5 x 10^{-3} M [C5-mim][PF6] in buffer borate solution significantly increases the corrosion resistance of iron. The addition of the studied inhibitor decreases the anodic and cathodic current density. The inhibitor decreases the cathodic current density at potentials more negative than −200mV, indicating that the hydrogen evolution reaction is altered [7]. These results demonstrate that [C5-mim][PF6] exhibits both anodic and cathodic inhibition effects and acts as a mixed-type inhibitor in borate buffer (pH = 8.47). In potentials more positive than −200mV, the presence of inhibitor did not change the values of cathodic current density. This fact means that the inhibition of [C5-mim][PF6] depends on electrode potential.

Determination of the potential of zero charge PZC

The *ac* impedance study was used to evaluate the potential of zero charge, PZC, of iron in chloride and borate buffer solutions. The impedance measurements were performed at each potential value in the frequency range, 10^5 to 10^{-2} Hz. At such high frequencies, the electrical double layer capacitor shortcuts. The potential of zero charge (E_{pzc}) is the potential of an electrode on whose surface there are no free excess charge and can be determined by measuring the double layer capacity using *ac* impedance spectroscopy. The capacity is connected with the charge, Q and the potential difference, ΔE at the double layer interface:

$$Q = C_{dl}\Delta E = C_{dl}(E-E_{pzc}) \tag{1}$$

The potential corresponding to the minimum value of C_{dl} is considered as the PZC of the electrode. The difference between *E*corr and PZC values is equal to φ. The positive or negative values of φ imply that the values of *E*corr are more positive ore more negative than the corresponding PZC. At potential positive to E_{pzc} negatively charged species adsorbed and at potential negative to E_{pzc} positively charged species become adsorbed.

To know if the electrode is positively or negatively charged, the potential difference, ΔE of the metal in electrolyte should be experimentally determined. At potential positive to E_{pzc} anions – negatively charged species become adsorbed and at potential negative to E_{pzc} cations – positively charged species become adsorbed.

Inhibition properties of [C5-mim][PF6] **on iron in borate buffer, pH = 8.47**

In order to gain more information about the electrostatic adsorption mechanism of the imidazole RTIL, C_{dl} versus E plots were recorded for iron in borate buffer (pH = 8.47). To know if the charge of the electrode is positive or negative the difference between the corrosion potential and ZCP of the corroding metal was determined The potential corresponding to the minimum value of C_{dl} is considered as the PZC of the electrode. From the obtained results the iron surface is negatively charged in borate buffer solution at the open corrosion potential (-0.27 V). These results confirm the electrostatic adsorption of positively charged imidaizole cations on the negatively charged iron surface in borate buffer solution.

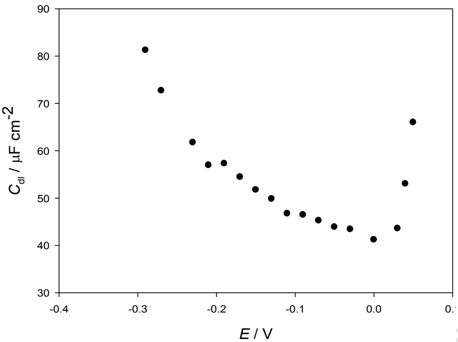

Figure 3. Capacitance vs. voltage plots recorded for iron in borate buffer (pH = 8.47).

Immersion time

Fig. 4 shows the impedance spectra obtained after different immersion times in borate buffer (pH = 8.47) with and without $5x10^{-3}$ M of [C5-mim][PF6]. The diameter of the capacitive loop increases in size with increasing immersion time, reaching a maximum after 21 h. These results indicate that the adsorption model, arrangement and orientation of [C5-mim][PF6] on the surface of the carbon steel, changes with time. Considering that adsorption is essentially controlled by electrostatic attraction, as the immersion time increases, more [C5-mim][PF6] will be adsorbed on the surface helping to the formation of the inhibitor layers.

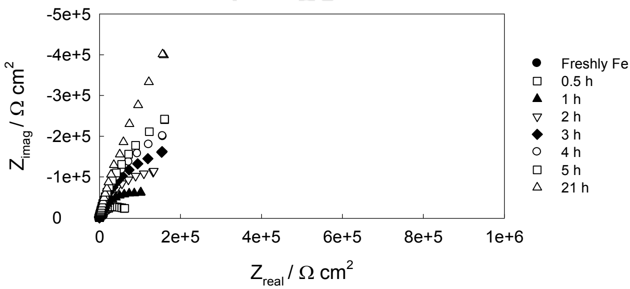

Figure 4. EIS measurements at the OCP of Fe in 5 mM C5Mem Im in borate buffer solution with[C5-mim][PF6]

Inhibition properties of RTIL on iron in chloride solution

In order to gain information about the electrostatic adsorption mechanism of the imidazole RTIL on iron the potential of zero charge (PZC) of iron in HCl solution as function of pH was determined. Fig. 5 shows C_{dl} versus *E* plots were recorded.

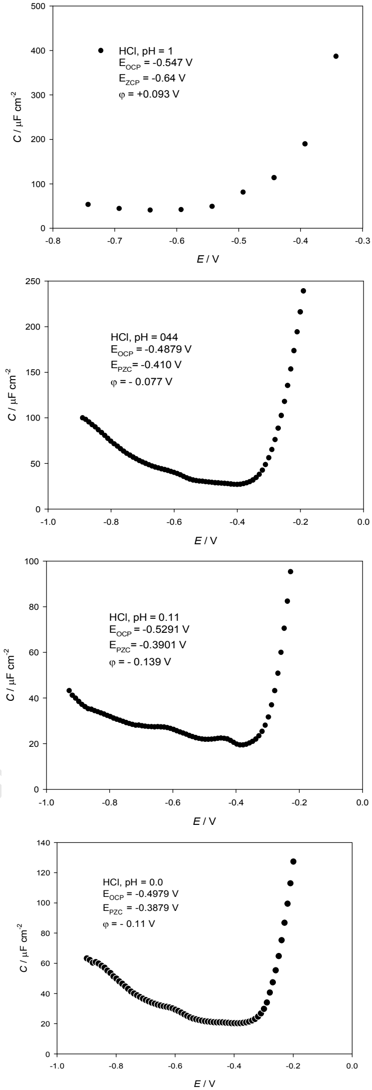

Figure 5. Double layer capacitance of Fe as a function of pH in deaerated HCl solution.

From the obtained results it is visible that the iron surface is negatively charged in HCl solutions at the measured different pH values. With the decreasing pH value, PZC shifts toward positive potentials. The negative value of PZC confirm the electrostatic adsorption of positively charged imidazole cations $[C5\text{-}mim]^+$ on the negatively charged iron surface in all pH values of solutions.

Immersion time

Fig. 6 shows the impedance spectra obtained after different immersion times in deaerated 1 M HCl with and without $5x10^{-3}$ M of [C5-mim][PF6]. The diameter of the capacitive loop increases in size with increasing immersion time, reaching a maximum after 12 h, and then starts to decrease. These results indicate that the adsorption model, arrangement and orientation of [C5-mim][PF6] on the surface of the iron, changes with time.

Considering that adsorption is essentially controlled by electrostatic attraction, as the immersion time increases, more [C5-mim][PF6] will be adsorbed on the negative iron surface helping to the formation of the inhibitor layers. However as soon as all the active sites become saturated with inhibitor, the development of the inhibitor layer is gradually slows down. Furthermore, with time it seems the inhibiting effect decreases probably because some defects exist on the film leading to the access of aggressive anions to the iron/inhibitor interface.

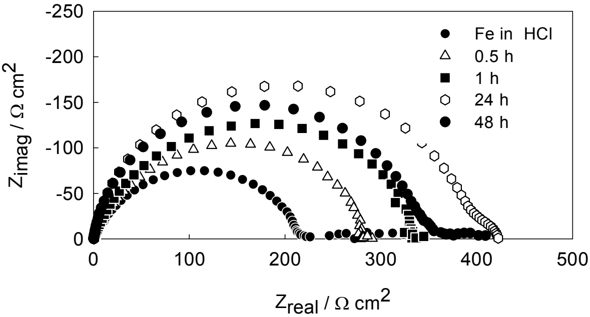

Fig. 6. Capacitance vs. voltage plots recorded for iron in 1.0 M HCl with IL solution.

Inhibition efficiency of [C5-mim][PF6] on iron in chloride and borate buffer solutions

An addition of 1-penthyl-3-methyl imidalozium hexafluorophosphates in chloride and buffer solutions significantly increases the corrosion resistance of iron. This positive influence is time and concentration depending. The highest inhibition efficiencies (E%) were achieved for 5×10^{-3} mol dm^{-3} solution of imidazolium RTIL in both electrolyte solutions. The inhibition efficiencies also increase with increasing immersion time of iron electrode in electrolytes containing RTIL, see Table 1. The inhibition efficiency (IE%) was calculated from:

$$E\% = \frac{I_{\mathrm{corr}} - I^{\mathrm{o}}_{\mathrm{corr}}}{I_{\mathrm{corr}}}\,\mathrm{x}100 \qquad (2)$$

where I_{corr} and I^{0}_{corr} are the inhibited and the uninhibited corrosion current densities.

Table 1. Inhibition efficiency of imidalozium RTIL on iron in different electrolyte solutions

Time / h	**Inhibition efficiency**

	HCl, pH = 0.11	Buffer, pH = 8.47
1	39.0	92.1
24	71.5	98.1

From table 1, it could be noted that inhibition efficiency increased with increasing immersion time reaching values of inhibition efficiency (IE%) up to 71.5 % at a concentration of 5 x 10^{-3} M in HCl solution.

CONCLUSIONS

The principal findings and conclusions of this work are as follows:

The studies have shown that [C5-mim][PF6] was the efficient inhibitor reaching values of inhibition efficiency (IE%) up to 71.5 % at a concentration of 5 x 10^{-3} M. The process of inhibition was attributed to the formation of adsorbed film on the metal surface that protects the metal against corrosive agents. The results of EIS and polarization curves demonstrated that films of the [C5-mim][PF6] were able to protect iron from corrosion effectively. The protection efficiency increased with increase in immersion times.

The [C5-mim][PF6] affected both anodic and cathodic reactions so they are classified as mixed type inhibitor. The inhibitor acts by stopping hydrogen evolution reactions and decreasing cathodic currents. However, for long immersion times, the inhibitive efficiency decreases.

REFERENCES

[1] Trabanelli G., Corciaiti V., in: Fontana M.G., Staehle R.W. (Eds.), *Advances in Corrosion Science and Technology*, vol. 1, Plenum Press, New York, p. 147. 1970

[2] Olivier-Bourbigou H., Magna L., Morvan D., *Applied Catalysis A: General*, vol. 373, pp. 1, 2010).

[3] Solmaz R., Kardas G., Yazicl B., Erbil M., *Colloids Surf. A: Physicochem. Eng. Aspects*, vol. 312, pp. 7, 2008.

[4] 4. Quraishi M.A., Hariom K., *Mater. Chem. Phys*. Vol. 78, pp. 18, 2002.

[5] Hukovic-Metikos M., Babic R., Grubac Z., *J. Appl. Electrochem.* Vol. 32, pp. 35, 2002.

[6] Ai J.Z., Guo X.P., Qu J.E., Chen Z.Y., Zheng J.S., *Colloids Surf. A: Physicochem. Eng. Aspects*, vol. 281, pp. 147, 2006.

[7] Lagrenee M., Mernari B., Bouanis M., Traisnel M., Bentiss F., *Corros. Sci. vol. 44*, pp. 573. 2002.

CREATING A DESIGN FOR ENVIRONMENT PROGRAM

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ABSTRACT

Design for environment (DfE) is „the systematic consideration of design performance with respect to environmental, health and safety objectives over the full product and process life cycle [1]. Some designers view DfE as simply calculating an environmental measurement, similar to estimating cost. This perception is due to the trend of companies implementing standalone DfE tools without explanation. This paper describes the step necessary for creating a DfE program within a product development organization.

Keywords: Design for environment, Environment, Program, Stakeholders

INTRODUCTION

A DfE program cannot be implemented in isolation from other programs within a product-development organization. The program needs to be integrated with other programs that fall under the corporate responsibility umbrella and carry the same weight. Typical corporate responsibility programs include giving back to the community, promoting diversity awareness. These programs have detailed plans and goals that are disseminated to all employees through a substantial medium such as a communications meeting. The employees then begin "living" these programs, which results in a corporate culture.

Most product-development organizations environmental awareness initiatives are based at the manufacturing level rather than the product level. A new DfE program will most likely be integrated with this preexisting portion of environmental awareness. Upon implementation, the program objectives and specific process need to be clearly presented to employees. The commitment from the upper management within the organization should be enough to get the program rolling. If there is resistance, the organization may need to implement a system that rewards those who participate. Only after seeing the organization's commitment and receiving direction can the engineers do their jobs and determine how to meet the goals [6].

IDENTIFYING THE STAKEHOLDERS

The first step in creating a DfE program is to identify and understand the environmental stakeholders. Stakeholders ultimately define the objectives and resulting environmental metrics of the DfE program. Between the typical stakeholders for product development organizations are:

- board members,
- socially responsible investors,
- non-government organizations,
- government organizations,
- customers,
- competitors,
- community.

Each stakeholders has different environmental interests, which leaves the organization with a considerable amount of environmental demands to meet. Since product development organization operate with limited resources, the stakeholders will need to be prioritized based on their influence on the organization.

CREATING ENVIRONMENTAL OBJECTIVES

After a through analysis of the stakeholders, it is possible to create environmental objectives for the DfE program. The environmental objectives will need to align with as many of the environmental demands of the stakeholders as possible. The objectives will also need to align with the values and culture of the corporation.

Since it is necessary for an employee to adapt to the values will align with employee values and should be successfully implemented. When creating environmental objectives, it is important to use the correct level of specificity. The objectives should be broad enough that they do not have to be frequently updated but specific enough that they provide consistent direction for the DfE program. An environmental objective of "protect the Earth" would be too broad, while "eliminate the use of lead" would be too specific. Environmental objectives should have lower-level targets associated with the so the company can assess its progress toward objectives. For example "eliminate the use of lead" could be a lower-level target for the environmental objective "reduce the use of hazardous materials" [3].

IMPLEMENTING A DfE PROCESS

In this capitol is defined a DfE process that naturally integrates environmental issues into the existing product-development process with little extra effort or time. Every stage requires certain tasks to be completed before management signs off, giving permission to proceed to next stage.

Safety reviews are meetings intended for reviewers to evaluate the assessment, actions, and process of the design team in addressing product safety. The DfE process adds an environmental review to the agenda of the safety reviews held during stages 2,4 and 5. A separate environmental review will be held during stage 3, an important design stage, in order to focus specifically on the environmental issues for the particular product. The environmental reviews will require design team to review the checklist of key requirement and to consider guidelines for reducing environmental impact.

When the DfE process is first implemented, design teams will have to fill out the environmental scorecard only during stage 5 after the product design is complete. Doing this begins the process of recording environmental data and allows design teams to adapt gradually to the new process. When design teams become more familiar with the process, the scorecard will be completed two or more times during the stage-gate process in order to track design changes that affect environmental metrics during the development process.

Environmental targets will be set during stage 1 as goals for the new product. The design team will write a lessons-learned summary during stage 8 to highlight innovative environmental design changes. The lesson-learned summary will provide the innovation statement metric. Figure 1 show the Safety Review Process and Environmental Review Process running parallel [2], [4], [5].

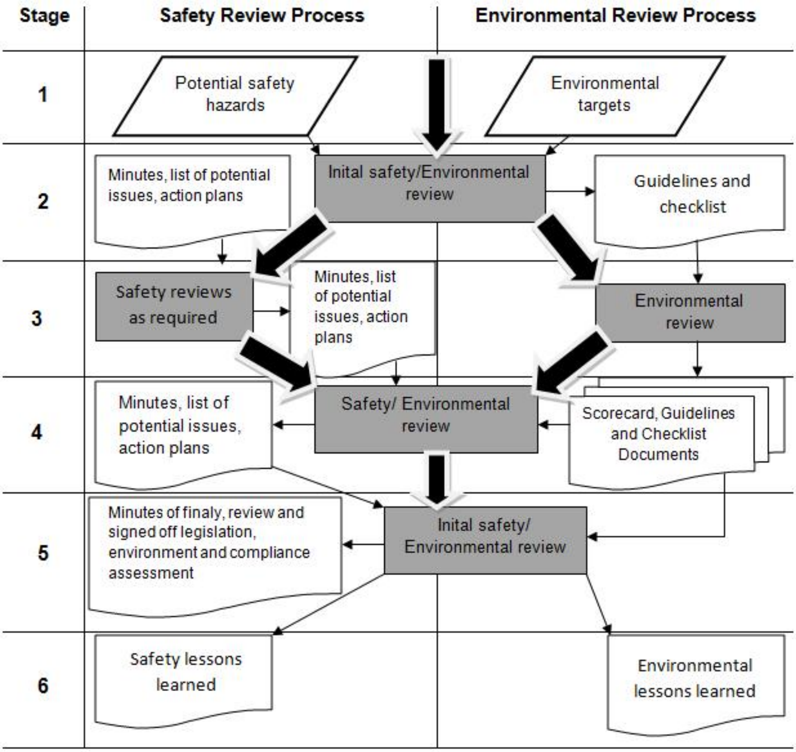
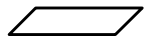


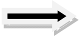
Figure 1 Combined safety and environmental review process

Legend:

 = Deliverable

 = Input

 = Process

 = Path of main processess

The first environmental review is coupled with a safety review. During this meeting, the design team should discus current environmental regulations, design guidelines and environmental metrics. The environmental metrics can be found in the guidelines and checklist document.

The second environmental review is held separately from the safety hazard review. During this meeting, the project team will check compliance regulations, fill in the guidelines and checklist document, and discuss the metrics in the scorecard and review opportunities and additional environmental issues.

The third environmental review is coupled with a safety review. During this meeting, the project team should ensure that all environmental compliance issues are resolved. There should be no further changes to the design due to environmental reasons after this meeting. The lead engineer will update the scorecard for the next meeting.

The fourth and final environmental review is coupled with a safety review. During this meeting, all environmental compliance issues must be resolved. Optimally, no design changes due to environmental reasons would have been made between the last meeting and this meeting. The result of the meeting is a final guidelines and checklist document and meeting minutes. The reliability representative will finalize the guidelines and checklist document and write the minutes. The lead engineer will finalize the scorecard and create a Material Declaration Statement packet for the product.

CONCLUSION

The completed guidelines and checklist documents and lessons-learned summaries create a feedback loop for the DfE process. Design engineers working on similar products can use this information to make better decisions immediately, and the information is also valuable when the next generation of the product is designed years down the road. Design engineers will decision information, scorecards, and comments on the guidelines document will be archived permanently. The goal is to save the right things so the information is there in the future when more feedback activities, such as a product tear-down to verify scorecard metrics, can be introduced.

ACKNOWLEDGEMENT

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REFERENCES

[1] FIKSEL, J.: Design for Environment: Creating Eco-efficient Products and Processes. McGraw-Hill, New York, 1996

[2] LADOMERSKÝ, J., HRONCOVÁ, E., SAMEŠOVÁ, D., 2009: Safety Technique and Emission Limits on Recycling of Cooling Devices and Freezing Equipment. In. Tribina 6 – Zbornik Radova. Instittut za preventivu – Srbsko. s. 76 -80. ISBN 978-86-87912-00-1

[3] ROVŇÁK, M. - BEDNÁROVÁ, L.: Návrh štruktúry informačného systému pre mestský informačný manažment. 5.ročník Medzinárodní Baťovy konference pro doktorandy a mladé vědecké pracovníky 2.4.2009. Univerzita Tomáše Bati ve Zlíně. 2009. ISBN 978-80-7318-812-2.

[4] RUSKO, M. - BOSÁK, M. - ANDREJOVSKÝ, P. - ROVŇÁK, M.: Economical Aspects of Environmental Safety, Research Papers Faculty of Materials Science and Technology Slovak University of Technology in Trnava, Vol 18, No 29, 2010, pp. 83-89, ISSN 1336-1589.

[5] RUSKO, M. - TUREKOVÁ, I. - OČENÁŠOVÁ, D.: Integrated prevention and pollution controll as an important tool of environmental policy in Slovak Republic. In: Vedecké práce MtF STU v Bratislave so sídlom v Trnave. Research papers Faculty of Materials Science and Technology Slovak University of Technology in Trnava. - ISSN 1336-1589. - Vol. 18, č. 28 (2010), s. 141-148.

[6] WILEY, J. & SONS: Environmentally Conscious Mechanical Design. Myer Kutz. 2007, pp. 394, ISBN 13 978-0-471-72636-4.

CREATION OF INFORMATION-ANALYTICAL SYSTEM FOR THE ESTIMATION OF THE ECOLOGICAL CONDITION OF CASPIAN SEA

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ABSTRACT

This article is devoted to the solution of such problems, as research and an assessment of ecological state of the Caspian Sea, carried out on the basis of integrated ecosystem approach technique and information analytical system. Applying the integrated ecosystem approach allows to make scientifically-proved decisions and take adequate measures for ensuring its ecological safety.

Keywords: Caspian Sea, information analytical system, ecological safety

INTRODUCTION

Environmental problems of the Caspian Sea and its coasts are consequences of intensive economic development in the countries of this region. The problems caused by deterioration of ecological conditions are connected with the growth of pollution level of the Caspian Sea and requires constant attention and taking appropriate measures for environmental protection in this region.

Now all coastal zones of the Caspian sea, including and the Azerbaijan sector, is in a difficult ecological condition and carrying out large-scale researches with application of methods of the integrated ecosystem approach on the basis of integrated environmental monitoring scheme, undoubtedly, is of great importance for obtaining detailed information on its ecological condition [1]. During complex research of ecological conditions of the Caspian sea, natural variability of parameters of ecosystem and variety of chemical and biochemical processes which greatly influence live organisms of water ecosystem are significant valuable.

The ecosystem approach should rely on the corresponding gradation of influence, effects and consequences. The purpose of an ecosystem approach is preservation of structure and functions of ecosystems and their natural changes, and also studying changes in parameters of ecosystems for the assessment of their levels, dynamics of their conditions and consequences of man-made interventions.

When applying such approach it is necessary to consider steady and long-term changes in an ecosystem. In recent years ecological "indicator" which includes any parameter with relevant information on the state of environment and its changes under the influence of different impacts is successfully applied to research of ecosystems. These indicators are conditionally subdivided into three groups:

1. Influence indicators – pollution sources, volumes of wastes, rate of anthropogenic accidents.

2. Indicators of pollution level that damage the environment, changes in the populations and communities, death of wildlife.
3. Response indicators - measures of regulation and restriction, standards and norms, technical and technological solutions.

Thus, application of the integrated ecosystem approach in research and assessment of ecological state of the Caspian Sea allows making scientific decisions and taking adequate measures for ensuring its ecological safety.

Carrying out research on dynamics of the ecological state of the Caspian sea and studying the impact of various processes - anthropogenic and ecological factors are very important. Carrying out researches with application of techniques of ecosystem approach and on the basis of the scientific scheme of complex environmental monitoring allows to provide more detailed and growing databank on the Caspian Sea water areas. The results received during research are useful and reliable, thus confirming their importance of solving current environmental problems of the considered water areas at the present, and in the near future [2].

Today before mankind there appeared a number of environmental problems of global importance, connected with considerable anthropogenic impact on the nature. From this point of view, offshore oil production in the Caspian Sea leads to a number of very serious environmental problems.

To solve these global environmental problems existing contact and remote control techniques and facilities are analyzed, scientific and technical ideas for improvement of existing, and also creating new data – analytical systems and measuring equipment and their carriers are developed [3].

In this article results of system processing pictures received from space in 2004-2005 are presented, which allowed to identify sources of pollution in the Middle and the Southern parts of the Caspian sea. Processing this data is effective addition to land measurements, which accurately reveal areas of spreading pollutants in the studied space in time.

Researches of man-made factors, their relation to environment require more effective supply with data and development of modern techniques of the analysis of geological data by means of the latest software.

The results of processing data received from ground stations and satellite in the South of Caspian sea and in the areas of the rivers Lenkoranchay and the Kur, and also in the Baku bay are taken as basis of information and analytical system for pollution level assessment in water areas (Fig. 1).

The information and analytical system is necessary for an assessment of ecological state and for revealing sources of anthropological pollution of a coastal zone. Its realization is carried out by means of application of a technique of the data processing consisting of three below given main stages:

- processing data of land measurements;
- processing data received from satellite
- integration of data in geological and information system with providing comparative analysis [4].

GENERAL SCHEME OF FUNCTIONING OF INFORMATION AND ANALYTICAL SYSTEM

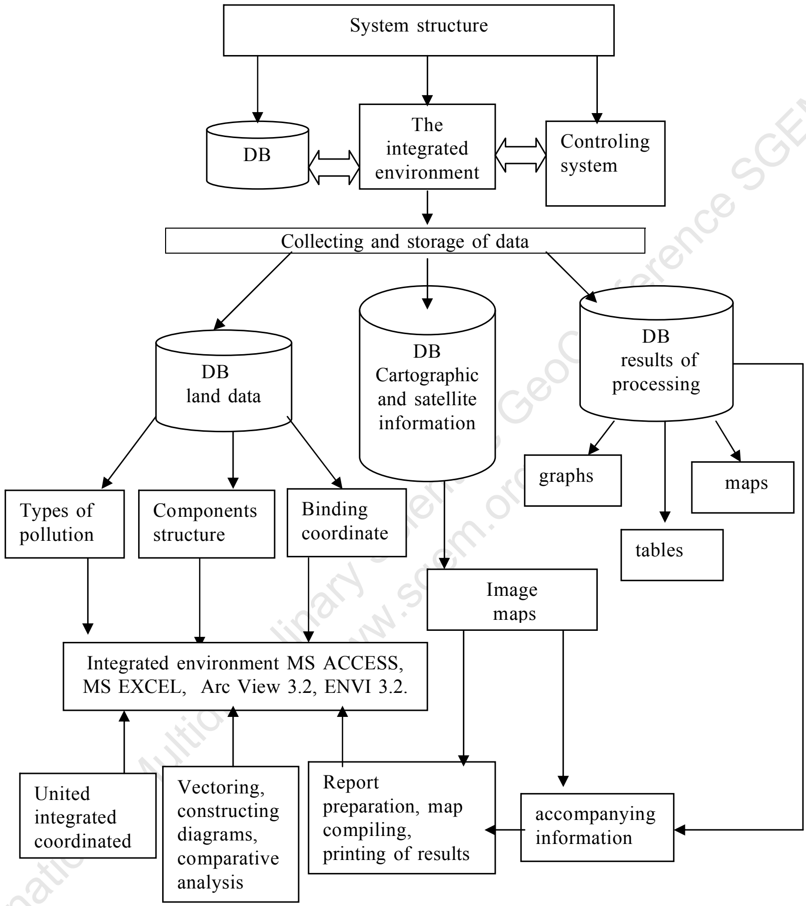
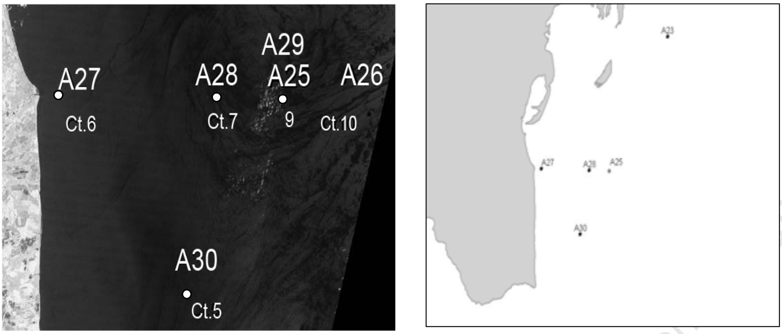


Fig. 1. The information of analytical system

Land data represent measurements of the state of water environment in 2002-2005. These are data on pollution indicators of sea water taken in points where researches are carried out, they are shown in fig. 2: station 6 (point A27), station 7 (A28), station 9 (A25 and A29), station 10 (A26), station 5 (A30), station 13 (A23).



a b

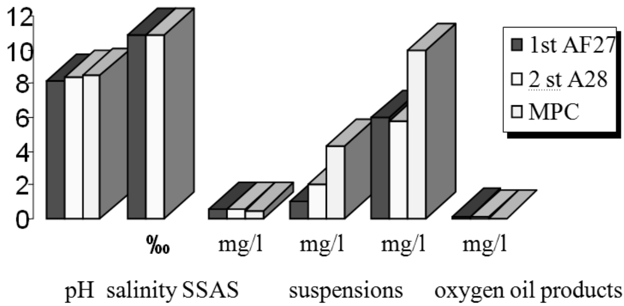
Fig. 2. Areas of research and points of measurement of land data:
a) stations of measurements are shown on the background against the picture received from satellite, b) a contour map.

Data from land stations on measurements of the marine environment is placed in table 1 and analyzed. Stations of measurements are located on the rivers Lenkaranchay (5 stations) and the Kur (one station). Points of measurements have coordinated geographical binding. For the comparative analysis histograms of tabular values [5] are constructed.

Table 1

Title	Unit of measurement	MPC	38045'-48054' St. №6	38045'-49006' St. №7
			1 stations A27	2 stations A28
pH		8.5	8,16	8,4
Salinity	‰		10,9	10,9
SSAS	mg/l	0,5	0,6	0,6
Suspension	mg/l	4,25	1	2
Oxygen	mg/l	10	6	5,8
Zinc	mg/l	0.1	0.898	0.878
Oil products	mg/l	0,05	0,16	0,109
Sulfates	mg/l	500	2440,78	2531,34
Cu	mkg/l	10	39	38,75
Ni	mkg/l	0.01	0.33	0.29
Pb	mkg/l	30	134	132,75
Mn	mkg/l	100	18	16,25
Cd	mkg/l	0.005	6,2	7,3
Co	mg/l	0.01	0. 39	0.37
Fe	mkg/l	0.05	78,25	96,75

The analysis given by computer graphics (fig. 3) shows that on station 6 (point A27) (it is located on the bank of the river Lenkaranchay pH practically is normal (slightly higher in point A28), organic suspensions are 3 times lower than maximum concentration limit , low content of oxygen is observed (2 times lower than maximum concentration limit), Synthetic surface-active substances at maximum concentration limit level, and oil products are slightly higher than maximum concentration limit. Sulfates 5 times exceed maximum concentration limit (fig. 4).



The fig. 3. Histogram according to tabular data for stations 6 and 7

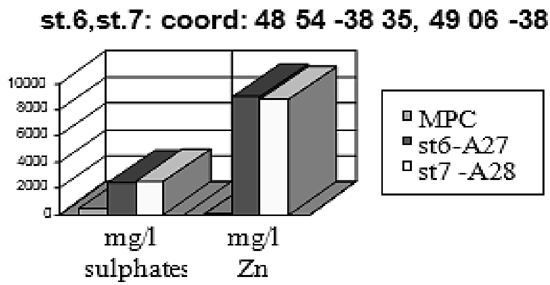


Fig. 4 The histogram of data on the sulfates and zinc content (St. 6 и7)

Excess of cobalt and nickel content is observed (cobalt 38,8 times is higher than maximum concentration limit, nickel 33,4 at station 6, and 33.4 and 29.1 respectively at station 7), significant excess of iron, copper and lead content is also observed, but the content of manganese and cadmium is lower than maximum concentration limit. Data at stations 6 and 7 practically coincide, except quantity of suspensions which exceed at station 7 (fig. 5).

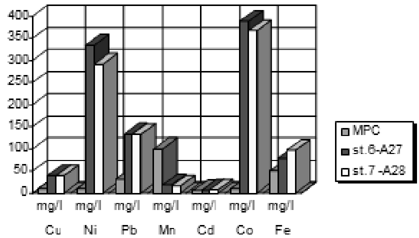


Fig. 5. The histogram on the heavy metal contents (St. 6 and 7).

The developed information - analytical system on the basis of satellite and land station information is important in decision-making for ecological assessment of type, degree and the reasons of man-made (anthropological) pollution of water ecosystem.

REFERENCES

[1] Badalova A.N. The analysis and an assessment of dynamics of an ecological status of the Caspian Sea, Scientific notes of National Aviation Academy, Baku, 2008, series 4, pp 47-53;

[2] Badalova A.N. An assessment and the analysis of an ecological status of a coastal zone of the Azerbaijan sector of the Caspian Sea using satellite information, Scientific works, National Aviation Academy, Baku, 2008, pp 146-154;

[3] Badalova A.N. An assessment of an ecological status of the Caspian Sea on the basis of schemes of complex and environmental monitoring, The International conference, Moscow, 2004, volume 1, pp 115-122;

[4] Ismatova H.R. Formation of a geoinformation model of development of ecologically dangerous situations of the coastal territory of the Caspian Sea, Collection of scientific articles of the Moscow scientific conference, 2004, pp 459-467;

[5] Mekhtiyev A.Sh., Badalova A.N., Ismatova Kh.R./An Approach to survey of pollution of the Caspian sea/International Academy of Science H& Baku-Innsbruck, 2007, pp.77-85.

DECREASING ENVIRONMENTAL IMPACT OF OLD SMALL HYDRAULIC POWER STATION

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ABSTRACT

The environmental impact produce be the hydraulic power stations is considerable. It is proved that the environmental impact increase with the age of the hydraulic power station. This fact is due to the absence of environmental regulation in the beginning period of hydraulic power stations. Even the environmental impact of the small hydraulic power station is smaller then in the case of the bigger hydraulic power station, it had to be taken into consideration because can create important local problems.

In this paper we analysed the environmental impact of small hydraulic power station and find solutions to decrease it. In order to do this, we made an environmental impact model for theoretical analyse and software. All these tools have been applied on a study case and have helped us to class correctly the environmental impact of the entire hydraulic power station arrangement scheme. After that we analysed the possibility to decrease the environmental impact and find the best solution for each component part of hydraulic power station arrangement scheme. In this way we managed to decrease the environmental impact for the entire hydraulic power station arrangement scheme.

Keywords: environmental impact, hydraulic power stations, model for theoretical analyse.

INTRODUCTION

In order to observe the effects produced by the old small hydraulic power station, on environment is necessary to consider the each element component of the power station, environmental impact generated by its construction and operation.

Hydraulic power station elements are: hydrotechnical construction of damming on the river in order to accumulate a volume of water required for different uses; hydrotechnical construction of water catchment;_hydrotechnical construction for the transport of water from the catchment to the place where water is valued; hydrotechnical construction where water is transformed in power; hydrotechnical construction used to restore natural water courses after water capitalization.

Some effects of existing old small hydraulic power station on the environment are: partial or total destruction of aquatic fauna and flora from the riverbed, because during the construction period, water flow from the river will be diverted and after that it will be reduced to ensure easement only normally flow and exceptionally flow discharged to the needs of the operating structure barring; the destruction of flora (forests, shrubs, vegetation) and fauna in certain areas of land as a result of flooding due to water losses from the water transport construction because of their partial or total damage and others [1].

STUDY CASE

Hydraulic power arrangement Toplet consist of two small hydraulic power stations, named MHC1 respectively MHC2, and annexes, operating in cascade, made to use the hydropower potential of Birza creek. The flow of the first power plant, MHC1, is taken by the second power plant, MHC2, located downstream. The flow of the second power plant is supplemented with water drawn from the creek Birza and evacuated approximately a distance of 500 meters downstream riverbed close to the confluence with the River Cerna.

Short description of the hydraulic power station MHC1:

- The catchment area is composed from three water sources and consists in several walls which direct the water to the supply channel. To make the supply channel dry the catchment channel is provided with two lateral drain water gates providing the Birza creek. A flow of 550 l/s is taken immediately after springs to supply the trout farmed, the flow is fully restored in the supply channel. A flow of 220 l/s provide drinking water for Orsova city.

- The supply channel is composed of two segments. First part is composed from a concrete channel alternate with natural channel. The section of the channel is variable, between 1 to 2 meters wide and between 1 to 1.5 meters depth. On the channel bottom are provided two 220mm diameter pipes for water supply of industrial platform, which currently is inoperable. Second part in consists of a rectangular section (1.25m wide and 1.17 m high) made of sheet metal 6-10mm thick. Entry into this channel is provided with a grate to stop leaves and vegetation from the first segment of supply channel. Part of the second section of the supply channel lay on support construction for crossing valleys.

- Loading chamber is made of reinforced concrete and provided with an overflow pipe consists of a stream discharging into Birza creek. The chamber is equipped with a grate for removing leaves and float. Cleaning the grate is done manually. A side gate is provided for draining disaster and washing silt accumulated in the supply channel.

- The forced pipe is made of riveted steel pipe with 0.90 meters diameter.

- The power plant has plan dimensions of 20 x 8 meters, and is provided with a Francis turbine.

- Tail race is rectangular, made of reinforced concrete and has also the role of settling basin.

Short description of the hydraulic power station MHC2:

- The supply channel for MHC2 is connected to tail race of MHC1.

- The water intake from Birza creek which is to ensure increased flow requirement for the MHC2 is not equipped for winter usage.

- Loading chamber is made of reinforced concrete and equipped with a gate for removing leaves and float and also a side gate for draining in case of malfunction and also for washing the silt accumulated in the supply channel.

- Forced pipe is made from a well with a vertical drop about 6 meters and a rectangular section pipe concrete.

- The power plant has plan dimensions of 16 x 12 meters, and is provided with a Francis turbine.

- Tail race of rectangular section, ensure drainage for machining water in Birza creek.

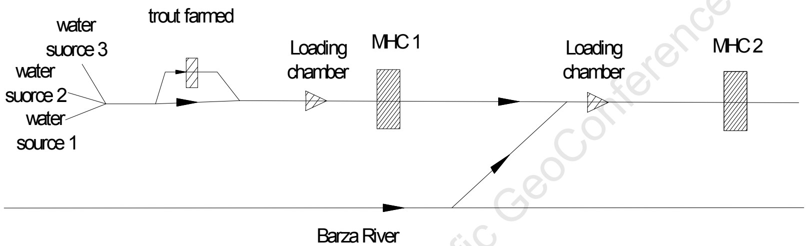

Fig.1. River arrangement MHC1+MHC - plan

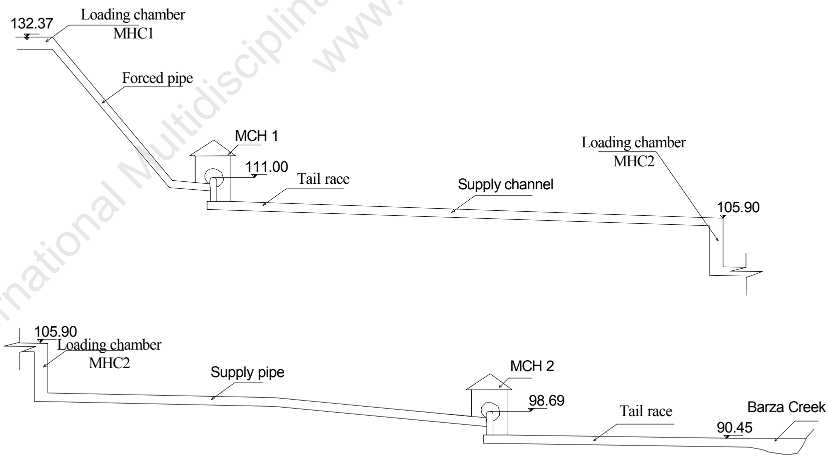

Fig.2. River arrangement MHC1+MHC2 - longitudinal section

Environmental problems and proposed actions will be summarized in table 1.

Table no 1. Model of analyse for the environmental impact produce be the hydraulic power arrangement

Crt. No	Analysed element	Reported problems	Proposed action	Environmental impact optimisation
1	catchment area	-silting of water sources	water sources cleaning	YES
2	supply channel first segment MHC1	- destruction of the supply channel in different sections (figure 1) - silting of supply channel - degradation of the bottom pipes	replacement of the old supply channel with a new concrete channel or pressure pipe	YES
3	supply channel second segment MHC1	-destruction of the supply channel made of sheet metal especially in the area of support construction for crossing valleys.	replacement of the old supply channel with a new concrete channel or pressure pipe	YES
4	Loading chamber MHC1	-degradation of the side gates (can not be opened in case of emergences)	replacement of the old gate	YES
5	supply channel MHC2	- degradation of the supply channel in different sections - silting of supply channel	replacement of the old supply channel with a new concrete channel or pressure pipe	YES
6	Loading chamber MHC2	-degradation of the side gates (can not be opened in case of emergences)	replacement of the old gate	YES

Fig.2. Deteriorate sector of supply channel MHC1

The proposed action after the environmental analyse was made are: building a storage room at the beginning of the supply channel equipped with automatic over the spillway dam and discharge of debts greater than the maximum expected flow; construction of an open supply channel offers the advantage of using prefabricated channel sections that may facilitate their assembly.

ENVIRONMENTAL IMPACT EVALUATION

In order to evaluate the environmental impact produced by hydraulic power arrangement a comparative evaluation method was used between the actual state of the environment, and the state of environment after the proposed actions are considerate to be made, taking into discussion four environmental factors: air, water, soil and human habitation [2], [3],[4], [5].

Quality indicators are used to evaluate the general state of environmental factors and also to correlate these factors in a graphical method synthetic appreciation. Each of the environmental factors analyzed is characterized by representative quality indicators for assessing the pollution level. In this sense, in a first stage, environmental factors relate to the limits allowed by national standards are used in order to achieve the pollution index Ip. For Ip = 0-1, the environment is affected in permissible limits and if the Ip > 1, the environment is affected more than the permissible limits.

Rojanschi illustrative method was used to obtain a graphical representation. The ideal state is represented graphically by a regular geometric form, (depending on the environmental factors taken into consideration: water, air, soil, and human habitation) with sides equal to 10 units of good standing [2]. Through union of the points an irregular geometric chart is obtained with a smaller surface, inscribed in the ideal state which is regular geometric chart. Global pollution index of ecosystem (IPG) consists of the rapport between ideal surface and real surface. According to the specialty literature there have been made assessments on global environmental pollution index for different situations, from which it was established a rating scale for IPG values from 1-6, the resulting environmental impact.

If the global pollution index IPG has the value 1 when there are no changes in the quality environmental factors, so there is no pollution.

If the global pollution index IPG will get progressively values between 2 and 6 than there are changes in the quality environmental factors.

Quality indicators and grades of creditworthiness for the two states of the environment (actual and propose) will be presented in the table 2.

Table no 2. Quality indicators and grades of creditworthiness

Environmental factor	Qc Actual situation	Gc Actual situation	Qc Propose situation	Gc Propose situation
water	0 - 0,25	8	0 - 0,25	9
air	0 - 0,25	8	0 - 0,25	9
soil, vegetation , fauna	-1,0	6	0.25-0.50	8
human habitation	0	10	0	10

Global pollution index IPG formula 1

$$IPG = \frac{S_i}{S_r} (1)$$

S_i – Ideal surface

S_r – Real surface

For the actual state of environment

$$S_r = 128$$

$$S_i = 200$$

$$IPG = \frac{S_i}{S_r} = \frac{200}{128}$$

$$IPG = 1.56$$

For the state of environment after the proposed actions are considerate to be made

$$S_r = 162$$

$$S_i = 200$$

$$IPG = \frac{S_i}{S_r} = \frac{200}{162}$$

$$IPG = 1.23$$

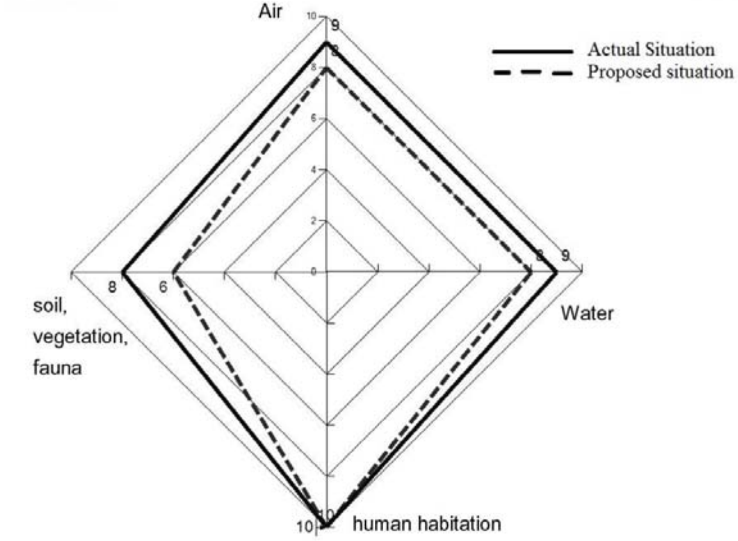

Fig.3. Global pollution index using Rojanschi method

CONCLUSIONS

The grades of creditworthiness are use in the Rojanschi method and result can be seen in the figure 3. Global pollution index IPG =1.23 estimated if proposed actions are considerate to be made, will produce a global contamination of the environment (water, air, soil, human habitation) that will smaller that global pollution index for the actual state IPG=1.56.

The proposed action building a storage room at the beginning of the supply channel and construction of an open supply channel will decrease the actual state IPG from 1.56 to 1.23. This is a really important change from the environmental point of view and is made for people to be aware that the proposed actions are an important investment for environment.

Environmental investments are generally expensive and are hard to be realised. In this case the proposed actions have benefits even from economical point of view. These benefits result from the increases of the flows which are used to produces electrical power.

REFERENCES

[1] Cristian Girbaciu, Contributions to the optimization of complex systems of integrated management of water, Polytechnic Editor, Romania, 2011.

[2] Octavian Liviu Munteanu, Evaluation of human impact on the environment, House Book of Science Editor, Romania, vol.1/issue 1, 2005.

[3] Vladimir Rojanschi & Florina Bran & Gheorghita Diaconu. Protection and Environmental Engineering, Economical Editor, Romania, vol. 1/issue 2, 2002.

[4] Vladimir Rojanschi & Florina Bran, Environmental policies and strategies, House Editor, Romania, 2002.

[5]*** HG 445/2009, for framework procedure for environmental impact assessment for specific public and private projects.

DESIGN OF CONSUMER MODEL AND ENVIRONMENTAL ASSESSMENT OF USED BUILDING MATERIALS

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ABSTRACT

Environmentally friendly building materials and constructions are intended to reduce energy and material flows during the entire building life cycle. The evaluation is focused on the assessment of consumption and depletion of material resources, especially non-renewable resources, to minimize the life-cycle impact of materials on the environment and enhance the indoor environmental quality by concentrating on the evaluation of energy flows through the building constructions. Energy effective houses increase efficiency of sources utilization (energy, water and materials) and they are designed in order to decrease effect on human health and environment during their life-cycle by means of better location, design, constructions, operation, maintenance and reconstruction. The factor of performance is their main contribution what means lower energy consumption and lower operating costs too. The energy effective houses don't present the new definition of projection but it is more improving of attested processes and adaptation to new requests. These buildings have certain specifications in the sphere of the thermal-technical demands – on external walls, roofs, ceilings above unheated space, ground floor, windows, doors – in comparison with common development. Constructions that divide spaces with different indoor air temperatures must meet a lot of building-constructional and building-physical conditions. Constructions that divide spaces with different indoor air temperatures must meet a lot of building-constructional and building-physical conditions. These conditions will be solved by design of consumer model. The aim of this paper is design of consumer model and environmental assessment of used building materials focused on life cycle analysis.

Keywords: building construction, environmental assessment, renewable energy sources

INTRODUCTION

With the economic development is increased demand of energy resources and energy. Depletion of fossil fuels and negative impact on environment and combustion of fossil fuels leads to finding other sources of energy. Through the burning of fossil fuels into the air is release a significant amount of pollutants, particularly CO_2 emissions which is currently most discussed theme. In accordance with long-term strategic objectives of reducing emissions and improving energy efficiency, adoption of the Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings raised commitment by 2020 to reduce overall greenhouse gas emissions by at least 20 %. The Directive requires Member States to design all new buildings with nearly zero energy by 31 December 2020 [1].

The objectives of the Directive can be applied in conjunction excellent thermal parameters packaging designs energy efficient buildings and shape solutions. The optimal design of energy-efficient buildings has a significant impact external geometry, i.e. compact shape and surface topography. The energy-efficient buildings is possible to build a number of parameters of packing structural modifications, but the shape that has been proposed in the early stage of architectural design, usually remains unchanged throughout the life of the building [15,16]. With an emphasis on the need for heat energy are the most compact design objects, only a small degree of segmentation.

The quality of most buildings can affect the initial phase of the architectural design is shown in the Figure 1 [2], it is important at this stage to optimize the input parameters are the energy balance of a building affects the most. In principle it is possible to speak of the deterministic approach - which is considered the input parameters as fixed, immutable and stochastic approach - which takes into account a wider set of input parameters.

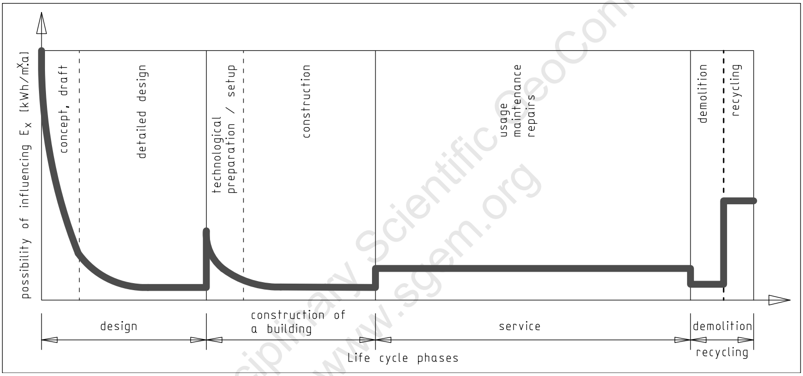

Figure 1: Potential for affecting the quality of solutions, cost and environmental impact of the life cycle [2]

ENERGY EFFICIENCY OF BUILDINGS

Improving energy efficiency in buildings is a major priority worldwide [3]. Sustainable building design, construction and operation require innovations in both engineering and management areas at all stages of a building's life. The lifespan of buildings is composed of a series of interlocking processes, starting from initial architectural and structural design, through to actual construction, and then to maintenance and control as well as to eventual demolition or renovation of buildings. Inside this lifespan, essential requirements are generated from considerations of social, environmental, and economic issues for high-efficient energy-saving building systems in compliance with building codes and regulations. In this regard, building assessment is becoming popular in order to have a standard method to evaluate new and existing building design [4]. The importance of the built environment from an environmental impact and energy use perspective is well established. High thermal efficiency of the constructed building envelope is a key strategy in the design and construction of buildings which limit use of active space conditioning systems [5]. Buildings are durable and building decisions have long-term consequences [6]. As a result, design decisions are critical for effective management of future energy requirement [5, 7].

Energy efficient building increase the efficiency of resource use (energy, water and materials) and are also designed to reduce impacts on human health and the environment throughout their lifecycle, through better location, design, construction, operation, maintenance and after rehabilitation. Their main benefit is the efficiency factor, lower operating costs through lower power consumption. Nevertheless, energy efficient homes are not entirely new definition of design, but rather to the improvement of best practices and adapt them to new requirements. Compared with conventional construction until recently, when these buildings show some specifics such as thermal and technical demands - on walls, roofs, floors above unheated spaces, ground floor, windows, doors. The structures that separate areas with different air temperatures must meet a number of construction and design and construction and physical requirements for the design of consumer model.

The consumer model

The assessment of the environmental performances of building materials and products is a complex issue which requires the use of a set of comprehensive criteria [8]. Energy and environmental impact are two major concerns of today's new building design and construction [9]. The aim of this paper is present concept of building structure design and environmental assessment for consumer model of research in order to force the integration of renewable energy sources. In this paper is presented an initial integration of the energy and environmental performance of consumer model. This consumer model will be confronted with measurement in situ. The consumer model is designed as a Passive House with the specific heat energy demand for heating of consumer model is less than 15 kWh/m^{2}a. The specific total final demand of consumer model is 40-60 kWh/ m^{2}a. The total amount of primary energy of consumer model is 100-120 kWh/m^{2}a. In consumer model is comfortable ventilation system with heat recuperations. The heat transmittance coefficient: envelope structures: U<0.10 – 0.13 W/m^2.K; roof structures: U<0.10 W/m^2.K; floor on the ground: U<0.10 – 0.15 W/m^2.K; windows: U<0.8 W/m^2.K.

Consumer model is experimental building that is part of the research faculty. Experimental building will be built in the laboratory hall, the whole building will be placed in climate chambers, where will be simulated exterior temperatures. Parameters of peripheral structures correspond to the parameters of passive house. The paper is presented systems to ensure the internal environment in rooms with the help of air conditioning and heating systems using renewable energy sources.

The consumer model is a single-story building with one bedroom, one living room with kitchen and one baths and toilet. In the figure (Figure 2) is shown view of the consumer model and in the figure (Figure 3) shows the floor plan of the consumer model. In the figure (Figure 4) is shown cut of the consumer model. Built-up area is 55,2 m^2. The consumer model has been designed in two alternative of thermal insulation. The alternative I. with mineral insulation and the alternative II. with polystyrene insulation.

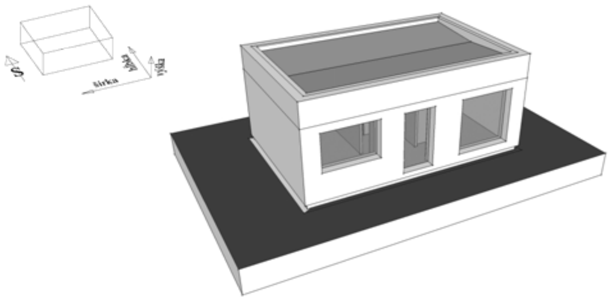

Figure 1: View of the consumer model

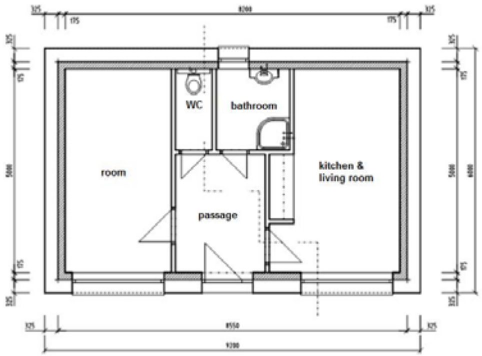

Figure 2: The floor plan of the consumer model

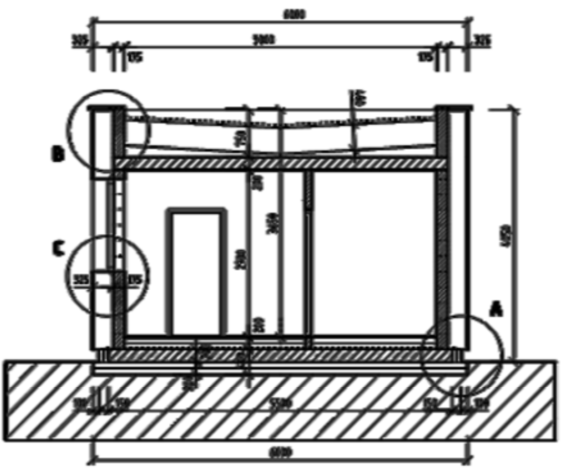

Figure 3: The cut of the consumer model

ASSESSMENT OF BUILDING IN TERMS OF ENERGY NEED FOR HEATING

The annual energy consumption affects the amount of input parameters. When considering quantitative thermal variables of transparent and opaque building envelope design and the resulting average heat transfer coefficient U_{em} (primary variable describing the quality of the building envelope in terms of heat loss) must satisfy the conditions of the building annual energy consumption in buildings [10].

Boundary conditions for the calculation:
Outside air temperature calculated in the winter to shall designate the location of the building, depending on the geographic location according to maps of temperature fields and, depending on altitude **Košice 297 m above sea level (**2. temperature region**), θe = -13 °C.** Calculated relative humidity of ambient air is determined by the ambient temperature as calculated: **φe = 84%**. Calculation of the internal air temperature for the residential part of the building: **θi = 20 °C**. Relative humidity of indoor air: **φi = 50%**. Surcharge for heating temperatures dipped to decrease indoor air: **to 5 K**

The heat for heating the house demonstration
Select structural system we determine the future value of the quantity of input parameters of the building envelope structures that affect heat energy demand. The design is important to know which of the input parameters are influencing the need for heat to heat up and then pay more attention to these parameters.
In calculating the energy need for heating the consumer model is considered the input parameters within the ranges as shown in the table (Table 1). Annual energy consumption was calculated by the method of quasi-stationary seasonal STN 73 0540 [10] in MS Excel.

Table 1: Input parameters to calculate the heat energy of model house

Parameter			min. value	med. value	max. value
index	name	unit			
U_{st}	Transmission heat loss coefficient wall	[W/m^2.K]	0.10	0.13	0.20
U_{pdl}	Transmission heat loss coefficient of floor	[W/m^2.K]	0.12	0.15	0.25
U_{st}	Transmission heat loss coefficient of roof	[W/m^2.K]	0.10	0.12	0.15
U_{ok}	Transmission heat loss coefficient of window	[W/m^2.K]	0.40	0.80	1.10
% ok S	% of window to wall - N	[%]	30	50	70
% ok J	% of window to wall - S	[%]	30	50	70
% ok V	% of window to wall - E	[%]	30	50	70
% ok Z	% of window to wall - W	[%]	30	50	70
g_{ok} - S	Total solar energy transmittance - N	[-]	0.10	0.50	0.90
g_{ok} - J	Total solar energy transmittance - S	[-]	0.10	0,50	0.90
g_{ok} - V	Total solar energy transmittance - E	[-]	0.10	0.50	0.90
go_k - Z	Total solar energy transmittance -	[-]	0.10	0.50	0.90

	W				
n	Air change rate	[1/h]	0.10	0.30	0.50
ΔU	Efect of termal bridge, offset by flat [6]	[W/(m.K)]	-0.04	0.00	0.10
ΔUA	Connection of the substructure of the circumferential wall	[W/(m.K)]	-0.04	0.00	0.10
ΔUB	Connection of the external wall to the roof construction	[W/(m.K)]	-0.04	0.00	0.10
ΔUC	Connection opening structures to a perimeter wall	[W/(m.K)]	-0.04	0.00	0.10
ΔUD	The walls in the corner	[W/(m.K)]	-0.04	0.00	0.10

The impact sensitivity of input parameters to the need for heat energy can be expressed by the correlation coefficient, which we determine the order of sensitivity (Figure 4, 5) In this case, the correlation coefficient determined by the combination of input parameters 20000.

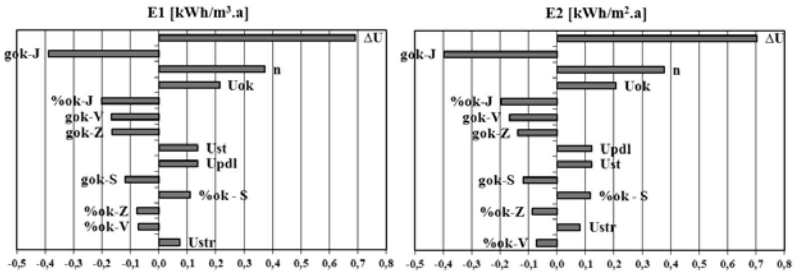

Figure 4: The correlation coefficient of sensitivity of input parameters on the need for heating, left - E_1 [kWh/m^3.a], right – E_2 [kWh/m^2.a], Effect of thermal bridges counted exactly.

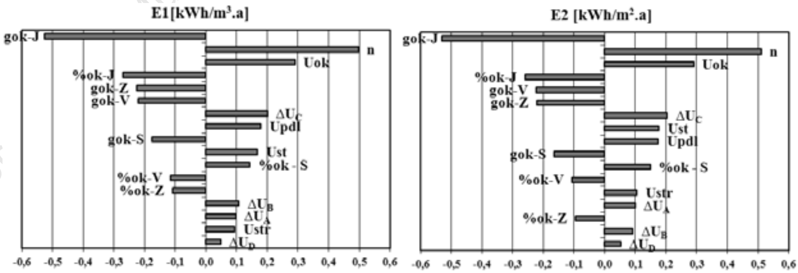

Figure 5: The correlation coefficient of sensitivity of input parameters on the need for heating, left - E_1[kWh/m^3.a], right – E_2 [kWh/m^2.a], Effect of thermal bridges counted exactly.

ENVIRONMENTAL PERFORMANCE OF CONSUMER MODEL

The construction industry has a significant impact on the environment, economy, and society. Buildings are one of the biggest contributors to greenhouse gas emissions; for which they are responsible for 38% of all CO_2 emissions [11]. The environmental impact of the consumer modes has been computed using the information database Passivhaus Bauteilkatalog [12]. Building materials, components and structures of two alternative of consumer model was evaluated according to amount of CO_2. The present knowledge allows evaluating the part of life cycle, from raw material exploitation to production of architectural elements. The values of primary energy for this part of the life cycle are determined by specialists. The consumer model was assessed from primary energy point of view derived from non-renewable energy. The global warming potential is expressed as equivalent amount of CO_2, which significantly contributes to the greenhouse effect. The following figure (Figure 4) shows the amount of CO_2 emissions related to building materials and structures used in the evaluated office. The total CO_2 emissions represent the value 17 970.20 kg per year in alternative I and 97522.4 kg per year in alternative II. The total area of building represents value 55.2 m^2. The value of CO_2 emissions related to m^2 area of the building represents a value of 325.54 kg/m^2 per year in alternative I and 1766.7 kg/m^2 per year in alternative II.

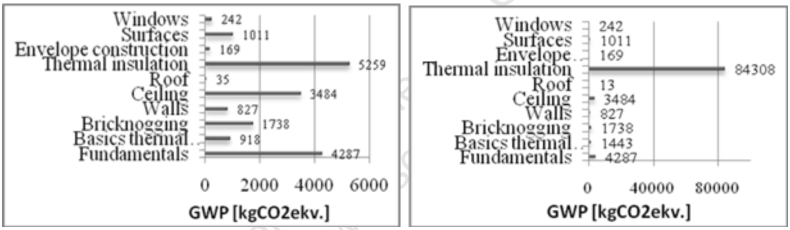

Figure 4: Global warming potential [$kg_{CO2,ekv}$] – a- alternative I, b-alternative II

CONSCLUSION

In order to identify savings in energy and emissions from any type of bioenergy production and use, a thorough evaluation from "cradle to grave„ must be carefully carried out [13] but our LCA analyse has been computed from „cradle to gate". Energy efficiency is a basic principle of the Passive House concept, but despite its importance, efficiency of household appliances is designated as an optional Passive House solution [14]. Energy efficiency is a basic principle of the Passive House concept, but despite its importance, efficiency of household appliances is designated as an optional Passive House solution. Therefore, the consumer model will be confronted with measurement in situ. Based on the results of measurements and after fine-tuning simulations of the experimental building will be to obtain relevant results applicable in practice for the design of passive buildings, in compliance with basic hygienic requirements in terms of structures, internal environment and in terms of design and use of heating or ventilation systems. The objective of this article was presents concept of building structure design and environmental assessment for consumer model of research in order to force the integration of renewable energy sources.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings

[2] Hájek, P.: Civil engineering and sustainable development. In: Construction bulletin 2004. Prague: JAGA Group 2003.

[3] Diakaki, Ch. Et al: A multi-objective decision model for the improvement of energyefficiency in buildings. In: Energy 35 (2010), p. 5483-5496.

[4] Chen, Z. et al. A multicriteria lifespan energyefficiency approach to intelligent building assessment. In: Energy and Buildings 38 (2006), p. 393-409.

[5] Morrissey, J., Horne, RE. Life cycle cost implications of energy efficiency measures in new residential building. In: Energy and Buildings 43 (2011), p. 915-924.

[6] M. Ryghaug, K.H. Sørensen, How energy efficiency fails in the building industry,

Energy Policy 37 (3) (2009), p. 984–991.

[7] G. Manioglu, Z. Yilmaz, Economic evaluation of the building envelope and operation period of heating system in terms of thermal comfort, Energy and Buildings 38 (3) (2006), p. 266–272.

[8] Harris, DJ. A quantitative approach to the assessment of the environmental impact of building materials. In Building and the Environment, vol. 34, no. 6, 1999, p. 751-758.

[9] Yong, X. T., Yimin, Z. An initial energy and environmental impact study of an Innovida Patio House. Final Report, 2010, p. 47.

[10] STN 73 0540, 1-4: Thermal performance of buildings and components. Thermal protection of buildings, Part 1: Terminology, Part 2: Functional requirements, Part 3: Properties of environments, Part 4: Methods of calculation. SUTN 2006. [in Slovak].

[11] Retrieved from: EIA, Energy Information Administration. Annual energy outlook. US department of Energy. http://www.eia.doe.gov/oia/aeo/indes.html

[12]http://www.createrra.sk/pasivny_dom/aktualne/Entries/2008/11/26_Vypocet_PEI,_CO2_a_SO2.html; [accessed 26.04.2012] [in Slovak]

[13] Lam, MK. Lee, KT., Mohamed, AR. Life cycle assessment for the production of biodiesel: a case study in Malaysia for palm oil versus jatropha oil. In Biofeuls Bioprod Bioferin, vol 3. 2009, p. 601-612.

[14] Passive House Solutions. Concept of building structure design and environmental assessment for consumer model of research in order to force the integration of renewable energy sources. May 2006, p. 50.

[15] Kapalo, P.: Effect of concentration CO_2 on the energy efficiency of buildings. In: 4. Cassotherm, Vysoké Tatry, 2012, p. 110-113, ISBN 978-80-89385-19-5.

[16] Lis, P.: Shape index of school buildings and energy consumption for heating.

DESIGN OF UNDERFLOOR VENTILATION IN HISTORIC BUILDINGS USING CFC SIMULATIONS

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ABSTRACT

Concepts of remedial treatments of historic buildings using ventilated floors, with a few exceptions, are with considerable popularity preferred by the representatives of monument protection. The fact that they require small interventions in the masonry is of great benefit for compliance with the methodology of cultural heritage protection, as is the fact that such interventions do not compromise the structural analysis of buildings. These concepts have gained great popularity also because they can be considered kind of a "return" to historical example. With these technologies we return to the methods and principles that the ancient Egyptians were already familiar with. The paradox is that these methods are used for many centuries, until today they are only proposed on the basis of empiricism. There is no proven relationship and calculation nor any literature that would address the airflow in floors, ventilation ducts and galleries around the base building construction. The remaining problem is the draft of air cavities in general. The exact calculation of airflow in the underfloor cavity has not yet been formulated. To assessment the airflow in the air cavity the recently often used CFD simulations can be employed. Using simulation, respective design cycles, which shall be ultimately verified by laboratory experiments and also by in situ measurements, may be accelerated.

Keywords: Reconstructions, Historic buildings, Ventilated Floor, Air flow, CFD

INTRODUCTION

Historically impressive churches may still be found in various parts of the Slovak Republic. It is often only due to these structures, that we gain valuable insight into historical the design and construction of historical buildings in Slovakia. Despite the fact that such culturally valuable structures deserve proper attention and care, many of them remain forgotten and fall into disrepair.

Moisture ingress is amongst the most common problems that affect historic buildings. One of the few options available to prevent the gradual destruction of the interior surface involves the use of natural ventilation in the interior. This non-destructive method is often applied to historical monuments. Fluctuation properties of the environment in naturally ventilated churches are described in studies [1, 2].

This article also divulges another method based on historical examples, by applying underfloor air cavities that promote natural ventilation as a result of external wind effects. Similar design problems and air cavity assessments are described in paper [3].

UNDERFLOOR VENTILATION

A basic requirement with rising damp is the installation of a retrofitted horizontal damp proofing course with the essential accompanying treatments. Only once the cause of the moisture penetration into the masonry wall has been eliminated, the masonry will dry out. This reduction results from the evaporation of the moisture in the masonry, whereas the speed of evaporation depends on the thickness of the masonry, the degree of salinization and moisture penetration, on the climatic conditions around the facility and the airflow around the wall, as well as the make-up of the wall surface [4].

Maintaining underfloor ventilation (Figure 1) is an important part of controlling damp, as it allows soil moisture to evaporate beneath the floor and to pass out through the vents in the lower walls. Without this ventilation the moisture "stress" on the walls would be much greater. One of the worst mistakes of renovators is to remove a ventilated timber floor and replace it with a concrete slab poured on sand or fill. The concrete prevents evaporation and all the soil moisture rising beneath the building is now focused on the walls (Figure 2) [5].

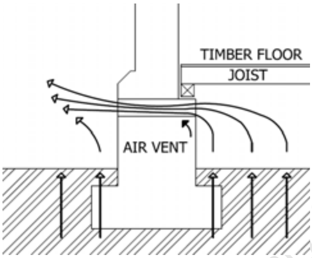

Figure 1: Well-ventilated underfloor space allows soil moisture to evaporate to the open air [2]

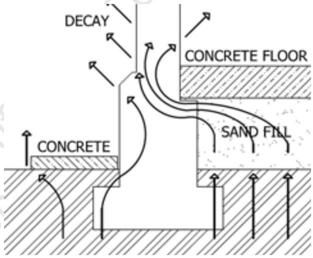

Figure 2: Concrete slabs prevent evaporation, so soil moisture is forced up the wall [2]

MODEL EXAMPLE

A historical church, illustrated in (Figure 3, 4) is selected as a model example of underfloor ventilated cavities. The geometry and structural composition of the church is typical of many religious buildings scattered throughout the territory of the Slovak Republic.

The air cavity is designed according to empirical principles. The total area of the intake and exhaust openings approximates 1/100th of the ventilated floor space. The cavity has a height of 450 mm (determined by the height of the embankment), a size larger than the recommended minimum of 100 mm. Inlets are designed on windward (north) side, leaving exhaust outlets on the leeward (south) side.

In the event that the interior of the church is artificially heated during the winter, appropriately positioned thermal insulation will be required in accordance with the requirements of STN 73 0540-2 [6] and calculations determined by the boundary conditions of STN 73 0540-3 [7]. The evaluation of annual energy consumptions according to STN EN ISO 13790/NA [8] procedures and the evaluation of thermal bridges according to EN ISO 10211 [9] are in this case (historic building) inadequate.

CFD SIMULATION

ANSYS CFX [10] is used to assess the underfloor ventilation model example (Figure 3, 4). Of the two completed simulations, the first overall geometry of a modeled church, ascertains the actual pressure on the walls due to wind effects. Results from the first simulation are applied as boundary conditions, where the geometric model represents the underfloor air cavity.

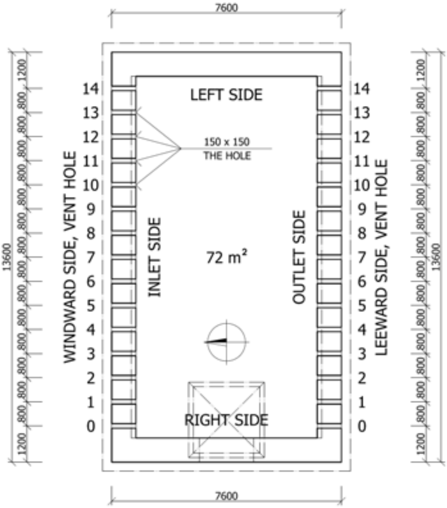

Figure 3: Ground plane of church

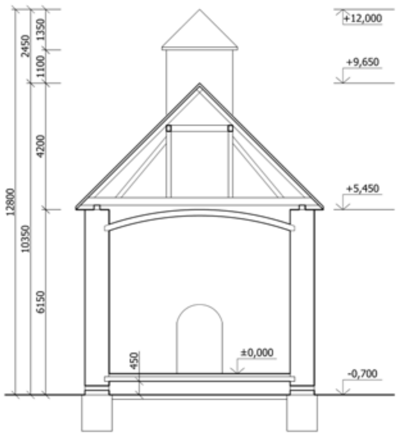

Figure 4: Cross section of church

The overall geometric model of the church is simulated by a wind flow of 3 $m.s^{-1}$ induced at the north face, which increases with height. The modeling process is realized due to changes in pressure along the length and height of the windward and leeward sides. However, modeling an air flow with constant speed of 3 $m.s^{-1}$ for each inlet (in second simulations), is deemed inappropriate.

Figure 5 illustrates the pressure induced on the windward (north) side of the church. It is visible that wall pressure waves are symmetrical, changing in length and height according to the wall. Inlet pressure increases towards the centre of the ventilation's inlets.

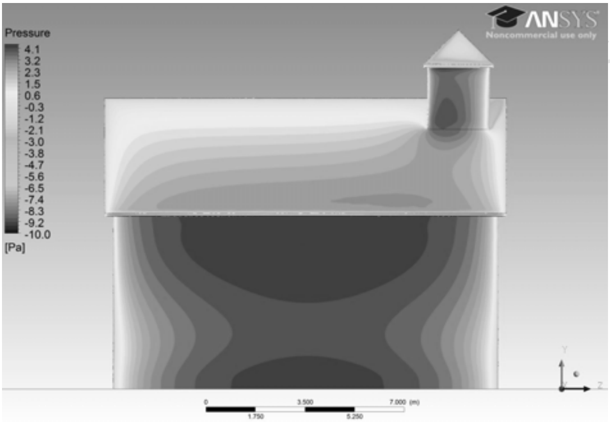

Figure 5: Pressures on the windward side

Figure 6 reveals the air suction on the leeward (south) side. The pressure wave is greatly influenced by the church tower. Here, air suction is asymmetric at the opening.

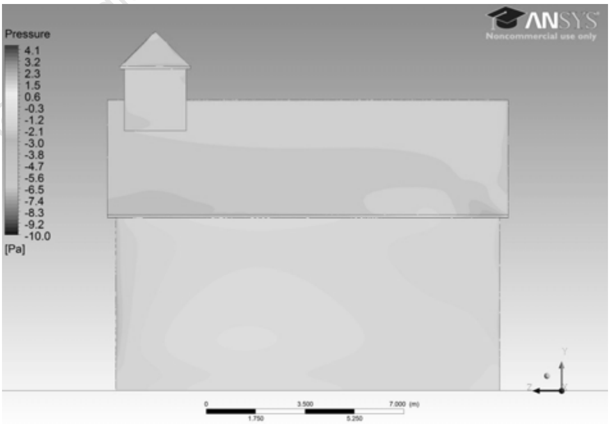

Figure 6: Pressures on the leeward side

The designation of input boundary conditions for the second simulation (independent cavity) requires the logging of exact pressure values at the intake and exhaust openings. Curves are shown in Figure 7.

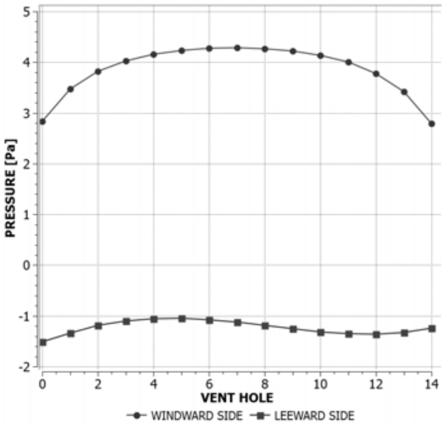

Figure 7: Pressures on holes

Secondly, the geometry of the underfloor air cavity with the intake and exhaust openings is independently modeled. After deducting the windward and leeward pressures (Figure 7) individual values are entered as input boundary conditions (input, output) for the modeled cavity.

In Figure 8 an air velocity is produced along the longitudinal section of the cavity axis. From these results it is obvious that the airstream flows from the side of the openings towards the centre of the cavity.

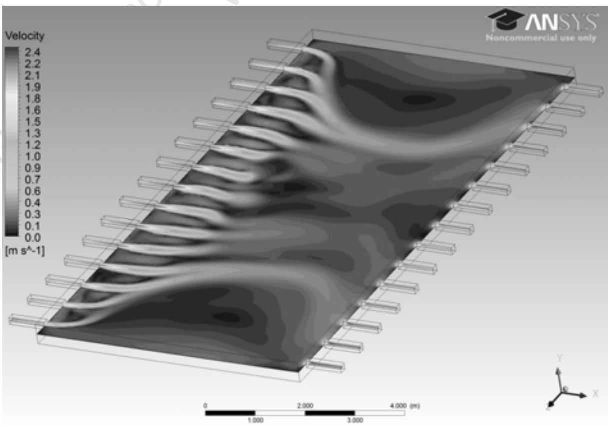

Figure 8: Air velocity in underfloor cavity – longitudinal section

In figure 9, the air velocity flows across transverse sections of the holes axes. An observable increase in air velocity can be seen near the centre of the cavity. This fact is influenced by the course of real pressure acting on the wall at wind speeds of 3 m.s^{-1} (Figure 7).

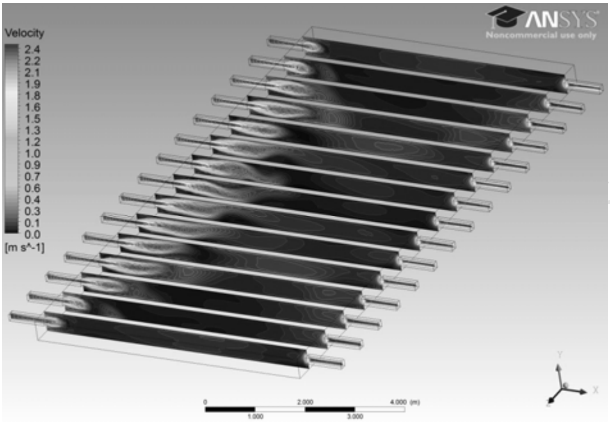

Figure 9: Air velocity in underfloor cavity – cross section

Figure 10 provides a more accurate estimate of places with limited air velocity. On the right and left side of the cavity around the middle you can observe points of turbulence that slow the rate of air flow rate.

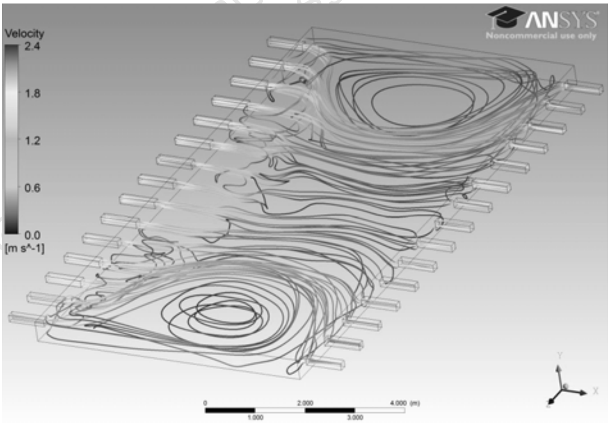

Figure 10: Streamlines of air velocity in underfloor cavity

From the velocity profiles (Figure 8, 9, 10) it is evident that the air cavity produces a sufficient volume of airflow. For a complete assessment of the air flow, further analysis of air flow rates around the edges of the cavity are required (walls).

Figure 11 depicts a graph of airflow velocity in the vicinity of the shorter sides of the assessed cavity. Assessed sides are divided into 300 equal parts, corresponding to a 20 mm diameter. From the air velocity curve, influenced by the church tower, it is evident that there is a minimum difference between the right and left side of the cavity. Airflow is not zero.

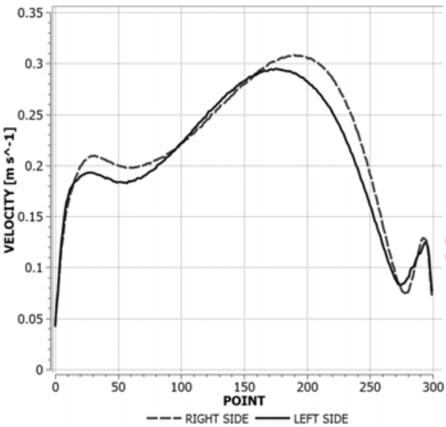

Figure 11: Air velocity near the shorter sides of the cavity

Figure 12 shows an airflow velocity graph in the vicinity of the longer sides of the assessed air cavity. Assessed sides are divided into 600 equal parts, corresponding to a 20 mm diameter. The chart shows that rates are the same course as pressures from Figure 7. Airflow is not zero.

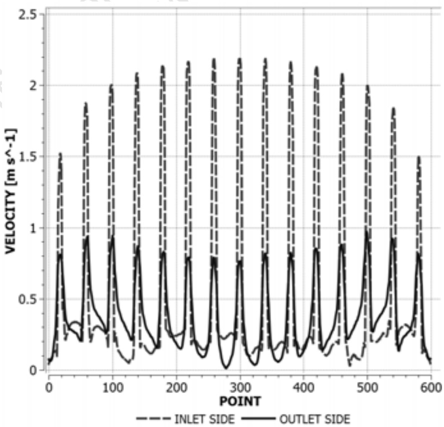

Figure 12: Air velocity near the longer sides of the cavity

CONCLUSION

The paper aims to highlight the possibilities of CFD computer simulation programs to assess airflow in underfloor cavities. The application of simple geometric models can accurately confirm or refute the appropriateness of a proposed solution.

The above results disclose that the modeled air cavity works reliably. Except for two places that are affected by excessive turbulence (Figure 10) the velocity of the cavity tend to work reliably.

The given model was realized with an air flow of 3 $m.s^{-1}$, during the summer with air temperatures approximating 25 °C. It may be considered that the assessment is similar to an evaluation for air flows in a cavity of variable wind speeds and also for winter periods, where average temperatures are below freezing.

ACKNOWLEDGEMENT

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REFERENCES

[1] Björling M. & Stymne H. & Boman C.A. 2009. The Indoor Climate of a Naturally Ventilated Church. Proceedings of Healthy Buildings 2009, USA, 2009

[2] Arumägi E. & Kalamees T. & Broström T. Indoor climate in a naturally ventilated unheated medieval church in Harju-Risti, Estonia. 10th REHVA World congress Clima, Turkey, 2010.

[3] Kalousek M. & Šikula O. CFD simulation of ventilated air cavity. Building Simulation and Environmental Engineering 2008, 5. conference, Czech Republic, 2008.

[4] Frössel F. Masonry Drying and Cellar Rehabilitation, Germany, 2007

[5] Young D. Salt attack and rising damp, A guide to salt damp in historic and older buildings, South Australian, 2008

[6] STN 73 0540-2. Thermal performance of buildings and components. Thermal protection of buildings. Part 2: Functional requirements. Slovak Republic, 2002.

[7] STN 73 0540-3. Thermal performance of buildings and components. Thermal protection of buildings. Part 3: Properties of environments and building products. Slovak Republic, 2002.

[8] STN EN ISO 13790/NA. Energy performance of buildings. Calculation of energy use for space heating and cooling. 2010.

[9] STN EN ISO 10211. Thermal bridges in building construction. Heat flows and surface temperatures. Detailed calculations. 2008.

[10] ANSYS Inc. CFX 12.1. Tutorials, Ansys CFX, Release 12.1.

DEVELOPMENT AND UTILIZATION OF A BIOREACTOR WITH ABORIGINAL MICROFLORA FOR OILY SOIL BIOREMEDIATION

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ABSTRACT

The process of bioremediation of oily soils implemented on technological sites was investigated. Different researches making possible to expose optimal parameters of bioremediation process under control were undertaken and the results of microbiological studies and biodegradation dynamics of oil products in bioreactor conditions are presented. The effectiveness of oil products biodestruction in a bioreactor and on technological sites was comparatively analyzed. Initial data for experimental-industrial bioreactor designing were obtained.

Keywords: bioremediation, bioreactor, hydrocarbon oxidizing microorganisms, oily soil.

INTRODUCTION

The penetration of oil and oil products in the soil causes disturbance of the natural soil biocenosis and the fine fraction emission of oil products in the air and water. As a result there are risks of environment and people's health degradation [1].

Nowadays in Russia a technology of remediation is used on technological sites for restoration of oily soil. It takes long time within several vegetation periods and is accompanied by alienation of considerable parts of land. Its effectiveness depends on climatic conditions and the geographical peculiarities of territory. It's possible to avoid these shortcomings in the event of using bioreactor technology which lets to implement the process of oily soil cleaning under control and to create optimal parameters necessary for effective microbiological destruction.

The aim of this work was to give proof of bioreactor construction for restoration of oily soil and to estimate the effectiveness of biodegradation process with specified settings.

To get this aim the following problems were solved:

– optimal parameters of bioremediation process in a bioreactor were detected: humidity of substratum, its temperature, pH, formulation, height of layer processed in bioreactor, periodicity of substratum mixing;

– the structure of biocenosis emerging in bioreactor and the dynamics of its development depending on oil products content were researched;

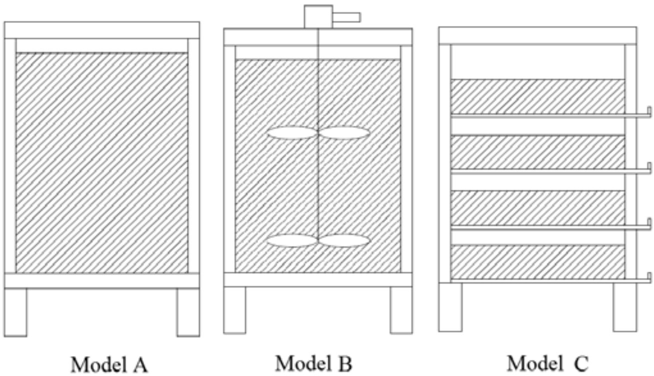
– initial data to give proof to experimental-industrial reactor construction were received.

METHODOLOGICAL SUPPORT OF EXPERIMENTAL RESEARCHES

To research the dynamics of microbe community structure in oily soils a plating of microorganisms was produced. The purpose was to find hard elective mediums: Tauson medium for hydrocarbon oxidizing microorganisms; KAA medium for actinomycetes; Chapek medium for microscopic fungi; Eshbi medium for Azotobacter bacteria (method of soil clots) and oligonitrophyls; MPA medium (beef-extract agar) for heterotrophic microorganisms [2].

Microscope Carl Zeiss with 40x20 zoom was used for direct count of microorganisms. The effectiveness of the cleaning process was estimated in terms of the total content of hydrocarbons in soil by UR-spectrometry method.

Optimal parameters of biodestruction process were examined on model plants with different configuration in a laboratory (pic. 1)



Pic.1 Model plants of reactors for oily soil cleaning: Model A – a reactor without mixing of oily soil; Model B – a reactor with mixing of oily soil; Model C – a reactor with sectional placement of oily soil.

The model plants used in our experiment made it possible to research two parameters influencing significantly on the process of oily soil cleaning: periodicity of substratum mixing (Model A and Model B) and the maximum height of oily soil layer when anaerobic zones are not formed (Model A and Model C).

Model A was a vertical tank without a mixing device; Model B was a vertical tank with a mixing device; Model C was a reactor with sectional placement of oily soil. Aeration in all reactors was natural. The weight of oily soil processed in every reactor was 20 kg.

The following basic parameters of bioremediation process were established in the process of preceding researches [3], [4]: the volume share of structurating device (softwood sawdust) – 30%, substratum temperature - (21 ± 2) °C, humidity - 80%, pH = 6,5...8,0.

Experimental research of bioremediation in bioreactors took 120 days.

The process of cleaning were under control according to microbiological indicators once every two weeks (dynamics of microbiological community development: total number of microorganisms, number of saprophytes, number of microscopic fungi, hydrocarbon oxidizing microorganisms, actinomycetes, Azotobacter bacteria and oligonitrophyls) and according to physics-mathematical indicators once a month (pH, total content of oil products).

THE RESULTS OF EXPERIMENTAL RESEARCHES

The results of microbiological researches of oily soil cleaning in bioreactors of different construction are presented in Tab.1

Table 1 – Microbiological characteristics of oily soils in bioreactors of different construction

Indicators	Initial oily soil	Test samples of oily soil (120 days of exposition)			Control (sod-podzol soil)
		Model A	Model B	Model C	
Total number of microorganisms, cell/g	$6,0 \cdot 10^7$	$4,0 \cdot 10^8$	$2,8 \cdot 10^8$	$1,5 \cdot 10^9$	$1,4 \cdot 10^9$
Number of saprophytes bacteria, CFU/g (colony forming units/g)	$1,8 \cdot 10^4$	$5,5 \cdot 10^4$	$4,5 \cdot 10^4$	$6,4 \cdot 10^4$	$2,8 \cdot 10^4$
Hydrocarbon oxidizing microorganisms, CFU/g	$1,8 \cdot 10^3$	$4,5 \cdot 10^3$	$8,0 \cdot 10^3$	$7,0 \cdot 10^3$	not detected
Actinomycetes, CFU/g	Not found	$6,5 \cdot 10^4$	$1,2 \cdot 10^4$	$5,1 \cdot 10^4$	$2,7 \cdot 10^5$
Microscopic fungi, CFU/g	Not found	$2,4 \cdot 10^4$	$2,1 \cdot 10^4$	$3,0 \cdot 10^4$	$7,8 \cdot 10^5$
Aztobacter bacteriums, % of clots accumulation	Not found	23,0	41,7	61,6	100,0
Oligonitrophyls, CFU/g	$3,1 \cdot 10^3$	$3,0 \cdot 10^2$	$5,0 \cdot 10^2$	$1,0 \cdot 10^2$	$1,9 \cdot 10^1$

During the process of cleaning an increase of the total number of microorganisms including saprophytes and hydrocarbon oxidizing bacteria was established in all reactors. The main representatives of saprophytes isolated from oily soil were Bacillus sp. and Pseudomonas sp. The number of actinomycetes and microscopic fungi was increasing during all time of experiment. Microscopic fungi were presented by *Penicillium sp.*, *Aspergillus sp.*, *Fusarium sp.*, *Trichoderma sp.*.

The number of oligonitrophyls was decreasing during the experiment; at the same same on the 100th day after beginning of the experiment an appearance of *Azotobacter sp.* Bacteria was established.

Effectiveness of cleaning in bioreactors of different construction was estimated on the basis of oil products content in soil at the beginning and at the end of the experiment. (Tab.2). Content of oil products in initial oily soil was 75 g/kg.

Table 2 – The effectiveness of oily soil cleaning in reactors of different construction

Investigated oily soil	Content of oil products, g/kg	Effectiveness of cleaning, %
Oily soil from Model A	41,2	45,07
Oily soil from Model B	50,1	33,20
Oily soil from Model C	25,7	65,70

After processing of the experiment results and comparison of them with initial oily soil and the control sample it was established that oily soil destructed in the sectional bioreactor (Model C) was the closest (65,7 %) to control sample by its microbiological characteristics.

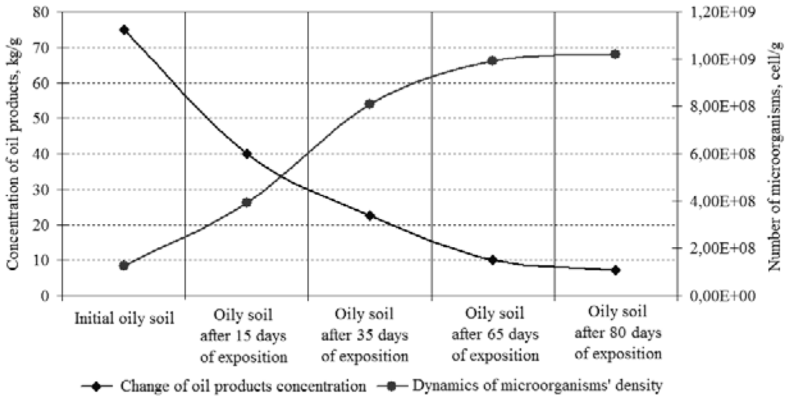
All data received were used for giving proof of construction of a laboratory sectional bioreactor working in stationary-discrete conditions.

The reactor construction corresponded a vertical tank made of corrosion-resistant material and divided into sections that made possible to use passive method of substratum aeration and exclude any ability of zones with aerobic conditions appearance. Mixing of oily soil in the process of cleaning was not provided for in order to maintain the integrity of microscopic fungi and actinomycetes mycelium which is important for biodestruction of residual oil hydrocarbons concentrations. The charging of substratum was processed from the top of every section.

The process of oily soil cleaning took 80 days. It was processed by application of aboriginal microflora with different associations of microorganisms capable of biodegradation of wide range of hydrocarbon fractions.

The following parameters were supported and controlled in the bioreactor: height of substratum layer in every section was 30 cm, temperature of substratum was (+20±2) ºC, humidity of substratum was 70-80 %, the volume share of structurating device was 30%.

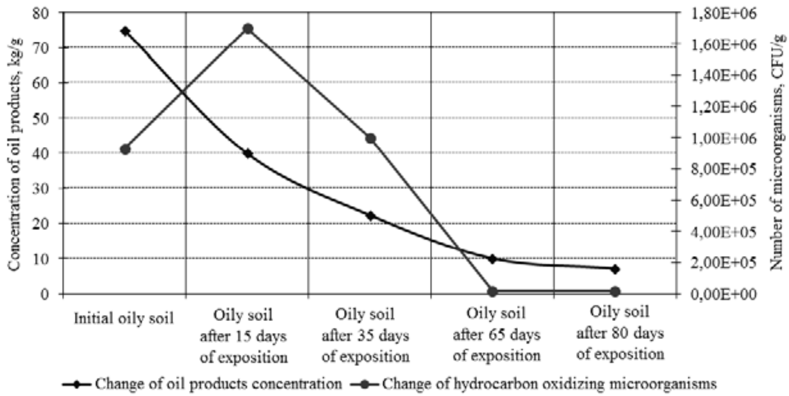
The results of researches of bioremediation process of oily soil in a bioreactor are presented on picture 2.



Picture 2 – Dependence of microorganisms' density changes in the process of cleaning in bioreactor from the oil products concentration and time of biodestruction.

During the cleaning process gradual increase of the total number of microorganisms up to $(1{,}02 \pm 0{,}4) \cdot 10^9$ cell/g by the end of our experiment was established.

Dynamics of hydrocarbon oxidizing microorganisms number was observed during the process of research. (picture 3)



Picture 3 – Change of hydrocarbon oxidizing microorganisms number in the process of cleaning of oily soil depending on concentration of oil products.

Decrease of hydrocarbon oxidizing microorganisms number by the end of exposition was caused by decrease of oil products content in the soil used by these microorganisms as a source of food. Data received is an indicator of oil hydrocarbon biodesruction.

Picture 4 presents a microscopic picture of hydrocarbon oxidizing microorganisms isolated on nutrient medium with raw oil as a source of hydrocarbons.

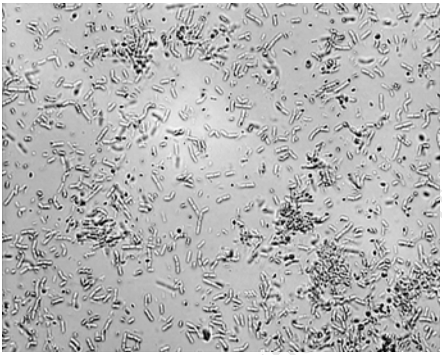


Рис. 4 – Hydrocarbon oxidizing microorganisms isolated on selective Tauson medium

Saprophytic microorganisms in the initial soil were presented mainly by *Pseudomonas sp.* and *Rhodococcus sp.* kinds but by the end of the exposition there were found some more such as *Bacillus sp*., *Micrococcus sp*., *Nocardia sp*. and others. This increase of saprophytic microorganisms' diversity by the end of experiment indicates that initial conditions of microbiocenosis development changed after oil and oil products contamination of soil are restored in the process of cleaning.

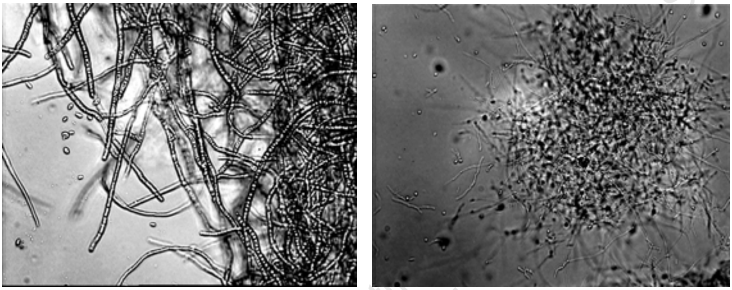
Presence of nitrogen-fixing bacteria is an important indicator of soil of any type condition. So the works on isolation of Azotobacter bacteria were carried out. In the process of oily soil cleaning the increase of the percentage of the clots' fouling by Azotobacter bacteria was found out. By the end of the exposition this percentage reached 100 and it was an indicator of gradual decrease of oily soil toxicity for this kind of bacteria.

Eshbi medium gave development of not only Azotobacter sp. bacteria but also oligonitrophils. The number of oligonitrophils were decreasing while the increasing of azotobacter reached $(1,3\pm0,4)\cdot10^3$ CFU/g by the end of exposition.

It is known from literature sources that actinomycetes and microscopic fungi play an important role in the process of oil products boidestruction. They can use oil components as a source of carbon in their life activity and can oxidize residual small concentrations of oil products. It makes them important on finishing stages of the bioremediation process.

The total number of actinomycetes and microscopic fungi were determined in the process of oily soil cleaning in bioreactor. There were no actinomycetes and fungi in the initial sample of oily soil but by the end of the experiment their number increased and was $(3,1\pm1,1)\cdot10^4$ CFU/g and $(5,0\pm1,4)\cdot10^4$ CFU/g respectively. Actinomycetes and fungi were presented by *Actinomyces sp*., *Scedosporium sp*., *Penicillium sp*., *Aspergillus sp*., *Fusarium sp*. kinds.

Mycelium of microscopic fungi and actinomycetes isolated from the experimental samples are presented on picture 5.



a b

Picture 5 – Mycelium of microscopic fungi (a) and actinomycetes (b) isolated from the experimental samples.

The total count of microorganisms showed an increase of their number in soil by the end of the experiment. The growth of microorganisms' density indicates a decrease of oily soil toxicity and shows a development of new groups of microorganisms sensitive to high concentrations of oil products. While the number of hydrocarbon oxidizing microorganisms went down new fungi and actinomycetes appeared in the soil bieng cleaned.

Analysis of the results of our experimental research showed the following:

– maximum effectiveness of oily soil cleaning is reached by using of a bioreactor of sectional type working discrete-continuously and providing the following conditions: height of substratum layer - 30 cm, substratum temperature - (+20±2) ºC, substratum humidity - 30%;

– effectiveness of oily soil cleaning from oil products in a bioreactor within 80 days of exposition was about 90%, at the same time the application of traditional methods of bioremediation on technological sites allows to reach similar characteristics of purity only after 4 vegetation periods;

– different changes of biocenosis structure of the processed soil took place in the process of bioremediation: the total number of microorganisms including saprophytes was increasing, at the same time the number of hydrocarbon oxidizing microorganisms were decreasing significantly. The development of microscopic fungi and actynomycetes as well as nitrogen-fixing bacteria and oligonitrophyls was observed.

– initial data for designing of an experimental-industrial bioreactor were received. These data make it possible to control the process of oily soil cleaning in a bioreactor as well as on bioremediation sites.

In spite of high speed of oily soil cleaning process in a bioreactor this technology can be limited by the volume of soil processed in comparison with bioremediation on technological sites. An increase of bioreactor efficiency can be reached by combination of different methods of oily soil bioremediation. For example it is possible to clean oily soil in a bioreactor first to reach some specified values of oil products content and to use afterpurification on bioremediation technological sites later.

REFERENCES

[1] Oily biocenosis: monograph / A. Oborin – The Russian Academy of Sciences; Perm State Technical University – Perm, 2008 – 511 pages

[2] Practical training lesson on microbiology: tutorial for students of institutions of higher education/edited by A.Netrusova - Moscow: Academia, 2005 – 608 pages, p.2

[3] Bikmansurova E. Research of oily bioremediation processes in laboratory bioreactors of different type./ E.Bikmansurova, L. Rudakova, M. Akhmadiev// Environmental protection in oil and gas industry – Moscow, 2008 - #12 – pp 21-26

[4] Rudakova L. Utilization of bioreactor technology for oily soil restoration / Rudakova L., Sakaeva E., Petrov V. // Environmental protection in oil and gas industry – Moscow, 2011. - #7. pp 35-38.

DIAGNOSTIC METHODS TO STUDY OF THE WASTE WATER BIOCORROSION IMPACTS TO THE BUILDING MATERIALS

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ABSTRACT

The corrosion processes of mineral, metal and polymeric building materials can be influenced by biological factors. The effect of bio-agents on the construction materials in recent years is the subject of scientific interest. Scientific approach particularly relating to the surface changes of corroded materials requires the development of diagnostic methods of interdisciplinary character. Current research in the field is aimed with respect to the potential of innovative diagnostic techniques in microscopy, new spectroscopic and other techniques for the study of corrosion products and biofilms.

This paper aims to present the results of the evaluation of concrete durability affected by bacterial corrosion. The X-ray fluorescence analysis (XRF), infrared analysis (FTIR), thermal analysis (TG/DSC) and atomic force microscopy (AFM) were used for the investigation of the concrete samples before and after the experiments. The experiments proceeded in real sewage system during 6 months. The sulphur-oxidising and sulphate reducing bacteria present in waste water was considered to be the main corrosion factor.

The corrosion process has been demonstrated by the tensile strength changes of concrete samples as well as by the chemical composition changes.

Keywords: concrete, wastewater, biodeterioration, XRF, FTIR, DSC/TG

INTRODUCTION

Concrete is used extremely widely in building and civil engineering structures. Compared to other commonly used building materials it has achieved good durability, relative high strength and the highest versatility grade to be prepared in-situ [1]. Due to these abilities there are a high number of varieties in building of prefabricated elements available on the market in the form of panels, drainage, sewer pipes and various concrete units. Concrete structures and elements are exposed to different conditions of environment. It leads to its failures, cracking, weathering and deterioration. Under aggressive conditions, the concrete is liable to a corrosive process which is not usually caused by one specific factor but by combination of aggressive media. In many cases there is very difficult to find out which factor is the most important or dangerous regarding to building material destruction. External and internal influences on concrete jointly lead to physical, chemical and mechanical processes. During these processes the life conditions of environment can be suitable for the microorganisms' being and growth. The microorganisms in this specific case are called biodetergents and the process is microbially involved corrosion – biocorrosion. Biodetergents are demanding on water, humidity, pH, temperature, nutrients and anorganic matters, but on the other hand they produce metabolic products which are very aggressive to the building material [2,3,4]. The most visible degradations are going on in the water environment but often only the presence of high humidity for the starts of biocorrosion is sufficient [5].

Waste water contains a lot of organic matters which encourage the sulphate formation. Sulphate create by decomposition of proteins and sulphates in anaerobic conditions [4,5]. A lot of microorganisms' genuses can be indentifying in sewers, e.g. *Acidithiobacillus novellus*, *Acidithiobacillus neapolitanus*, *Acidithiobacillus denitrificant*, *Acidithiobacillus ferooxidans*. Mainly bacteria *Acidithiobacillus thiooxidans* play the important role in biocorrosion processes in concrete sewer system. These bacteria are captured in biofilm on solid surface and has good oxidation ability related to sulphate [2,3]. Oxidation consequently leads to sulphuric acid formation. Sulphuric acid can be released in temperature of water 10 - 20 °C up to 9%. After the temperature raising to 30 °C the concentration of H_2SO_4 can reach 34.4 % [8]. During in sewers not only the biocorrosion processes are harmful but also the mechanical degradation – abrasion caused by particular matters occurs in wastewater. Matters like sand chafe the concrete surfaces and it leads to decease of thickness of concrete surface layer. That is why the recipe of concrete has to be prepared with respect the environment (degree of exposure classes) where building elements or concrete construction will be placed. Concrete used in the field of civil engineering as well as concrete used for sewers must meet the requirements in accordance with EN 206-1 [7]. Especially accent need to be asked to satisfy the requirements to exposure classes XC2 (corrosion induced by carbonation – appears in wet, rarely dry environment and concrete surfaces subject to long-term water contact (e.g. foundations)) and XA (Moderately aggressive chemical environment) [7].

Measurements of characteristic related to the durability viewpoint of concrete placed into the wastewater in real sewer pipes are presented in this paper. Results published here follow-up the results continuously measured in the same conditions but in the different time and were previously published in [1,6].

MATERIAL AND METHODS

Experimental part was aimed at the study and evaluation of chemical changes of concrete samples exposed to the real conditions of waste water. The weight changes and the compressive strength were measured and evaluated before and after the experiment.

The concrete samples used for the experiments were prepared in accordance with Slovak standard STN EN 206-1 – C35/45 using cement CEM I 42.5 R. The concrete samples were prepared considering the exposure classes (XC2 and XF3) in accordance with the standard mentioned above. For concrete preparation plasticizer Murasan BWA 14 were used. 6 samples of size 150x150x150 mm were prepared. Three samples were placed into the sewer for 6 months and three samples were intended as reference samples.

The pH value of wastewater was 7.42; the measured basic parameter concentrations were 418.0, 23.0, 1.01, 8.96, 8.55, 17.68 and 45.93 mg/L for soluble substances, insoluble substances, total amount of phosphorous, total amount of nitrogen, ammonia nitrogen, BOD_5 and COD, respectively. The presence of sulphate-reducing

Desulfovibrio spp. and sulphur-oxidising bacteria *Acidithiobacilli* spp. were confirmed in the wastewater as reported in our previously work [13]. The bacteria mentioned are responsible for the start and the course of biogenic sulphate attack on the concrete samples.

The chemical composition of tested concrete samples was investigated by X-ray fluorescence analysis (XRF) using SPECTRO iQ II (Ametek, Germany) with SDD silicon drift detector. The concrete samples were pulverized by using planetary ball miller SFM (MTI corp., USA and prepared as pressed tablets of diameter 32 mm by mixing 5 g of cement and 1 g of dilution material (M-HWC) and pressed at pressure of 0.1 MPa/m^2. The samples were measured during 300 s at voltage of 25 kV and 50 kV at current of 0.5 and 1.0 mA, respectively under helium atmosphere by using the standardized method of fundamental parameters for cement pellets.

Thermal properties of prepared concrete composite were studied by using STA 449F3 thermo analyser (Netzsch, Germany) in the temperature range from 25 to 1000 °C with the heating rate of 10 K/min under nitrogen atmosphere using DTA/TG mode. The concrete samples of weight about 80.0 mg were heated in Al_2O_3 crucibles.

Infrared spectroscopy with Fourier transformation (FTIR) was used for the concrete samples characterization in terms of functional groups qualitative analysis. FTIR measurements were performed using an Spectrometer Alpha-T (Bruker, Germany) with ATR technique allowing the direct measurements of powder samples without KBr tablets preparation. Measurements proceeded in transmittance mode, in the range 400 – 4000 cm^{-1} with resolution of 4 cm^{-1}.

AFM (JPK Instruments, Germany) and SEM were used for both parts (immersed and non- immersed) of concrete samples' investigation. A NanoWizardII constant mode AFM was used to image the surface of concrete samples. For AFM imaging, silicon cantilever CSC 37 B (Micromash Estonia) with force constant 0.3 N/m, resonance frequency 37 Hz was used. Set point was 750 mV. Each AFM image consists of 512 by 512 pixels.

RESULTS

The average compressive strength of the concrete samples measured after the experiment of 6 months exposition in sewage pipes wastewater was increased (Table 1).

Table 1: Compressive strength of studied concrete samples

	Compressive strength [MPa]
Reference sample	45.0
Sample after 6 months exposition	57.9

The compressive strength increase is probably caused by continual hydratation processes which took place in the concrete matrix. The 6 month exposition in wastewater seems not to be enough for the concrete deterioration process resulted in compressive strength decrease.

The XRF measured chemical composition of studied concrete samples before (reference sample A) and after the experiment (sample B) is illustrated (because of scale in two separated figures) in Figures 1 and 2.

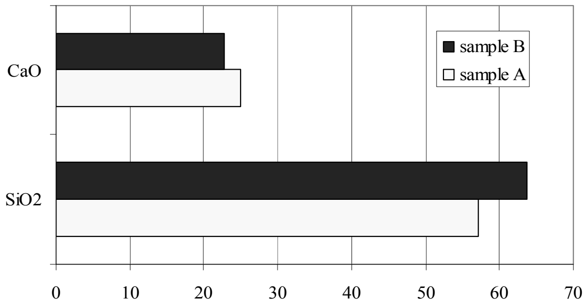

Figure 1: SiO_2 and CaO content in concrete sample before and after the biocorrosion experiment

As it shown in Figure 1, the percentage content of calcium oxide decreased in case of samples placed for 6 months into the sewage pipes wastewater in comparison to the reference sample. On the contrary, the content of silicon dioxide has been increased.

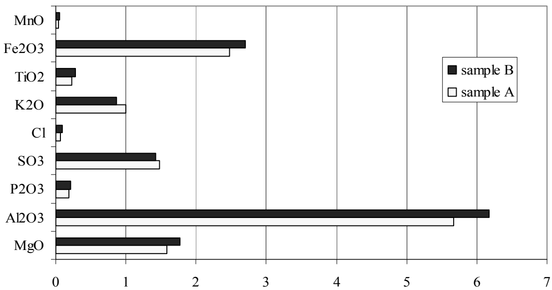

Figure 2: Basic components of concrete sample before and after the biocorrosion experiment

The percentage content of Fe_2O_3 and Al_2O_3 a little increased after 6 months wastewater exposition (sample B) compared to the reference sample. MgO and K_2O concentrations decreased after the exposition to the aggressive environment. In case of the other chemical components, the values remained almost the same or only very small decrease was determined.

Thermal behaviour of studied samples before and after the experiment is described in Table 2.

Table 2: TG/DTA analysis of samples A and B

Sample	Top of the peak [°C]	Process description	Weight losses [%]
Reference sample A	125	C-S-H decomposition	2.59
	472.2	$Ca(OH)_2$-portland decomposition	1.47
	561	fine-grained $CaCO_3$	5.17
	895	feritic phase oxidation	0.37
			Σ 9.60
Sample after the experiment B	85	absorbed water releasing	0.5
	125	C-S-H decomposition	1.5
	471.5	$Ca(OH)_2$-portland decomposition	0.46
	565.3	fine-grained $CaCO_3$	0.3
	756.7	coarse-grained $CaCO_3$ decomposition	3.13
	895.8	feritic phase oxidation	0.13
			Σ 8.88

Thermal processes are described as follows:

- endothermic effects in range of 25 to 105 °C is caused by evaporation of surface absorbed water
- endothermic effect in range of 105 to 350 °C means dehydratation of C-S-H

or leads to $CaSO_4.nH_2O$ or C-A-H decomposition [13-15]

- next process in sphere close to the top of the peak (430 - 460 °C) indicates

decomposition of Portland – $Ca(OH)_2$, which creates during hydratation of cement according to (1):

$$Ca(OH)_2\ (s) \rightarrow CaO\ (s) + H_2O\ (g) \qquad (1)$$

- endothermic effect in range of 550 to 580 °C and 700 to 900 °C meets requirements of $CaCO_3$ (s) decomposition (2)

$$CaCO_3\ (s) \rightarrow CaO\ (s) + CO_2\ (g) \qquad (2)$$

Results of experiments presented in this paper corresponds with theoretical knowledge, the process of carbonation started and higher concentration of SO_4^{2-} was confirmed.

FTIR method was used for the assessment of quality changes. Comparison of the reference sample and sample after 6 month exposition to aggressive environment is shown in Figure 3.

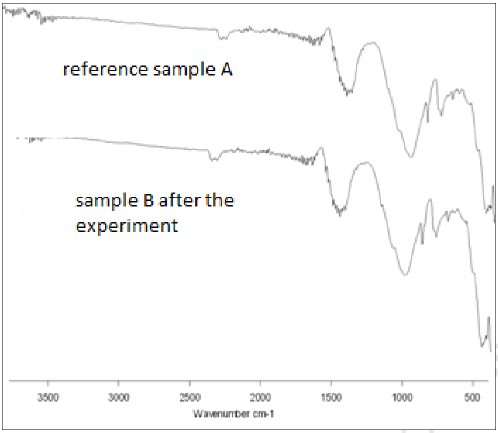

Figure 3: IR spectra of reference sample A and sample B after the 6 months exposition.

According to the spectra, the typical vibrations detected for the main functional groups are described in Table 3.

Table 3: Main vibrations of functional groups detected

Wave number data based [cm^{-1}]	Functional group vibrations	Reference sample A [cm^{-1}]	Sample B after 6 months exposition [cm^{-1}]
2037	SO_4^{2-}	2040	2041
1796-1794	ν_2 CO_3	1795	-
1637	δ O-H (H_2O)	1636	1637
1618-1616	ν_2 O-H (H_2O)	1619	1619
1429	ettringite	1429	1430
1081	Si-O	1081	1084
876-875	ν_2 CO_3	872	875
863	ettringite	-	861
779-778	Si-O	778	776
693	SO_4^{2-}	691	693
625	ettringite	-	628
617	Si-O	617	616
460-465	Si-O-Si, Fe-O	459	459

The wave numbers detected were discussed in accordance to the literature [9,10]. When compared the reference sample to the sample after the wastewater exposition, no significant differences were noticed.

The considerable changes of concrete samples' structure were observed after 6 months deposition in sewer using AFM. Figures 4 and 5 illustrate a surface of concrete specimen before the experiment (reference sample) and the visible surface changes after 6 months, respectively.

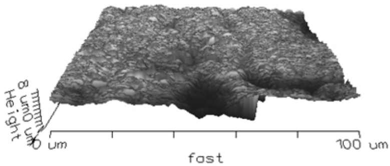

Figure 4: Surface of concrete sample before the experiment

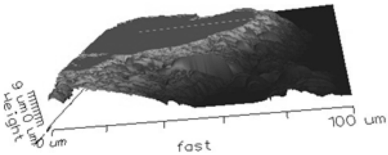

Figure 5: Surface of concrete sample after 6 months of waste water effect

The surface was quite smooth with only low roughness in the case of the reference sample (Figure 4). The roughness has been increased for sample B and some aggregates were fallen out of concrete surface (Figure 5).

CONCLUSION

The effect of the deterioration processes caused by wastewater aggressive environment on the concrete samples was investigated in this study. Various analytical methods were used. The compressive strength increase by 28.67 % in case of the concrete sample after the experiment is probably caused by continual hydratation processes taking place in the concrete matrix. Both the increase and decrease in studied elements concentrations were detected by XRF method. The considerable changes of concrete samples' in terms of the roughness increase were noticed by AFM method. No significant changes of tested concrete samples before and after the experiment were measured using TG/DTA and FTIR methods.

Acknowledgement

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REFERENCES

[1] Denkhaus E. & Meisen S. & Telgheder U. & Wingender J. Chemical and Physical Methods for Characterization of Biofilms, Microchimica Acta 158, pp.1-27; 2007.

[2] Wasserbauer R. Biological degradation of structures, Prague: ABF, PP. 252, 2000.

[3] Stevulova N. & Harbulakova, V. O. & Luptákova, A. & Estokova A. & Repka M. Analysis of the Influence of Aggressive Environment on the Concrete Composites, Proceedings of the 2nd European Conference of Civil Engineering (ECCIE 11), Puerto De La Cruz, Tenerife, Spain, pp.97-100, 2011.

[4] Luptakova A. Biocorrosion of building materials, vol. 11, no.2, pp. 339-344, 2006.

[5] Terpakova E. The study of building biocorrosion, In: Chemical papers, vol. 102, n. symposia, pp. 919-920, 2008.

[6] Foraiova K. Biocorrosion of concrete sewer pipes, In: Proceeding of 9th international conference Sanitary constructions, Small waterworks, Landscape and Water management in Strbske Pleso, pp. 115-122, 2010 (in Slovak).

[7] STN EN 206-1:2009, Concrete: Part 1. Specification, Performance, Production Conformity (in Slovak).

[8] Kubalík P. Biocorrosion of concrete sewer pipes and its reconstruction, In: Conference on Operational reliability and important pipeline system of Slovakia safety, Zilina, pp.69-76, 2012 (in Slovak).

[9] Matoušek M. & Drochytka R. Atmospheric corrosion of concrete, IKAS, pp. 171, 1998 (in Czech).

[10] Sicakova A. & Terpakova E. & Estokova A. Changes of selected parameters of concrete after sulphate-magnesium attack. 12th International conference on Environmental science and technology, Rhodes, Greece, Global- Nest, pp. B976-B983, 2011.

DIFFUSE POLLUTION EVALUATION OF MELIORATION CHANNELS IN A NATURE RESERVE ZÁBŘEŽSKÉ AND KOUTSKÉ LOUKY MEADOWS (CZECH REPUBLIC)

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ABSTRACT

The aim of presented contribution is to highlight the results of research that was focused on the evaluation of water pollutants concentrations in melioration channels in a nature reserve Zábřežské and Koutské Louky meadows. For the purpose of overall pollution evaluation were on the bases of laboratory analyzes calculated values for parameters of biological and chemical oxygen demands and for contaminants N-NH4, N-NO3 and phosphor. The used methodology included the calculation of hydrological balance which means atmospheric deposition, direct water outflow, hypodermic outflow, primary outflow as well as diffuse sources of municipal and agricultural character. The research proved that a large concentration of contaminants was in the melioration channels. The concentration was caused by diffuse of water flow from the surrounding parcels. These contaminants finally caused significant pollution of water quality in small streams in which the channels flowed out. This study provides new information and knowledge in the area of local contamination and these will be further useful in hydrobiological practice. The observed data should be helpful to evaluate the drains affection in similar habitat areas and also in concept of the future treatments. Presented contribution also should draw to attention to improper use of the land melioration methods in ecologically valuable ecosystems.

Keywords: amelioration channel, diffuse sources, laboratory analysis, evaluation of chemical indicators

INTRODUCTION

Territory of Zábřežské a Koutské Louky Nature Reserve is located in the northwestern outskirts of the city of Ostrava between the left bank of the Opava River and the southern boundary of continuously built-up cadastral area Kravaře at an altitude of 225-234 meters above sea level. It is an important site of wetland ecosystems, where is a large number of specially protected species such as Rana ridibunda, Rana arvalis, Castor fiber and plants such as Ophioglossum vulgatum, Epipactis albensis, Senecio sarracenicus and it is also an important nesting place of bird species Tringa tetanus and Alcedo.atthis.

The wetland as such creates a transition between terrestrial and aquatic ecosystems. The most important significance of wetland is that it represents a natural reservoir of water in the landscape so it has a high retention capacity in case of excessive rainfall. A wetland also provides suitable conditions for the existence of specific organisms and it

represents habitat for a number of plants and animals adapted to life in the wetlands. [3] It is one of the largest pools of genetic biodiversity, it belongs to one of the three habitats with the greatest biological activity. [3] In addition, the wetlands equalize flow conditions, have a cooling effect, a basin with wetlands catches more organic material (C organisms) and in turn exports more of it than the basin with no wetlands, so basins with wetlands act as biochemical centre.
The stream which flows through the whole site is called Štěpánka. This monitored stream flows more or less through the center of the area of interest with several smaller water streams flowing into Štěpánka. This natural network is connected with a system of amelioration channels that is currently still partially functional. One of drainage channels which is located in our monitored area is used for waste water discharges, thereby contributing to the degradation of remnants of valuable plant communities with the occurrence of specially protected species associated with occurrence of higher levels of ground water. The other serves as drainage for a field over the road adjacent to Koutské a Zábřežské louky Nature Reserve. [4] For this reason we started hydrological research in this study area. In control sampling of water samples there were found abnormal values of some elements, such as NH4-N, total P, BOD and BOD5 (Biochemical Oxygen Demand per 5 days) [2].

MATERIAL AND METHODS

Samples were collected monthly from April 2010 to March 2011. When sampling and in the analysis we followed the Directive 2000/60/EC of the European Parliament and the Council of 23 October 2000 constituting a framework for Community action in the field of water policy and related legislative norms in the area of water services. Analyses of collected 2-hour composite samples were carried out in a chemical laboratory at the Institute of Environmental Engineering always on day of sampling. In order to assess the area of interest there were selected the following water quality parameters: pH pH, five-day biochemical oxygen demand BOD5, chemical oxygen demand BOD, dissolved substances SD105 powdered, ammonium nitrogen NH4-N, nitrate nitrogen NO3-N and total phosphorus P total.
Monitoring of indicators was conducted at 10 sampling sites. The sampling sites were deliberately chosen with respect to the fact that the contamination is not spread with water flow but only by diffusion or by amelioration channels [7]. The nature reserve area is riddled with a number of ameliorative channels built in the 70´s - 80´s of the 20th century. This whole system of channels flows out in various places into Štěpánka flow which is the left tributary of the Opava river. Open and closed ameliorative channels make sporadically functional, large and already partially mapped network in this area.

METHODOLOGY

To determine the quality of water we used the legislative action:

Standard CSN 75 7221 Water quality - Classification of surface waters.

The principle of classification is to compare the characteristic values of indicators of water quality with a set of norms, which correspond with the assessment from general ecological point of view by calculating the probability values not exceeding 90 % (C90).
The values of indicators are ranked in descending order according to the size: x1 = the highest value, x2 = the second-highest ... etc. It is enough to build k of the highest

values into the descending order. This auxiliary variable is calculated according to equation

$k = (0.1 * n + 0.34)$ n = number of observations, k = the value rounded up to integer

C90 values are calculated from the equation:

$C90 = (d90 * c_{k-1}) + (1 - d90) * c_k$

$d90 = k - 0.1 * n - 0.34$

RESULT AND DISCUSSION

Table 2 sets out Czech Technical Standard - Water quality - Classification of surface waters CSN 75 7221. We performed a classification of characteristic values for the parameters of water quality and allocated them in classes. The pollution of surface water is determined by the five classes of water quality, which are detailed in Table 1

Tab. 1 Classification of surface water according to standard CSN 75 7221

Water quality class	Extent of pollution in water	Characteristics of water quality
I. class	water unpolluted	surface water status which has not significantly been affected by human activity yet and water quality parameters do not exceed the values corresponding to the normal background in natural streams
II. class	moderately polluted water	surface water status which has already been influenced by human activities but to only such an extent that water quality parameters reach values that still allow the existence of a rich, balanced and sustainable ecosystem.
III. class	polluted water	surface water status which has been influenced by human activities to such an extent, that water quality parameters reach values which do not have to create conditions for the existence of a rich, balanced and sustainable ecosystem.
IV. class	heavily polluted water	surface water status which has been influenced by human activities to such an extent that water quality parameters reach values that create conditions only enabling the existence of an unbalanced ecosystem.
V. class	extremely polluted water	surface water status, which has been influenced by human activities to such an extent that water quality parameters reach values that create conditions enabling the existence of only highly unbalanced ecosystem.

Tab. 2 According to the Czech technical standards - Water quality - Classification of surface waters CSN 75 7221

General, physical and chemical indicators						
Indicator	Unit	Class				
		I	II	III	IV	V
BOD5	**mg/l**	**< 2**	**< 4**	**< 8**	**< 15**	**> 15**
CHOD Cr	**mg/l**	**< 15**	**< 25**	**< 45**	**< 60**	**> 60**
nitrate nitrogen	**mg/l**	**< 0.3**	**< 0.7**	**< 2**	**< 4**	**> 4**
nitrate nitrogen	**mg/l**	**< 3**	**< 6**	**< 10**	**< 13**	**> 13**
total phosphorus	**mg/l**	**< 0.05**	**< 0.15**	**< 0.4**	**< 1**	**> 1**
solute	**mg/l**	**< 300**	**< 500**	**< 800**	**< 1200**	**>1200**

Evaluation of results from Figures 1

In Figure 1 we focused on ammonium nitrogen (NH_4-N). The results show that according to CSN 75 7221 Classification of surface water the values of all samples fall into the Class V pollution, which is extremely polluted water. Significant source of nitrogen is decaying biomass of dead microorganisms, sewage, waste water, etc. Another source is saturating of agriculturally cultivated soil with nitrogen fertilizers. Nitrates are found in almost all waters, their concentration in natural waters keeps going up due to increasing population and agricultural activities [5].

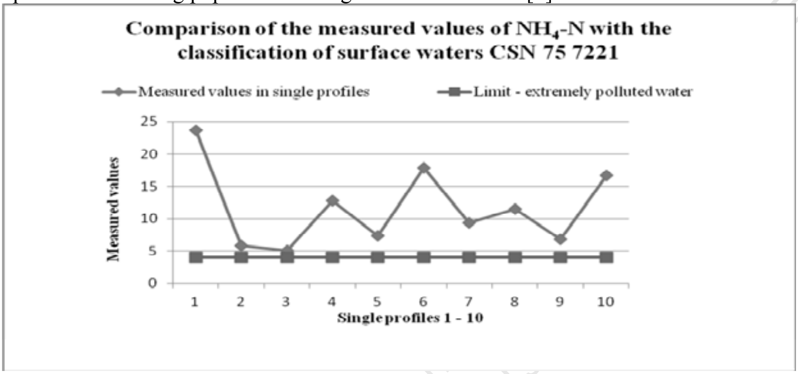

Figure 1 Comparison of the measured values of NH4-N with the classification of surface waters CSN 75 7221

Evaluation of the results of Figure 2

In Figure 2 we focused on nitrate nitrogen (NO_3-N). The results show that according to the Classification of surface waters CSN 75 7221 the values fall into the Class contamination III, which is polluted water, Class contamination II, which is slightly polluted water and Class contamination I, which is unpolluted water. According to the classification of surface waters, the values of NO_3-N are not alarming, but it is noticeable that there are some interactions of contamination values between collecting points [6].

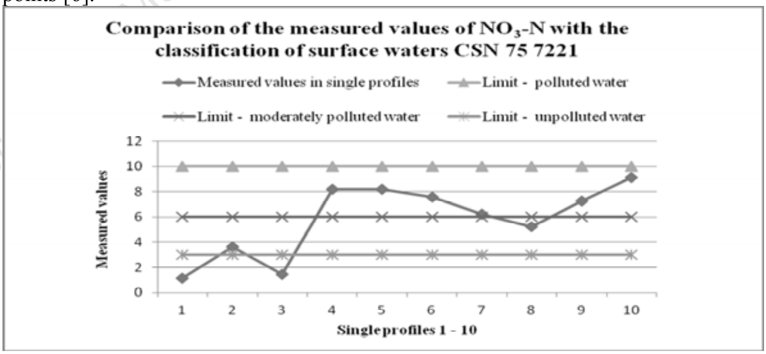

Figure 2: Comparison of the measured values of NO3-N with the classification of surface waters CSN 75 7221

Evaluation of the results of Figure 3

In Figure 3 we focused on biochemical oxygen demand (BOD5). The results show that according to the Classification of surface water CSN 75 7221 the values of all samples fall into the Class V, which is extremely polluted water. Biochemical oxygen demand is an indicator of organic pollution, it is one of the indicators of water purity and at the same time it is an indicator of oxygen regime. Biochemical oxygen demand is defined as the mass concentration of dissolved oxygen consumed under specified conditions, and in toxic environment it is defined by biochemical oxidation of organic compounds in water. BOD is used as a measure of the concentration of biologically degradable substances. It is expressed in mg / l. The course of biochemical oxygen demand depends on the time (incubation period). Complete biochemical oxidation of organic substances in water takes for about 20 days (using the standard dilution method). However, such a time is too long for practical usability of the results. Therefore there was chosen unified incubation period of 5 days. The result is referred to as the five-day biochemical oxygen demand BOD5 [5].

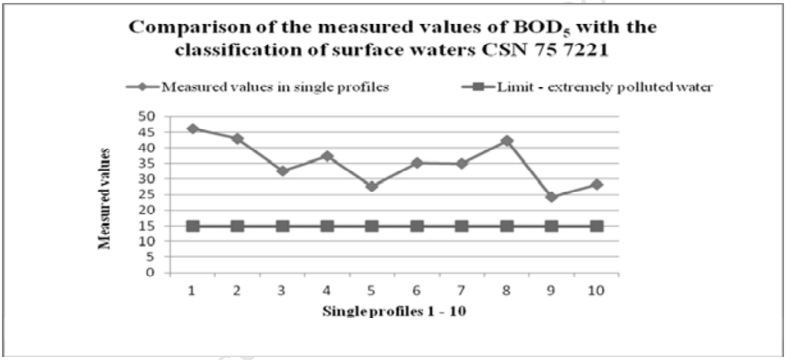

Figure 3: Comparison of the measured values of BOD5 with the classification of surface waters CSN 75 7221

Evaluation of the results of Figure 4

In Figure 4 we focused on P-total. The results show that according to the Classification of surface water CSN 75 7221 the values of all samples fall into the Class V, which is extremely polluted water. What is the anthropogenic source of inorganic phosphorus it is the application of phosphate fertilizers in agriculture and also waste water saturated with detergents' ortho-and polyphosphates. The phosphorus compounds also play an important role in the natural cycle of substances. They are necessary for both lower and higher organisms, which convert them to organically bound phosphorus. After the death and decay of organisms the phosphates are released back into the environment. The phosphates significantly participate on the growth of green organisms in the water (algae and cyanobacteria) and they are the cause of the rise of eutrophication [5].

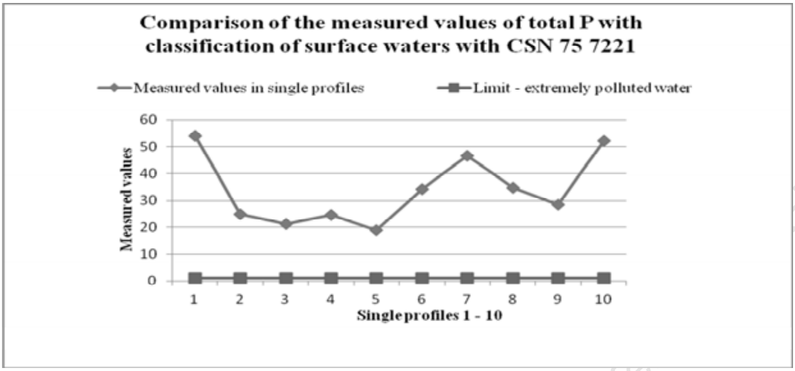

Figure 4: Comparison of the measured values of total P with classification of surface waters with CSN 75 7221

Evaluation of the results of Figure 5

In Figure 5 we focused on chemical oxygen demand by potassium dichromate (CHOD). The results show that according to the Classification of surface water CSN 75 7221 the values of all samples fall again into Class V, which is extremely polluted water.

Organic matter content in water is assessed by the amount of oxidizing agent which under certain circumstances must be spent on their oxidation. Results are expressed in milligrams of oxygen corresponding to consumption of oxidant per 1 liter of water. At the present time the determination of BOD is reported in all the standard methods of analysis of water as a uniform method of determination of organic substances in wastewater. You can quantitatively oxidize most organic compounds, and thereby figure out most efficiently the organic water pollution [5].

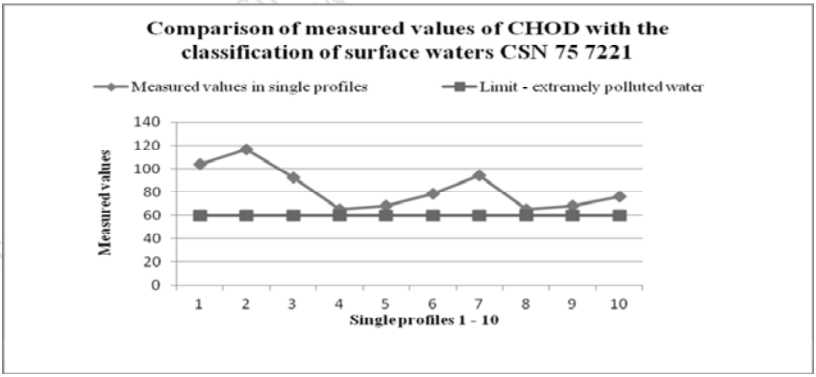

Figure 5: Comparison of measured values of BOD with the classification of surface waters CSN 75 7221

Evaluation of the results of Figure 6

In Figure 6 we focused on the solute (S). The results show that according to the Classification of surface waters CSN 75 7221 the values fall into the Class III., which is polluted water, and into the Class II, which is moderately polluted water. Dissolved substances are of organic or mineral origin and they cannot be removed from the water by sedimentation. The content of dissolved substances in water is represented mainly by cations Ca^{+}, Mg_2^{+}, Na^{+}, K^{+}, Fe_3^{+}, Fe_2^{+}, Mn_2^{+}, NH_4^{+}, anions HCO_3^{+} , Cl^{-}, SO_2^{-}, CO_4^{2-}, NO_2^{-}, NO_3^{-}, PO_4^{3-}, but also some organic and humic substances.

The content of dissolved solids brings information about the content of dissolved salts (mineralization of water). Dissolved substances are identified by means of evaporation of the filtered water sample, followed by drying the extract at 105 ° C and weighing the dried residue. They are reffered to as the solute dried SD105 [5].

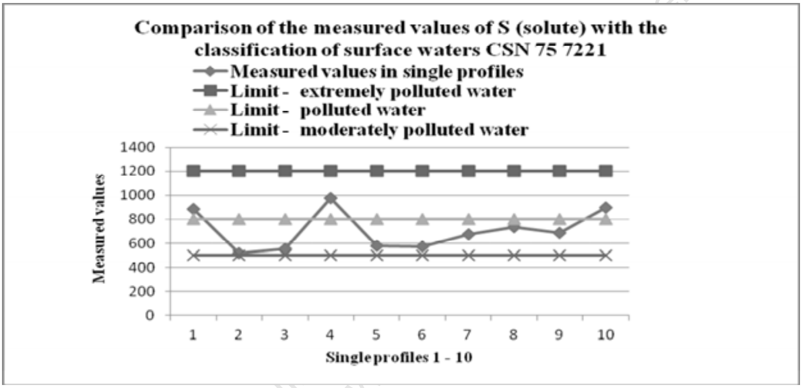

Figure 6: Comparison of the measured values of S with the classification of surface waters CSN 75 7221

CONCLUSION

The above measured results show that the studied area Zábřežské a Koutské louky Nature Reserve is heavily polluted, therefore the valuable plant communities with the occurrence of particularly protected species are critically endangered. It is apparent that the whole area suffers from severe eutrophication. The research further shows that there is very high water table (20 cm) in the area. From the Map 1 it is clear that despite seemingly no interaction of streams, there is the transfer of pollution via a plenty of amelioration channels and also via the underground - or through the diffuse pollution.

It is important to emphasize differentiation in future approaches. This means in practice to carry out or maintain drainage facilities only in areas where it can be appropriate and practical. In the future, any further deposits into drainage should primarily be based on rational economic grounds. Such an approach is eligible even in terms of nature conservation and landscape. Today there is a trend to restore the natural water features of the landscape and support the natural flood processes in floodplains [1].

As far as the site Zábřežské a Koutské Louky Nature Reserve is concerned we suggest to perform test backfilling of some ameliorative channels and further perform sampling and analyzes of water samples.

Furthermore, we propose to carry out revitalization of small streams which were equipped with tubes or otherwise regulated in the past. We will be further engaged in this research in more detail in 2012 and 2013.

Map 1: Collecting points in the area of interest Koutské a Zábřežské louky Nature Reserve (ArcMap 10)

REFERENCES

[1] Bashforth A. R. & Drábková J. & Opluštil S. & Gibling M. R. & Falcon-Lang H. J. Landscape gradients and patchiness in riparian vegetation on a Middle Pennsylvanian braided-river plain prone to flood disturbance (Nýřany Member, Central and Western Bohemian Basin, Czech Republic), 2011, 163 (3-4) , pp. 153-189.

[2] Holas J. & Holas M. & Chour V. Pollution by phosphorus and nitrogen in water streams feeding the Zelivka drinking water reservoir, 1999, 39 (12) , pp. 207-214

[3] Karpuzcu M. E. & Stringfellow W. T. Kinetics of nitrate removal in wetlands receiving agricultural drainage, 42 , pp. 295-303

[4] Martínková M. & Hesse C. & Krysanova V. & Vetter T. & Hanel M. Potential impact of climate change on nitrate load from the Jizera catchment (Czech Republic), 2011, 36 (13), pp. 673-683

[5] Pitter P. Hydrochemie. Praha, VŠCHT , 1999.

[6] Pitter P. & Lischke P. Biological degradability of organic substances [BIOCHEMISCHE ABBAUBARKEIT ORGANISCHER STOFFE], 1989 17 (2) , pp. 217-226

[7] Procházková L. & Blažka P. & Kopácek J. Impact of diffuse pollution on water quality of the Vltava River (Slapy Reservoir), Czech Republic, 1996, 33 (4-5) , pp. 145-152

ECO-FRIENDLY REHABILITATION OF ROAD RESISTANCE STRUCTURES

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ABSTRACT

One of the main criteria in choosing the technical solutions for different rehabilitation works on Romanian public roads is represented by the lowest possible cost, starting from the ever insufficient resources of the administrator. The purpose of obtaining results on a long term and the increase of efficiency in the realized works are often forgotten. The paper aims at emphasizing other possibilities of approaching the rehabilitation works on public roads, conception in which the radical solutions, such as remake on pavement (especially on the sections with reduced existing assets), hot or cold recycling (preferably by treating with cement) of the existing pavement, 20…30 cm deep and on the entire length of the section, promoting road layers with superior deformability characteristics, etc., can offer significantly better results on the long term. The article presents the results obtained by applying such technical solutions on certain public roads on the south-west Romania, underlying the advantages and the drawbacks noticed during the application of the technologies and the follow up of the realized sections.

The proposed solutions propose the extended use of the existing materials reducing the impact upon the environment. The solutions aim at reducing the carbon footprint and fuel consumption from supplying and transporting new materials.

Key words: hot and cold recycling, environment protection, reuse of existing materials

GENERAL ISSUES

The approach of new design conceptions for the rehabilitation of public roads derives from technical requirements (improving the bearing capacity of road structures in the circumstances of increases in heavy and very heavy traffic, respectively in axle load, ensuring an adequate technical condition for a longer period of time, ensuring high resistance to climate conditions, etc.), economical needs (increase of profitableness in the applied solutions through considering the total execution, maintenance, operation costs and the total standard axle stress allowed until the next capital repair) and ecological requirements (using less new materials, reuse of materials existing in the road pavement, valorization of sub-products, reducing noxa from manufacturing and laying hot macadam, reducing energy consumptions for manufacturing new road materials, etc.).

To this end, the modern conceptions adopted by the specialists for building and maintaining flexible and semi-rigid road pavements aim mainly to the following aspects [1]:
- creation of new road pavements within which the resistance part (taking over and distribution of vertical stress on larger areas, within the bearing capacity of each layer) is played by the so-called resistance layers, the bituminous road pavement being realized in thin, very thin or ultrathin layers;
- application of different recycling technologies (cold, hot, in situ, in fixed or mobile coating plants, etc.) for the rehabilitation of overdue pavements, with the view to improving the bearing capacity by binder addition and using to the fullest the existing materials in the upper road layers, reducing the costs for supplying and transporting new materials.

In Romania, the basic view applied in the case of public road rehabilitation implies calculating the thickness of new bituminous layers to be added to certain existing damaged bituminous layers often having significant thickness. This process results in road pavements made up of approximately equally thick granular layers (greatly clay contaminated) and asphalt layers added in consecutive stages. Such method proved disadvantageous on a long run since the new layers often do not benefit from the contribution of the bottom resistance layers (not dimensioned for today traffic intensity and axle load, with their bearing capacity altered by water infiltration subsequent to the clay contamination, etc.). In many cases the new bituminous layers become compromised before their design life completion.

On these grounds, some of the Romanian specialists militate to persuade the decision makers to adopt maintenance strategies based increasing the bearing capacity of the pavement with a minimum of new materials. They try promoting, wherever necessary, radical solutions aiming at totally remaking road structures with no adequate resistance layers, respectively promoting solutions for recycling existing road layers by stabilization with binders (mostly cement or cement + bituminous binder) with a view to creating a supporting layer with even and high bearing capacity to ensure a good operational behavior of asphalt strengthening layers [2].
Certainly, the financing efforts for such works will be significant, but their profitableness will be the main reason to promote these technical solutions on a large scale.

Besides the technical advantages offered by the in situ recycling technologies for existing road layers, important ecological advantages can be also drawn, in comparison with the classical strengthening solutions.

RADICAL TECHNOLOGIES FOR ROAD REHABILITATION

Starting from the general principles described above, from the concrete condition of existing pavements in Romania (mostly flexile pavements with poor resistance layers, respectively unpaved roads) and from the operational requirements (increase of traffic intensity and axle load), the authors offer to debate new ideas to be put at the basis of building more efficiently Romanian road pavements. Within these ideas, the mandatory realization of highly bearing road foundations such as road layers stabilized with hydraulic binders or with hydraulic and bituminous binders will be strictly followed up.

The road foundations obtained through cement or cement + bituminous binder recycling can use as basic material different natural aggregates, even partially contaminated, meeting certain grading conditions, maximum particle size, sand equivalent, Los Angeles wear. The main technical particularities of such technologies are shortly described further on.

The retreating of old road layers with hydraulic binder aims at structurally strengthening the damaged road complex, creating a new road foundation by reusing in situ the existing materials on a certain depth with additional binder and sometimes new natural aggregates. The thickness of the layer resulted from recycling is about 15…30 cm, the maximum thickness being generally limited by the specifications of the equipment. In these conditions, the technology aims at meeting the following objectives [5]:

- transforming and modifying the characteristics of damaged road layers into a layer with homogeneous bearing capacity and known mechanical characteristics, adapted to new stresses;
- increasing the bearing capacity of the road pavement, according to the traffic;
- improving the durability by increasing the insensibility to climate factors;
- protecting the infrastructure or the foundation layers whose characteristics are sometimes inferior to those stipulated by standards, by reducing the tensions and strains to which these are subject.

The recycling with hydraulic binder will result in considerably better bearing capacity of the new pavement, and the tensions and relative strains under the stabilized layer will be significantly reduced. Besides, existing rutting can be repaired and the possibility of new one occurring is very much diminished if the stabilized layer is thick enough. The drawbacks connected to the application of this technology concern mainly the contraction cracking, which in time is transmitted through the upper asphalt layers under the impact of traffic and temperature variation. On the other hand, there are many technologies to slow down the transmission of cracking, and the cracking occurring on the road surface, if dealt with adequately (silting up), do not create structural problems and do not alter the traffic comfort and safety.

The working dosages must be the result of laboratory research that takes into consideration the real material mix coming from milling the old road layers and additional granular materials. The additional granular material can be added to correct the grading of the milling material or to obtain a certain thickness of the final layer. It is added by even and continuous spreading on the retreated pavement. The used cement dosage is generally 3…6 % from the mass of dry material aiming at having a compression resistance after seven days of min. 2,5 MPa. The dimensioning counts on an elasticity module of 11 000…20 000 MPa, one year after execution, depending on the homogeneity of the stabilized material, the type of equipment, the cement dosage, etc. The protection and curing of the stabilized layer will aim at reducing the water loss, as well as the protection from climatic conditions and traffic. The most frequent method is the use of a film of cationic bitumen emulsion with 600 g/m^2 residual bitumen.

The retread process with bitumen emulsion or foamed bitumen is well suited to local roads which require an adaptation of the technical condition to the new operational needs without excluding the other road pavements (motorways, national roads, urban roads, harbor or airport areas, etc.). The technology aims mainly to reaching the following objectives [3], [5]:

- restoring the binding between the asphalt upper layers and their support and implicitly repairing the fatigue caused cracked surfaces due to the stripping of the bituminous layer from its support;
- restoring the quality of the asphalt mixture in the damaged asphalt layers, before realizing a new wearing course;
- repairing the cracked layers resulting from the binder ageing or thermal contractions;
- repairing the damaged additional climbing lane with no significant structural issues.

The recycling technology using bitumen binder can be realized with a large range of equipments, with different specifications and qualities, to ensure the following activities:
- milling and grinding the old material on the required depth, its bringing in a string or direct homogenization with the additional binder, including the additional water;
- taking over the material from the string (before or after its homogenization with additional binder), laying the new course and pre-compaction;
- compaction of the final layer.

The additional binder in the form of bitumen emulsion or foamed bitumen and the homogenization water will be introduced in different stages of the technological process (depending on the equipment available); they will be stocked in special tank wagons connected to the mixing equipment through hoses, moving along with it.

A sensitive stage of these technologies is the realization of the priming. To successfully solve this issue it is mandatory to install a priming ramp on the spreading equipment, before laying the recycled material.

The compaction needs to result in a density of the treated material to allow reaching the design mechanical characteristics. This material is difficult to compact, requiring much energy, and the choice of the rollers depends on several parameters (thickness and type of recycling, consistency and dosage of additional binder, increase in time of the material cohesion, weather conditions, etc.). A good compaction requires heavy and very heavy vibrating equipment, and the finalization of the compaction needs to be realized with rubber-tyred rollers. The aim is to obtain a residual void of 13…19 %.

After finishing the compaction, the surface of the layer can be close-textured by spreading a continuous and even film of bitumen emulsion (250…350 g/m^2 residual bitumen), and covering with 4-6 or 2-4 gravel (2…3 L/m^2).

To note the fact that the materials recycled with bitumen emulsion "mature" in time by eliminating part of the water. In order to facilitate the phenomenon, the new asphalt wear course will be realized two weeks after the finalization of the compaction at the earliest. The period will be chosen depending on the weather conditions, the traffic on the layer and its evolution after opening to traffic.

The retreading with bitumen emulsion (foamed bitumen) and cement is a technical solution offering results ranging between the previously presented technologies. We can mention that for cement dosages over 2 %, the characteristics and behavior of the retreaded road layer will be very close to those of the layers retreaded with cement.

ALTERNATIVE RESISTANCE STRUCTURES

In order to emphasize the technical and ecological advantages connected to the use of alternative rehabilitation technologies as compared to the classical one previously described, three resistance structures have been designed, dimensioned with the standard Romanian method to support a design traffic of 1,5 million standard axles of 115 kN [4]. Identical operation conditions have been maintained for the three variants (P4 type foundation ground with a dynamic elasticity module of 80 MPa, II climate type, 2b hydrological conditions), as well as identical road foundation and pavement (in order to make the comparisons between the considered technical solutions more eloquent).

The three considered road structures can be differentiated by the way of realizing the base course, as follows (fig. 1):
- a flexible pavement (classical), realized with a hot macadam base course manufactured in fixed plants;
- a semi-rigid road pavement for which the base course is realized through in situ recycling of the granular materials in the existing layers with asphalt and hydraulic binder;
- a semi-rigid road pavement for which the base course is realized through in situ recycling of the granular materials in the existing layers with hydraulic binder.

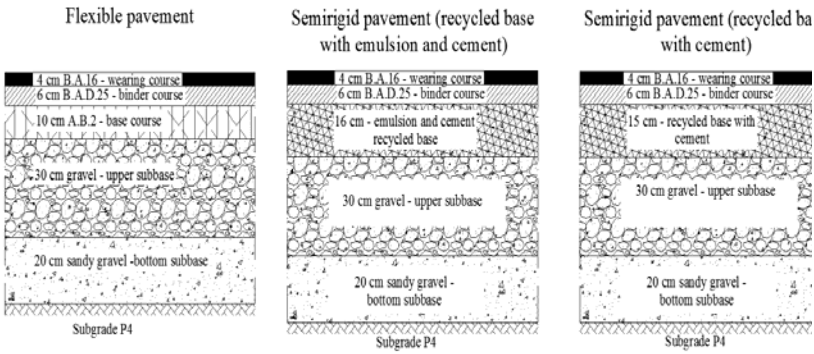

Fig. 1. Alternative types of road pavements.

From the structural point of view, the comparison of the three structures was realized emphasizing the specific tensions and strains on which the dimensioning criteria of the adopted method are based (fig. 2). The conclusions drawn from the analysis of the tensions and strains in the considered road pavements are as follows:
- the specific horizontal strain at the bottom of the bituminous pavement (ε_r) is higher in the case of the classic structure by about 42 % in comparison with the semi-rigid road pavement with base course stabilized exclusively with cement and by about 28 % higher as compared to the structure with base course stabilized with mixed binder. This aspect impacts also upon the rate of deterioration from fatigue of the bituminous layers which is almost on edge for the classical pavement (0,89 compared to 0,90) and significantly lower than the limit value in the other two cases;
- the value of the specific vertical strain on the foundation ground (ε_z) is the lowest in the case of the road pavement with the layer treated with hydraulic binder, which shows

that such a layer avoids the best exceeding the specific compression strains on the foundation ground. It is worth noticing that all the designed road pavements observe the dimensioning criterion of the specific vertical strain on the foundation ground (the value admitted in the given situation being 295 micro-deformations);

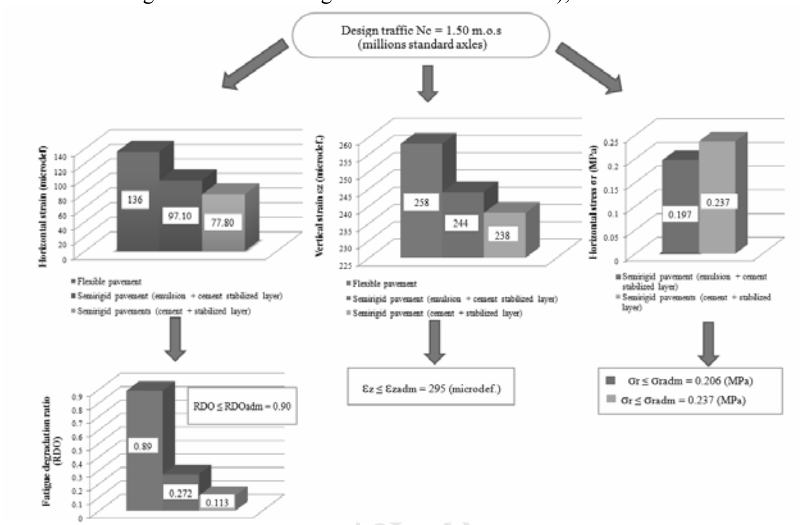

Fig. 2. Stress and strain in the adopted road pavements.

- the semi-rigid road pavement with the layer stabilized with bitumen emulsion shows a better behavior from the point of view of the horizontal tension stresses at the bottom of the base course due to its more reduced rigidity. On the other hand, such a layer protects less the foundation ground and the asphalt layers in the pavement, as previously seen.

In order to compare the three road structures from the point of view of the environment protection (energy consumption and greenhouse gas emission in the atmosphere during construction), the authors used several data from the scientific literature and presented in tables 1 and 2 [1],[3].

Table 1: Energy consumption in the technologies used for base courses

Adopted technology	Energy consumption, in MJ/t, for:					
	binder	aggregate	manufacturing	transport	laying	total
Hot macadam	280	55	405	125	20	775
In situ recycling with cement and bituminous emulsion	285	5	-	40	20	350
In situ recycling with cement	380	5	-	40	20	445

Table 2: Greenhouse gas emissions in base course technologies

Adopted technology	Gas emission, in CO_2/t, for:					
	binder	aggregate	manufacturing	transport	laying	total
Hot macadam	16	2	45	9	2	74
In situ recycling with cement and bituminous emulsion	10	-	-	3	2	15
In situ recycling with cement	18	-	-	3	2	23

It is mentioned that, all the layers of the analyzed road structures being identical, except for the base course, the research focused on the ecological benefits brought about by the technology in the realization of this layer.

Starting from the data mentioned above and taking into consideration the characteristics of the adopted base courses (thickness and density), the results shown in fig. 3 are obtained for the required energy consumption and volume of gas released during the realization of the base course surface unit.

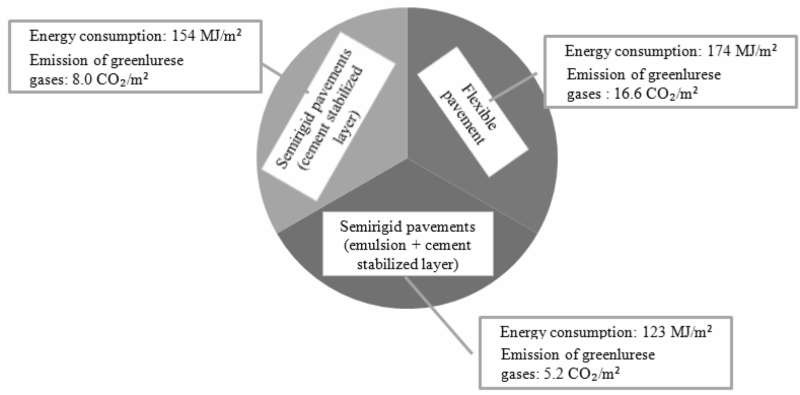

Fig. 3. Energy consumption and gas emissions for each technology.

The data show the fact that the adoption of rehabilitation road technologies based on in situ recycling old road layers with hydraulic binder (hydraulic binder + bituminous binder) results in important benefits not only technical but also ecological. Therefore, the realization of a base course with identical bearing capacity can provide power savings of up to 30 % and reductions of the greenhouse gas emissions up to 69 % in case of using cold recycling technologies in comparison with the classical solution using hot asphalt mixtures.

CONCLUSIONS

Even if old road layers recycling works cannot be applied in all cases (the presence of boulders, paving, geotextiles at the interface between the layers, etc., low bearing capacity of the supporting layer which does not allow the passing of the machine or would lead to rapid deterioration of the layer under traffic, bad weather conditions, etc.), these technologies show indisputable technical and ecological advantages for all categories of public roads.

From the technical point of view, the realization of a cement or cement + bituminous binder recycled resistance layer leads to a better protection of the foundation soil against stresses from traffic, as well as a significant reduction of specific tensile strains occurring in the bituminous pavement.

From the ecological point of view, the use of recycling technologies allows, on the one hand, to reduce the energy consumption in realizing layers with high bearing capacity (by using materials existing in the road pavement and avoiding supplying and transporting new natural aggregates) and, on the other hand, to reduce the greenhouse gas emission (by using technologies at environment temperatures, by reducing the transport distances for the equipment and restricting the use of new road materials).

The concrete conditions in Romania allow implementing on a large scale these technologies, the more so as there are available equipments and the technical condition and the composition of most of the road structures on all road categories require their use. There is a need for technical will and rational application, based on correct field and laboratory research, in order to avoid failure and dismissal of the respective technologies.

REFERENCES

[1] BARBET-IRASTORZE, D. et.al. (2003) Les enrobés bitumineux. Tome 1 and 2. Paris, l'Imprimerie Moderne de Bayeux.

[2] BELC, F. Tehnologii pentru întreţinerea drumurilor. (Road Maintaining Technologies), Timişoara, Editura Solness, 2012.

[3] CYNA, M., OSSOLA, F.-M., FOUCHARD, C. Les émulsions de bitume. Paris, Mame-Imprimeurs à Tours, 2006.

[4] LUCACI, G., COSTESCU, I., BELC, F. Construcţia drumurilor. (Road Building), Bucureşti, Editura tehnică, 2000.

[5] * * * Guides pour recyclages des chaussées. Comité technique AIPCR C7/8 "Chaussées routières", 2003.

ECOLOGICAL PLANNING OF AGRICULTURAL CROP TECHNOLOGIES BASED ON PRECIPITATION REGIME PROGNOSIS

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ABSTRACT

The paper presents a method of determining the prognosis of precipitation regime on a certain area and as its application - the ecological planning of agricultural technologies based on this prognosis. The studied area was the vineyard region of Valea Călugărească, for which the data related to precipitation regime were provided since 1936. The utilization of this planning method has led to optimizing the management of agricultural crops on long periods of time and protecting the environment by avoiding the soil compaction, diminishing the high fuel consumption and reducing pollution of noxious emissions. At the same time, the agricultural technologies planning according to precipitation prognosis has led to a harmonized interaction between the agricultural crop and the environment, namely a positive environmental-friendly relationship.

Keywords: ecological, planning, precipitation, prognosis, technologies

INTRODUCTION

According to [1] or [10], the average of annual precipitation of 400 mm is considered the lower limit of vine crops without irrigation. Upper limit for normal cultivation is considered 800 mm and between 600-700 mm is an optimum amount. The annual precipitation average in Romania is 637 mm, with higher values in the west area and at higher altitudes. The precipitation amount during the period 1.IV. - 30.IX. of 250-400 mm, favorable to cultivation of vine is realized in all vineyards regions, but is lower in the Colinele Dodrogei (Dobrogea hills) region. It is important that, based on the prognosis of precipitation regime to be able to choose the most appropriate technology, in order to protect the soil from unnecessary works, the loss of moisture and to avoid excessive energy consumption. To make such choices is required a long-term prognosis of precipitation regime and the clasical meteorological modelsproviding a more accurate prognosis on short term up to 150 hours [6], [7]. can not be used.

ELEMENTARY CALCULATION OF THE TYPICAL PERIODS OF PRECIPITATION IN THE VALEA CALUGAREASCA AREA

The elementary calculation of the typical periods of precipitation in the Valea Calugareasca area (station 44^{o}58’ 03.31’’ N, 26^o 09’ 02.59’’ E, elevation 206 m) is made by development in Fourier series of the numerical series of precipitation between years 1936 and 2007. The variation of the annual amount of precipitation in the Valea Calugareasca area between years 1936 – 2007 appears in figure 1.

To clarify the mathematical relations used we note $\{p_i\}_{1 \le i \le N}$ the string of the annual precipitation values, i taking values between 1 and N = 72 (the number of observed years). Be:

$$\overline{p} = \left(\sum_{i=1}^{N} p_i \right) \cdot N^{-1} \qquad (1)$$

the average of the string of annual precipitation values.

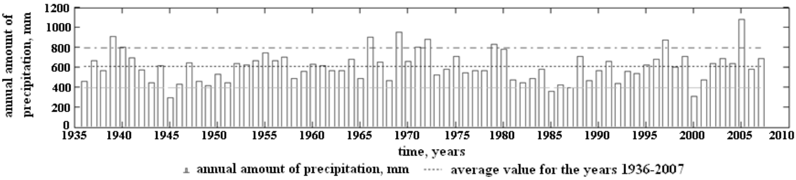

Fig. 1 The annual amount of precipitation in the Valea Calugareasca area, during the period 1936 -2007.

A string that can also highlights the possible periodicities in the temporal distribution of the annual amount of precipitation is its variation in relation to the average:

$$\delta_i = p_i - \overline{p},\ i = 1, \ldots, N\,. \qquad (2)$$

Developing in discrete Fourier series the string of the annual amount of precipitation, we obtain a set of main frequency, ranked according to the amplitude corresponding to each frequency. In the first half of the amplitudes, are found in order the frequency which give the next periods in years: 35.5, 1.029, 2.731, 1.578, 7.889, 1.145, 1.060, 17.75, 14.20, 1.076. If in the prognosis calculations are also included years 2008 - 2011, then, the periods have the values: 37.5, 1.027, 8.333, 1.136, 1.563, 2.778, 18.75, 1.056, 4.412, 1.293.

Fourier series spectrum shows that the fundamental frequency is 0.028 cycles/year, i.e. a period of 35.5 years. Although this period can be treated as Bruckner time cycler, [2], [3] or [9], however it is more likely to occur because the experimental data interval length: 71 years. Also, the period of 17.75 years is a quarter of the time interval considered or prognosis, so there is not a period proper for precipitation, at the increasing of calculation period at 75 years, it passes in 18.75 years. The period of 1.029, respectively 1.027 years is attributable to the annual seasonal regime (12 months).

If we develop in discrete Fourier series the string (2), then, in order of amplitudes, the main periods are: 35.5, 1.029, 2.731, 1.578, 7.889, 1.145, 17.75, 1.060, 14.2, 1.076 years, if is considered the interval 1936-2007 respectively 37.5, 1.027, 8.333, 1.136, 1.563, 2.778, 18.75, 1.056, 1.293, 4.412 years, if is considered the interval 1936 - 2011.

According to [1], the limits of annual amount of precipitation for the growth of vine culture are: 400 mm, respectively 800 mm. Romania is generally, characterized according to [1] by an average regime of precipitation with the value of 637 mm annually. For the Valea Calugareasca area, the annual average of precipitation during the period 1936 - 2007 is 608.3 mm and the average standard deviation is 151.113 mm. This average is close to the national average and very close to the optimal vine growth necessary. To graphically illustrate these data and their reporting to the limits above, in figure 2 was presented the excessive annual precipitation regime, its Fourier interpolation, the arithmetic average of the annual precipitation amount, as well as, the limits between which vine culture is developing normally.

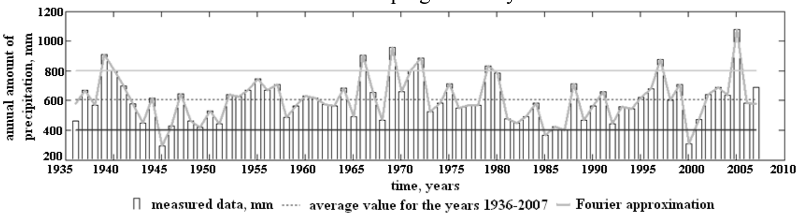

Fig. 2 The annual amount of precipitation , its Fourier approximation, and the average from 1936-2007, respectively the development limits of vine culture.

If we look carefully at the distribution of the annual amount of precipitation during the period 1936 - 2007 and we agree to call those years droughty years, when the annual amount of precipitation is below 400 mm, respectively rainy years, the years when precipitation exceeds the value of 800 mm, so, we can see that, in this period there are two groups of droughty years (1942-1946, 1981-1994) and two groups of rainy years (1966-1980, 1995-1999). These conclusions are consistent in most part with those in [8]. There are exceptions to these groups, however, insignificant. It is important that, the total number of years beeing 72 and the alternations between droughty years - rainy years being two, it results in an elementary calculation the period of 36 years, which is also found by the Fourier analysis (35.5 years) and can be related to the Brükner climatic cycles.

PREDICTION OF THE PLUVIAL REGIME

For the period 2012 - 2030, the Fourier series which approximates the string of the annual averages of precipitation during the period 1936-2007 in the Valea Calugareasca area is represented in figure 3.

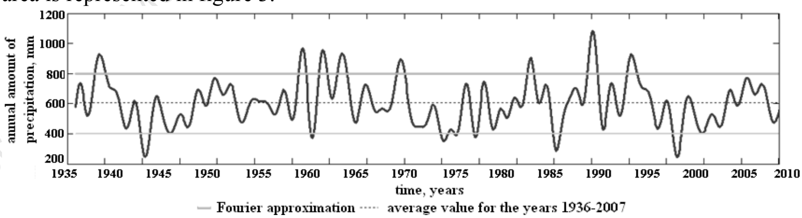

Fig. 3 Fourier approximation of the annual amount of precipitation during the period 1936 - 2011, starting from the data of the years 1936-2007

Using the prognosis in figure 3, it results, that for the future years is expected a short droughty period around the year 2016 and a period of precipitation below the average value between years 2016-2022. For a such period are recommended culture technologies of vine with soil conservation and until 2016 may be used normal working technologies, except the year 2014, when are recommended again technologies to conserve soil moisture. This is the prognosis provided by data processing for the years 1936-2007. For a more accurate prognosis the calculation was resumed, including in the database years 2008-2011. It is obtained the prognosis from figure 4.

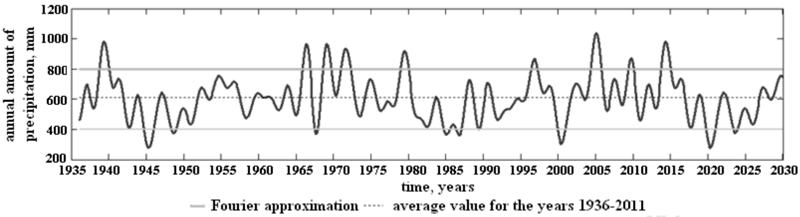

Fig. 4 Prognosis of the annual amount of precipitation during the period 2012 - 2030, based on data from the years 1936 - 2011.

It is noted that, the droughty year immediately following is expected in 2020, compared with the previous prognosis. The droughty period attached is situated between years 2020 and 2026.

From climatological point of view, precipitation periodicity means to compute the distance in time between two similar pluvial events. For droughty periods, if considered as events the sequences of years when precipitation are situated between 250 and 500 mm, can be obtained a periodicity of about 4 events in 75 years, so a period of 18.75 years. At about 18.75 years, a sequence of 2 until 7 droughty years (in the large sense, with precipitation between 250 and 500 mm annually) repeats. This fact can also be determined by developing in Fourier series of the function (the strings of droughty years):

$$ps_i = \begin{cases} p_i, p_i \in (250, 500] \\ 0, p_i \notin (250, 500] \end{cases}. \quad (2)$$

Fourier series which approximates the string of droughty years, (2), appears in figure 5. It is observed the demarcation which the approximation by Fourier series makes on the selected event (series of years with precipitation between 250 and 500 mm).

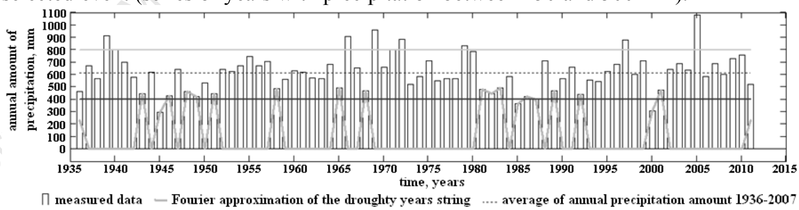

Fig. 5 Fourier approximation of the series string of droughty years.

The prognosis made by developing in Fourier series of the string (2), appears in figure 6 and shows that, the next series of droughty years could be in the Valea Calugareasca area between years 2017 - 2027.

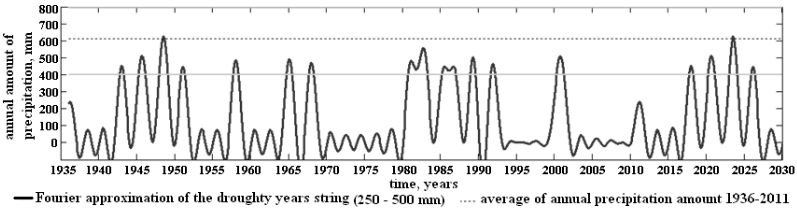

Fig. 6 Fourier series attached to the function of series of droughty years, (2) and prognosis of these series until 2030.

PROGNOSIS OF THE TECHNOLOGIES USED DURING THE PERIOD 2012-2025

Given the precipitation prognosis, recommendations on culture technology of vine can be made, relatively to the normal precipitation periods, abundant or droughty.
We start by checking the quality of forecast drawn from years 1936–2007. It compares the predicted precipitation amount for the years 2008 - 2011 with the amount of precipitation measured in the same year. Then, the technological recommendations will be given taking into account the prognosis.
In table 1 are given comparatively the quantities of precipitations predicted and measured for the years 2008, 2009, 2010 and 2011. It observes that, the prediction is good for 2008, satisfying for 2009 and 2010 and unsatisfactory for 2011. The prognosis for the first two years gives a value of the precipitation amount situated in the normal average interval for the area (600-800 mm), and the amount of precipitation fallen is in the same interval. The prognosis for 2010 is the characteristic of a rainy year (if the calculation is made during the period 1936-2007) and a normal year for longer calculation periods (1936-2008, 1936-2009), while in reality has been recorded a normal average to wet year. In 2011 the prognosis indicates a rainy year (prognosis calculated from the data of 1936 - 2007 and 1936 – 2008) and normal (for the calculated data during the periods 1936 – 2009 and 1936 – 2010), while in reality have been recorded precipitations into the normal average interval to the droughty part. It results that, the prognosis is affected by the random factors rather important.

Table 1 Comparison between the prognosis of the annual precipitation amount and he measured one. The hachure cells contain predictive values (extrapolation), those cells without hachure are read on the interpolated area

Calculation period	**Prognosis 2008**	**Prognosis 2009**	**Prognosis 2010**	**Prognosis 2011**
1936-2007	668.40	565.40	911.20	801.30
1936-2008	518.09	682.40	551.39	925.20
1936-2009	600.70	596.00	668.40	565.40
1936-2010	614.99	714.20	624.79	654.10
The measured value	**600.70**	**728.50**	**757.50**	**518.10**

In principle, for a satisfactory prediction is recommended that, the prognosis function to be recalculated each year and the prognosis to be given only for one maximum two years. However, to adopt this prognosis strategy should be considered the Gibbs phenomenon, showing that, the Fourier series approximates the functions well, excepting the points of discontinuity, where appreciable errors appear [4] or [5]. In the table 2 are given the interpolated and extrapolated values for the annual precipitation amount with attenuation of the Gibbs effect. The prognosis realized with attenuation of the Gibbs effect is slightly better than those which are made directly on the approximated Fourier series.

Table 2 Comparison between the annual precipitation amount prognosed for which the Gibbs effect was attenuated and the measured one. The hachure cells contain predictive values (extrapolation), those cells without hachure are read on the interpolated area

Calculation period	**Prognosis 2008**	**Prognosis 2009**	**Prognosis 2010**	**Prognosis 2011**
1936-2007	627.62	656.52	820.12	808.98
1936-2008	605.32	604.48	665.35	814.48
1936-2009	622.65	610.28	628.65	657.71
1936-2010	657.41	668.55	657.42	622.48
The measured value	**600.70**	**728.50**	**757.50**	**518.10**

More probably seems to be the prediction made with the aid of the string (2), figure 7, which shows that a droughty period, generally (amount of the annual precipitation below 500 mm), may install in the Valea Calugareasca viticultural area during the period 2017 and 2027. For this period, the technological recommendations are given below and those from the table 3. However, there is a warning to prepare the irrigation system firstly.

Table 3. The Recommendation of the technologies for vine culture in the Valea Calugareasca area according to the precipitation regime

Droughty pluvial regime **Strictly less than 400 mm per year**	**Normal pluvial regime** **Between 400 and 800 mm per year**
Cutting in dry of vine, up to 5 shoots on the vine	Administration of chemical fertilizers with N
Chopping vine shoots on the interval	Spring plowing + harrowing
Administration of chemical fertilizers	Soil aeration + harowing
Aerating soil + harrowing or compacted	Harrowing (twice)
Harrowing (twice)	Hoeing + harrowing on intervals (2 times)
Herbicide in vine (twice)	Water transport or soil aspersion
Water transport for herbicide	Aspersion (8 times from 2 to 2 rows)
Vine aspersion (two treatments from 2 to 2 rows)	Example: pits for planting vine in gaps
Water transport for aspersion	Autumn plowing + fertilization with P, K
Vine aspersion (5 treatments each interval)	
Drip irrigation	
Removal of vine shoots (twice)	
Autumn aeration of the soil	
Grapes transport	
Fuel consumption: 134.9 liters / ha per year	**Fuel consumption: 122.6 liters / ha per year**

The abundant precipitation regime does not mind the technology for vine culture because vineyards are located on slopes, the excess of water draining naturally.

TECHNOLOGICAL RECOMMENDATIONS

Technological works applied to the plant

-Reduction the fruit weight at the execution of cutting operations, depending on vines vigor;

-Execution of works in green (weeding, cutting the roots, reducing the number of inflorescences) to maintain the vegetative balance of vines;
-Performing of foliar fertilization with foliar fertilizers containing higher content of K in order to reduce water loss through perspiration;
-Standardization of the production, (reducing clusters of grapes), to create opportunity for the normal development of grape production.

Technological works applied to the soil

-Replacement of the spring plowing with the aeration work of the soil (from 14 to 16 cm) made with cultivator plow equipped with claws, attaching star harrow or heavy roller to compact the aeration surface of the soil. The work will be performed on early spring;
-Using during the vegetation period of vine of some solutions to protect the soil (mulching with vegetal debris, minimum tillage);
-Controling weeds, especially of "those problem weeds" with deep-rooting, which are high water and nutrients consuming through harrowing or shredding and leaving them on the soil, with vegetal debris chopping machine;
-Breaking of the soil crust through superficial works to avoid losses of water from the soil, work executed with vine plow equipped with claws for superficial aeration;
-Mandatory application of supply splashing in the young plantations (years I-III), which have a superficial root system;
-Irrigation of fruit plantations (especially those with grapes for consumption) by performing 2-3 watering with according to watering rules, in compliance with the evolution of the hydric regime in the soil;
-Drip irrigation throughout the growing season when water deficit is found in soil, with manual or automatic start.
-A decision procedure for prognosis of the vine culture technologies based on the precipitation regime can be given in the table 3.

CONCLUSIONS

Generally, long term prognosis for precipitation in meteorology, refers to the period of days, weeks or months. In this research we made attempts to long time prognosis : years, decades, most related to climatology field.
The prognosis method proposed is being in an early stage and its tests (tables 1 and 2) demonstrate that the results are, at least from qualitatively point of view, satisfactory.
To improve prognosis in terms of amount are taken into account two methods: statistical corrections in prognosis on several periods and respectively introducing some functions with general trend, which are to be overlapped by the Fourier approximated series.
The permanent dialogue with experts in agriculture, has demonstrated the usefulness of such prognosis in long-term management of farms and sustainable development in general.
It is needless to emphasize the harmonization of the human activity with the environment in the context of sustainable development. In this sense, the consequence of the existence of long-term prognosis of the annual precipitation, determines the posibility of planning agricultural technologies for regional cultures and implicitely the logistics involved in the process.

REFERENCES

[1] Tardea C., Dejeu L., Viticulture, Didactic and Pedagogical Publishing, Bucharest, BU III 8125, pp. 123, 1995.

[2] The Great Soviet Encyclopedia, 3rd Edition (1970-1979), © 2010 The Gale Group, Inc. , © 2010 The Gale Group, Inc. , 2010.

[3] O. M. Raspopov, O.I Shumilov, E. A. Kasatina, E. Turunen, M. Lindholm, 35-year climatic Bruckner cycle-solar control of climate variability ?, Proc. 1th Solar &Space Weather Euroconference "The Solar Cycle and Terrestrial", Santa Cruz de Tenerife, Tenerife, Spain, 25-29 September, ESA SP, Vol. 463, pp. 517, 2000.

[4] Panaitescu M., Gh., Procesarea numerica a semnalelor, Note de curs, Universitatea „Petrol – Gaze" Ploieşti, 2004.

[5] Carslaw H., S., Introduction to the theory of Fourier's series and integrals, volume 1, Third Edition, New York Dover Publications Inc. Chapter IX, 1930.

[6] Romanian National Agency of Meteorlogy website, www.meteoromania.ro/, 2012.

[7] ALADIN Numerical Weather Prediction Project, www.cnrm.meteo.fr/aladin/, 2012.

[8] Sandu I., The evolution of wheater patterns in Romania, Comunication ministry of Environment–National Meteology Administration, 2009.

[9] Henry, A, J., The Bruckner Cycle of Climatic Oscillations in the United States, Annas of the Assocition of American Geographers, vol. 17, , No. 2, pp.60-71, 1927.

[10]http://www.scritube.com/economie/agricultura/PARTICULARITATI-ALE-ECOLOGIEI-55819.php , 2012.

ECOLOGICAL RECONSTRUCTION OF SOILS POLLUTED WITH HEAVY METALS AND SULFUR COMPOUNDS IN ROMANIA

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ABSTRACT

Economy, development of the circulation network and increase in energy, prime materials and materials required for new technologies consumption, have in addition positive and negative effects on soil quality status. They can lead to major changes in soil quality that may be irreversible. In the monitoring system of the status of soil quality is important to determine the soil loading with elements and potentially polluting substances. It is therefore absolutely necessary to know in advance these changes to be evaluated their gravity. So, came the need to establish a national monitoring system of soils in order to determine their current status and trend. The paper presents the soil with potentially polluting elements and substances. The content of elements and potentially polluting substances in the soils is determined both by main characteristics of soils and of human actions. Some types of industrial pollution are the most aggressive pollution with heavy metals and oxides of sulfur which is found in Copşa Mică, Zlatna and Baia Mare. Are presented the concentrations of soluble heavy metals and sulfur in the three areas mentioned above and ecological reconstruction measures are proposed.

Keywords: monitoring, heavy metals, sulfur, soils, pollution.

1. INTRODUCTION

Urbanization, industrialization, agriculture, development of the circulation network and increase in energy, prime materials and materials required for new technologies consumption, have in addition positive and negative effects on soil quality status. They can lead to major changes in soil quality that may be irreversible.
It is therefore absolutely necessary to know in advance these changes to be evaluated their gravity.

So, came the need to establish a national monitoring system of soils in order to determine their current status and trend [11].
Monitoring system of the status of agricultural soils quality in Romania, as part of the National System of Environmental Quality, was founded in 1977. In 1992 they founded a new National System for Monitoring of Soil Quality in Romania, a system established in line with other European systems.

The paper presents the soil with potentially polluting elements and substances.
PPES contents in soils is determined by the main characteristics of soils (texture, pH, organic matter content), and human actions (fertilizer, plants treatments, pollution, etc.).

An important role in the concentration of pollutants in the soil it is relief, accumulative forms retaining a larger volume of polluting substances. Most sites in Romania are situated on horizontal land - very low pitched (50%) and the remaining land with different inclinations.

Approximately 50% of agricultural sites may suffer pollution by chemification works.

In terms of soil classes and soil types [5] on the Level I monitoring sites are:

- Chernozem, Kastanoziom, Phaeozem	23.14 %
- Cambisol Eutric, Cambisol Dystric	23.57 %
- Luvisol, Luvisol, Planosol	28.58 %
- Entic Podzols, Haplic Podzols	4.35 %
- Gleyosols, Stagnic Luvisols	3.93 %
- Undeveloped soils	14.82 %

Soils with slight texture not hold large PPES content, but favor strong mobilizing them. Fine textured soils retain high PPES content that can reach in the plants.
Soil reaction is of particular importance in terms of mobility PPES. Soils with weak alkaline reaction has very low-average vulnerability and the moderate and strong alkali are not vulnerable.

Vulnerability of soils to pollution with heavy metals is determined by soil characteristics listed above. The most aggressive industrial pollution is heavy metal and sulfur oxides in Alba, Maramures, Sibiu counties with compounds of fluorine in Prahova Olt, Bacau, Tulcea counties. Among the types of agricultural pollution, HCH and DDT residues pollution is important, wastewater, sludge livestock pollution.

2 PAPER PREPARATION

2.1 MATERIAL AND METHODS

Soil indicators followed into the monitoring works are:
- joint analysis: texture (particle size composition), pH, humus, total nitrogen, mobile phosphorus, mobile potassium, moisture, apparent density, penetration resistance, hydraulic conductivity, total porosity, contraction index;
- specific analysis: the sum of exchangeable bases, hydrolytic acidity, exchangeable aluminum, total cationic exchange capacity, base saturation degree, the total content of soluble salts, exchangeable sodium, total carbonates content;
- special analysis: heavy metal content, soluble sulfur content, soluble fluorine content, organo-chlorine pesticide content, the number of bacteria, mushrooms and dehydrogenate activity.

Methodologies used [3] to determine the special analysis refers to:
- Heavy metals are determined spectrophotometer by atomic absorption;
- Soluble sulfur content is determined by gravimetric dosing;
- Soluble fluoride content is determined by extraction in $CuCl_2$, micro-diffusion Brewer;

- Organo-chlorine pesticide content is determined chromatographic gaseous phase;
Interpretations and size classes for most of the indicators are those of the Development methodology of soil studies, vol. III [4] and special indicators are presented in Table 1.

Table 1. Range concentration provisional of some potentially polluting elements and substances

Pollutant	Degree loading, ppm					Normal content	Maximum available limits
	Low	Moderate	High	Very high	Excessive		
Cu	21-40	41-100	101-200	201-400	>400	<21	100
Pb	21-40	41-100	101-300	301-1000	>1000	<21	100
Zn	101-150	151-300	301-700	701-1500	>1500	<101	300
Cd	1.1-2.0	2.1-3.0	3.1-7.0	7.1-20,0	>20	<1,1	3
Co	21-30	31-50	51-100	101-200	>200	<21	50
Ni	21-30	31-50	51-100	101-200	>300	<21	50
Mn	901-1100	1101-1500	1501-2100	2100-2700	>2700	<901	1500
Cr	31-50	51-100	101-200	201-400	>400	<31	100
Soluble sulfur	151-300	301-500	501-700	701-1500	>1500	<151	-
Soluble fluorine	1.1-5.0	5.1-10.0	10,1-25.0	25.1-75.0	>75	<1,1	10
DDT total	0.011-0.050	0.051-0.100	0.101-0.500	0.501-5.000	>5	<0,011	0.1
HCH total	0.011-0.050	0.051-0.100	0.101-0.500	0.501-5.000	>5	<0,011	0.1

Normal content: heavy metals [1]; soluble sulfur – [12]; soluble fluorine [7], [10]; total DDT and HCH – [12].
Maximum available limits: heavy metals – [6]; soluble sulfur – [12]; soluble fluorine – [7], [10]; total DDT and HCH – [12].

2.2 RESULTS AND DISCUSSIONS

One of the most important types of soil pollution in Copsa Mica, Baia Mare and Zlatna area is pollution with heavy metals and sulfur compounds.

The soil pollution in Copşa Mică area was determined by non-ferrous metallurgy industry. Pollution is given by heavy metals (Cu, Pb, Zn, Cd) and sulfur compounds. The area is characterized by a great geomorphologic complexity and a wide variety of soils (chernozem, phaeozem, nitisol etc.). In agricultural soils the accumulation of pollutants is achieved in the first cm of the soil, wherefrom through agricultural work the pollutants get into the whole horizon A (Table 2).

Table 2. The concentration of heavy metals and sulfur [2]

Pollutant	Soil (0-5cm)	Normal content	Maximum available limits
Cu	46	20	100
Pb	394	15	100
Zn	287	50	300
Cd	6,7	1	3
Soluble sulfur	215	100	

From table 2 results that lead exceeds four times the maximum available limits, two times the cadmium and zinc is close to this limit. Copper and sulfur content exceeding 2 times normal.

Soil pollution in Zlatna area was determined by non-ferrous minerals processing companies that eliminate annual significant quantities of SO_2, oxides and sulfates of lead, zinc, copper, arsenic, antimony and bismuth in air. These sediment particles were deposited on the ground. [9] Pollution is given by heavy metals (Pb, Cu, Zn, Cd) and sulfur compounds (Table 3).

Table 3. The concentration of heavy metals and sulfur [2]

Pollutant	Soil (0-5cm)	Normal content	Maximum available limits
Cu	217	20	100
Pb	38	15	100
Zn	192	50	300
Cd	1.61	1	3
Soluble sulfur	608	100	

Polluted area is an area of hills and mountains, with varied soils (nitisol, luvisol, eutricambisol etc.) and with periods of calm atmosphere which promotes the stagnation of air masses and deposition of pollutants.

From table 3 results exceeding the maximum available copper limits by 2 times, and the normal lead content of 2.5 times, zinc 4 times and sulfur 6 times. Cadmium content is little high than normal.

In the area Baia Mare, mining companies of non-ferrous ores and their processing have been polluting factor. Soils pollution is given by heavy metals (Pb, Cu, Zn, Cd) and sulfur. The decisive role in the spread of pollutants is the relief. It is mountainous in the north constitute a barrier to pollution and is an alluvial plain in the south-west where the air currents allow the transport of heavy metal particulates. Lower meadows accumulate large quantities of heavy metals than higher landforms [8].

Also, the hydrological regime has an important role in heavy metal pollution. Surface water and groundwater contribute to the spread of pollutants and stagnant waters from micro depressions allow fixing of heavy metals on the surface of clay soils (Table 4).

Table 4. The concentration of heavy metals and sulfur [2]

Pollutant	Soil (0-5 cm)	Normal content	Maximum available limits
Cu	113	20	100
Pb	749	15	100
Zn	224	50	300
Cd	4.44	1	3
Soluble sulfur	1450	100	

From table 4 results an excess of 7.5 times of maximum available limits of lead and a small excess of copper. Normal content is exceeded by 5.5 times of zinc and 4.4 times by cadmium. Normal content is exceeded the soluble sulfur by 14.5 times.

Important sources of soils pollution with sulfur compounds are emissions from power plants that do not apply desulphurization processes, from sulfuric acid power plants, from non-ferrous metallurgy, etc.
Oxides of sulfur coming from air pollution generates, after several chemical and biological transformations, SO_4^{2-} and H^+ - ions which contribute to soil acidification. This leads to fewer bacteria and microbiological activity disorder.

The objectives of the national monitoring system of soils quality in Romania are:
a). systematic monitoring of quality characteristics of the soil;
b). processing the information obtained to assess the quality status;
c). elaboration of forecasts on the evolution of soil quality;
d). warning agencies and makers on the situations in which appear the dangerous intensification phenomena of pollution, in order to prevent or limit harmful effects on soils;
e). providing data needed to establish the main causes of soil pollution phenomena in order to build and improve prevention and improvement measures, including rehabilitation and / or recycling of waste substances usable and to avoid or mitigate damage to the economy;
f). tracking dynamics of effectiveness of preventive measures against pollution of soils;
g). providing information and data to establish technical and economic measures necessary to ensure the current and future stage, for consistency between the country's socio-economic development, protection of soil and environmental quality;
h). providing documentation necessary to support the national program of environmental protection;
i). using data on soils to achieve the national system of integrated environmental monitoring;
j). providing data of soils quality from Romania necessary to participation of the Romanian part to achieve International Reference System or other international programs.

For the reconstruction of agricultural soils contaminated with heavy metals and sulfur dioxide are necessary the works listed below:
a). general measures:
- reducing the emission of pollutants by upgrading polluting industries;
-attachment measures of waste dumps to prevent their scattering (Baia Mare);
- setting up perimeters of improvement of affected areas based on their mapping up-to-date;
- total or partial restructuring of uses in the areas affected.
b). specific measures:
- correcting acid reaction soil by applying calcareous amendments to bring the pH from a strong acid domain (pH < 5,8), into a moderately acid or weak acid domain (pH = 5,9-6,8). This reduces soil acidity so mobility of heavy metals and exchangeable aluminum concentrations. Doses of calcareous amendment are calculated using the formula (1):

$$D_{CaCO3} = SBi = [\ \frac{Vd}{Vi} - 1\ ]\ \frac{100}{Cn} \quad t/ha \qquad (1)$$

In which: Vd - desired degree of saturation, %;
Vi – initial degree of saturation, %;
SBi – sum of exchangeable bases, me/ 100g;

Cn - neutralizing capacity of the amendment.

- fertilizing of soil with manure, which brings a surplus of nutrients in the soil (N, P, K), formula (2);

$$D_G = \frac{0.4}{N}(15+\frac{30}{IN})(1.35-\frac{8}{A}) \quad \text{t/ha} \qquad (2)$$

In which: A- clay content with diameter of <0,002 mm, %;

N –nitrogen content of organic fertilizer, %;

IN – index of nitrogen according to the humus content and degree of base saturation.

-fertilization with nitrogen will consider cultivated plants and expected harvest and use nitro chalk;

- fertilization with phosphorus will be applying the relationship(3):

$$D_{P2O5} = \frac{50-P_{Al}}{0,04x6} - (Pg + PFg) \quad \text{kg s.a./ha} \qquad (3)$$

In which: 50- optimal content of mobile phosphorus from soil ppm;

P_{Al} – initial content of mobile phosphorus from soil ppm;

0,04- average growth rate of mobile phosphorus content depending on the amount of P_2O_5 applied as fertilizer;

6 –number of years that apply phosphorus fertilization;

Pg – P_2O_5 contribution by organic fertilization;

PFg – P_2O_5 intake by amendment with phosphogypsum.

- potassium fertilization. The dose is calculated with relation (4):

$$D_{K2O} = \frac{160-K_{Al}}{0,05x8} - Kg + Ccarb \quad \text{kg s.a. / ha} \qquad (4)$$

In which: 160- optimal mobile potassium content ppm;

K_{Al} – initial soil content in potassium mobile;

0,05 – average growth rate of mobile potassium content per kg of K_2O applied through fertilization ppm;

8 –number of years that apply ameliorative fertilization with K;

Kg – K_2O intake of organic fertilization;

Ccarb. –correction for carbonates

- afforestation of polluted areas function to intensity of pollution, namely: excessive heavily polluted area (acacia, black pine and bushes), the moderately polluted area (acacia, black pine, bushes, red oak), low polluted area (sessile, beech, hornbeam, mountain and plain maple, linden, cherry and bushes);
- establishing waste dumps with fallow furrows and seeding grasses, planting acacia and vine.

2.3 CONCLUSIONS

The results of research conducted in Copşa Mică, Zlatna and Baia Mare, lead to the following conclusions:

-soils investigated are vulnerable soils to pollution processes by sulfur compounds and heavy metals;

-the main pollutants that affect agricultural ecosystems are the acidic sulfur compounds, Pb, Cu, Zn and Cd;

-pollution effects on soils were highlighted through acidification and depletion of bases of the adsorption complex;
-due to pollution with heavy metals and sulfur compounds disturbance microbiological activity takes place;
-the effect of pollution is destroying the soil structure;
- increasing the mobility of aluminum and heavy metals, with toxic effects on vegetation;
- changes of nutritional conditions leading to premature drying of vegetation and loss soil protection functions.

REFERENCES

[1] Adriano, D.C. Trace Element in the Terrestrial Environment. Springer Verlag, New Zork, Berlin, Heidelberg, Tokio, 1986.

[2] Ciobanu, C. and Mihăilescu, A. Research on processes of soil degradation through pollution. Soil Science Magazine no. 2, Ed. Solness, Bucharest, Romania, 2001, pp 38-49.

[3] Dumitru, M. Monitoring of soil quality status from Romania, Ed. GNP, Bucharest, Romania, 2000.

[4] Florea, N., Bălăceanu, V., Răuţă, C. and Canarache, A. Development methodology of soil studies. Center for Teaching Materials and Agriculture Propaganda, Bucharest, Romania, 2003.

[5] Florea, N. and Munteanu, I. Romanian System of Soils Taxonomy. Ed. Esfalia, Bucharest, Romania, 2003.

[6] Kloke A. Orientierungsdaten fur Toleriebare Gesamtgehalte einiger Elemente in Kulturboden, Mitt., VDLUFA, H2, 1980.

[7] Larsen, S., Widdowson A.E. Soil Fluorine, Journal of Soil Science, vol.27, nr.2, Romania, 1971

[8] Lăcătuşu, R., Andăr, P., Dumitru, M., Ciobanu, C. and Popescu, D. The abundance of Cd and Pb in horizon A of Romania soil. Proceedings of XVth National Conference on Soil Science, vol. 29B, Bucharest, Romania, 1997, pp 131-142.

[9] Mihăilescu, A. and Ciobanu, C. Industrial pollution of soils and vegetation in Zlatna area. Forests Magazine, 105/3-4, Romania, 2000.

[10] Omuetti, J.A.I. and Jones, R.L. Fluorine distribution with depth in relation to profile development in Illinois, Soil Science. Soc. Am. J. 44, 1980, pp 247-249.

[11] Răuţă, C. and Cârstea, St. Preventing and soil pollution control. Ed. Ceres, Bucharest, Romania, 1983.

[12] Răuţă, C., Dumitru, M., Ciobanu, C., Blănaru, V., Cârstea, St., Latiş, L., Motelică, D.M., Lăcătuşu, R., Dumitru, E. and Enache, R. Monitoring of soil quality status from Romania, vol. I and II. Ed. Publistar, Bucharest, Romania, 1998.

ECOLOGICAL REFRIGERANTS IN COOLING SYSTEMS AS AN ALTERNATIVE FOR THE ENVIRONMENT PROTECTION

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ABSTRACT

The paper presents conditions in order to assure comfortable temperatures in working and living environments using cooling systems in sustaining life quality. They are treated aspects of the environmental pollution through the working fluids of the refrigeration, air-conditioning and heat-pumping systems and it is described the new strategy in using refrigerants in accordance with the international legislation. It is described the selection of refrigerants adapted to each utilization, based on the thermodynamic and -physical properties, the technological behavior, costs and use constraints as principal aspects of the environment protection.

Keywords: environmental protection, refrigerants, cooling, pollution, ecological substitutes

INTRODUCTION

The environment pollution represents a major risk for all that means life on our planet (men, flora, fauna), it consist not only in the local noxious effect of different pollutants but in the unbalances produced in a large scale on the whole planet. Environment protection represents the fundamental condition of the society's sustainable development, a priority purpose of national interest that is realized in institutional frame where the legal norms authoresses the development of activities with impact on environment and exert the control upon these.

The purpose of environment protection is to maintain the ecological balance, to maintain and improve the natural factors, to prevent and control pollution, the development of natural values, to assure better life and work condition for the present and future generations and it refers to all actions, means and measures undertaken for these purpose.

One of the minor components of atmosphere, the ozone has a special importance in maintaining the ecological balance. It is distributed in principal between the stratosphere (85…90%) and troposphere. Any perturbation of the atmospheric ozone concentration (it varies between 0 and 10 ppm, in function of the regions) has direct and immediately effect upon life.

For most of the states the problems of forming and maintaining the earth ozone layer, represents a major priority. In this context during the last 30 years, the European Union has adopted a great number of laws and regulations concerning environment protection, to correct the pollution effects, frequently by indirect directives, imposing allowable concentrations, asking for government collaboration, programs and projects for regulation of industrial activities and productions. The Alliance for Responsible Atmospheric Policy [11] maintains a brief summary of regulations for some countries.

ACTION OF REFRIGERANTS UPON THE ENVIRONMENT

Refrigerants are the working fluids in refrigeration, air-conditioning, and heat-pumping systems. The phase changes occur both in absorption and mechanical vapor compression systems, but not in systems operating on a gas cycle using a fluid such as air. The design of the refrigeration equipment depends strongly on the properties of the selected refrigerant.

Refrigerant selection involves compromises between conflicting desirable thermo physical properties. A refrigerant must satisfy many requirements, some of which do not directly relate to its ability to transfer heat. Chemical stability under conditions of use is an essential characteristic. Safety codes may require a nonflammable refrigerant of low toxicity for some applications. Cost, availability, efficiency, and compatibility with compressor lubricants and equipment materials are other concerns.

Minimizing all refrigerant releases from systems is important not only because of environmental impacts, but also because charge losses lead to insufficient system charge levels, which in turn results in suboptimal operation and lowered efficiency.

Working fluids escaped through leakages from refrigeration equipments, during the normal opera-ting (filling, empting) or accidental (damages), gathers in significant quantities in high levels of the atmosphere (stratosphere). There, through catalytically decompounding they deplete the ozone layer that normally is filtering the ultraviolet sun radiations, dangerous for living creatures and plants on earth. Stratospheric ozone depletion has been linked to the presence of chlorine and bromine in the stratosphere. Supplementary, refrigerants contributed to the global warming of atmosphere, as gases with greenhouse effect.

The average global temperature is determined by the balance of energy from the sun heating the earth and its atmosphere and of energy radiated from the earth and the atmosphere space. Greenhouse gases (GHGs), such as carbon dioxide (CO_2) and water vapor, as well as small particles trap heat at and near the surface, maintaining the average temperature of the Earth's surface about 34 K warmer than would be the case if these gases and particles were not present (the greenhouse effect).

Global warming is a concern because of an increase in the greenhouse effect from increasing concentrations of GHGs attributed to human activities. Thus, the negative influences of refrigerants, especially of Freon's upon environment, can be synthesized by the two effects:

– depletion of the ozone layer;
– contribution to global warming at planetary level by the greenhouse effect.

The measure of a material's ability to deplete stratospheric ozone is its *ozone depletion potential* (ODP), a value relative to that of R-11 which is 1.0.

The *global warming potential* (GWP) of a GHG is an index describing its relative ability to trap radiant energy compared to CO_2 (R-744), which has a very long atmospheric lifetime. Therefore refrigerants will be select so that the ozone depletion potential will be zero and with a reduced atmospheric global warming potential.

The most utilized refrigerants are those who derivate from methane and ethane and there toxicity and flammability is according to the number of Cl and H atoms.

Concerning the polluting action upon environment, for the atmospheric ozone, presented through the Montreal protocol (1987) and the further amendments, as well as for the green house effect according to the Kyoto protocol (1997), refrigerants can be classified as follows:

– having strong destructive action upon the ozone layer and with significant amplification of the greenhouse effect upon earth (Chlorofluorocarbons-CFCs);

– having reduced action upon the ozone layer and with moderate amplification of the greenhouse effect (Hydrochlorofluorocarbons-HCFCs);

– being non harmless upon the ozone layer, with less influence on greenhouse effect (Hydrofluoro-carbons-HFCs);

– being non harmless upon the ozone layer, with less influence on greenhouse effect (ammonia-NH_3, carbon dioxide-CO_2, natural hydrocarbons)

Refrigerants as Chlorofluorocarbons had been used since the 1930s because of their superior safety and performance characteristics. However, their production for use in developed countries has been eliminated because it has been shown that they deplete the ozone layer [13]. Production for use in developing countries will be eliminated by 2010, except as allowed under essential use exemptions or in feedstock applications.

Hydrochlorofluorocarbons also deplete the ozone layer, but to a much lesser extent than CFCs. Their production for use as refrigerants is scheduled for elimination by 2030 for developed countries, and by 2040 for developing countries.

Hydrofluorocarbons do not deplete the ozone layer and have many of the desirable properties of CFCs and HCFCs. They are being widely adopted as substitute refrigerants for CFCs and HCFCs. The HFC refrigerants have significant benefits regarding safety, stability and low toxicity, being proper for large applications.

A second influence of refrigerants upon the environment, preciously mentioned, guided to a new classification of refrigerants according to their contribution to the atmosphere warming. Comparison of this specific contribution to the greenhouse effect is realized even for R-11 (the most noxious even from point of view of ozone layer depletion) as well as for CO_2. Freon's placed on the undesirable position 3 (14%) between the gases with green house effect, could be explained by their great absorption capacity of infrared radiation.

In case of the refrigerating systems, supplementary with direct action to the green house effect, because of the refrigerants leakage in the atmosphere, it must be considered even the indirect action to global warming by the CO_2 quantity released in atmosphere during the transport of energy produced by the installation, obviously greater than the associated direct action. While the refrigerant quantity increases in the installation, the effect of direct action rises.

The total equivalent warming impact (TEWI) of an HVAC&R system is the sum of direct refrigerant emissions expressed in terms of CO_2 equivalents, and indirect emissions of CO_2 from the system's energy use over its service life.

Another measure is *life-cycle climate performance* (LCCP), which includes TEWI and adds direct and indirect emissions effects associated with manufacturing the refrigerant

The analysis of TEWI index for refrigerating systems, operating with divers refrigerants (CO_2, R22, NH_3, R134a, R404A) evidence that even the direct effect generated by CO_2 is negligible comparing with the other refrigerants [7]. The indirect effect generated by CO_2 is great because of the high condensation pressures that determine great energy consumption and in consequence the maximum value of TEWI for CO_2.

Environmentally preferred refrigerants have:

– low or zero ODP;

– relatively short atmospheric lifetimes;

– low GWP;

– provide good system efficiency;

– appropriate safety properties;
– yield a low TEWI or LCCP in system applications.

In Table 1 is presented the refrigerants effect upon the environment. Because HFCs do not contain chlorine or bromine, their ODP values are negligible and represented through 0 in this table.

Table 1. Effect of refrigerants upon environment

Group	Fluid	ODP	GWP (basis R-11)	GWP (CO_2=1)	Atmospherically lifetime (years)
0	1	2	3	4	5
CFC	R-11	1	1	4000	50…60
	R-12	1	2.1…3.05	10600	102…130
	R-113	0.8…1.07	1.3	4200	90…110
	R-114	0.7…1	4.15	6900	130…220
	R-12B_1	3…13	-	1300	11…25
	R13-B_1	10…16	1.65	6900	65…110
HCFC	R-21	0.05	0.1	-	<10
	R-22	0.055	0.34	1900	11.8
	R-123	0.02	0.02	120	1.4…2
	R-142b	0.065	0.3…0.46	2000	19…22.4
HFC	R-23	0	6	14800	24.3
	R-32	0	0.14	580	6…7.3
	R-125	0	0.58…0.85	3200	32.6
	R-134a	0	0.28	1600	14…15.6
	R-143a	0	0.75…1.2	3900	55…64.2
	R-152a	0	0.03…0.04	140	1.5…8
Azeotropic blends	R500(R12/R152a)	0.63…0.75	2.2	6000	-
	R501(R12/R22)	0.53	1.7	4200	-
	R502(R22/R115)	0.3…0.34	4.01…5.1	5600	>100
	R507(R125/R143a)	0	0.68	3800	-
Cvasiazeotrope blends	R404A(0.44R125/0.52R143a/ 0.04R134a)	0	0.6…0.94	3750	-
	R410A(0.5R32/0.5R125)	0	0.5	1890	-
	FX40(0.1R32/0.45R125/ 0.45R143)	0	0.6	3350	-
Zeotropic blends	R407A(0.2R32/0.4R125/ 0.4 R134a)	0	0.14…0.45	1920	-
	R407B(0.1R32/R0.7R125/ 0.2R134a)	0	0.1…0.5	2560	-
	R407C(0.23R32/0.25R125/ 0.52R134a)	0	0.29…0.37	1610	-

A major contribution against the climate changes has the European Union through regulations regarding some fluorinated gases with green house effect and it is a real support in the emission reducing resulted from these fluorinated gases all over Europe. All regulations establish a high protection level of the environment as well as an inside market for equipments containing fluorinated gases and for the members involved in this activities.

STRATEGY CONCERNING NONECOLOGICAL REFRIGERANTS

After the finding that CFCs, HCFCs and some other human-produced compounds deplete the ozone layer, most countries agreed to the Montreal protocol. This protocol is an international treaty, administered by the United Nations Environment Programs (UNEP) that controls consumption and production of ozone-depleting substances, including CFCs and HCFCs [13].

Hydrofluorocarbons (HFCs) do not deplete the ozone layer and have many of the desirable properties of CFCs and HCFCs. They are being widely adopted as substitute refrigerants for CFCs and HCFCs. However, HFCs are also associated with an environmental issue; they contribute to global warming if released into the atmosphere [14]. Countries, trade associations and companies are increasingly adopting regulations and voluntary programs to minimize these releases and, hence, minimize potential environmental effect while continuing to allow use of these refrigerants.

Consequently a new orientation appeared upon the utilization of working fluids. Thus, CFC refrigerants as R-11 and R-12 where substituted by simply compound refrigerants R-123 (HCFC) and R-134 (HFC) with a reduced even zero action upon the depletion of the ozone layer. This alternative is attractive because the substitutes have similar proprieties (temperature, pressure) with the replaced one, and the changes that took place directly on the existent installations will be realized with minimum of investments.

For other refrigerants it were not found simply compound fluids as for example for R-502 that could be replaced with a mixture of R-115 (CFC) and R-22 (HCFC) or in some cases only with R-22, that is a fluid for temporary replacement, conform with the international legislation.

By blending two or three pure Freon's we obtain new substances, better adaptable for desired cooling application. The first blends are named azeotropes while the others are named zeotropes. The use of blends could generate undesired aspects, especially by leakages of the working fluid, accidentally or during the installations filling.

Figure 1 presents the strategy concerning the refrigerants.

The substitutes for refrigerant R-22 could be R-134a, R-290, R-1270 and R-744, the HFC blends (R-407C, R-410A, R-417A, FX 90) and the ammonia (R-717).

None of these substances can efficiently substitute R-22, presenting a specific cooling power or a different saturation pressure, restricted application and specially demands in the installation design.

In new installations, for certain applications, R-143a is a good substitute, having a reduced delivering compressor pressure and temperature, but also an inferior specific cooling power being necessary a greater cylinder of the compressor.

The HFC zeotropic blends are considered substitutes for a short period. Between the natural fluids, the ammonia is the best substitute for R-22, having favorable thermodynamic proprieties, high heat transfer coefficient (3…4 times superior to R-22) and a performance coefficient similarly good for many applications, especially industrial one, with great cooling powers. It is cheap and ecological (ODP=0, GWP=0).

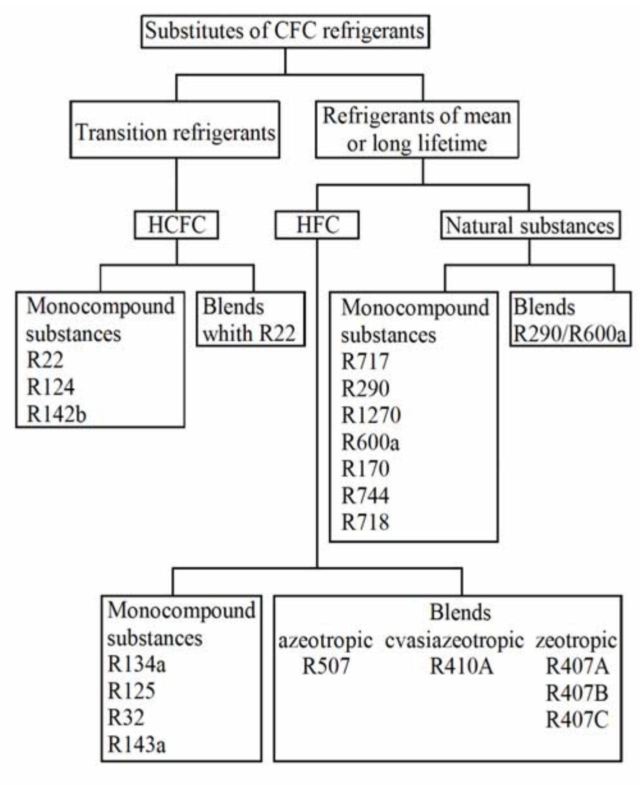

Fig. 1 Strategy concerning the refrigerants

Carbon dioxide (R-744) is a possible substitute for all refrigerants, being used even by low and high temperatures (cascade system, commercial cooling and air-conditioning). It is accessible, has a low cost and doesn't impact upon ozone, while his heating potential is negligible. His low critical temperature involves the use in supercritical cycles. The high saturation pressure and isotherm compression coefficient are considered as inconvenient.

Because thermodynamic and thermophysic proprieties influences the energetically performances of refrigerating systems and produces meantime the impact upon environment, they must be carefully analyzed and take in account by the installations conception and planning.

In table 3 are presented the principal thermodynamic proprieties of CO_2 and other natural refrigerants. These proprieties determine the advantages and also the disadvantages by using CO_2.

Table 2. Thermodynamic proprieties of principal natural refrigerants

Propertye	Carbon dioxide R-744	Ammnonia R-717	Water R-718	Propane R-290	Isobutane R-600a
0	1	2	3	4	5
Molecular mass [g/mol]	44	17	18	44.1	58.1
Critical temperature [°C]	30.98	132.4	374	96.8	135
Critical pressure [bar]	73.75	113.5	221	44.1	36.5
Normal boiling point [°C]	-37	-33.5	100	-42.2	-11.7
Freezing point [°C]	-56.57	-77.9	0	-187.1	-159.6
Adiabatic compression index (c_p/c_v)	1.7015	1.400	-	1.140	1.110
Compression ratio (-15/35 °C)	3.147	5.72	-	4.21	-
Refrigeration volumetric capacity [kJ/m^3] (-15/35 °C)	4922	2156.4	-	450	130

CONCLUSIONS

Scientific research based on mono-compound substances or mixtures, will lead to find adequate substitutes for cooling applications, that will be ecological (ODP = 0, reduced GWP), nonflammable and nonpoisonous, but also with favorable thermo-dynamic proprieties.

A possible solution is the use of inorganic refrigerants (NH_3, CO_2) and hydrocarbon refrigerants (propane, isobutene, ethylene, propylene) for industrial applications, in air-conditioning or food and household cooling. Because the hydrocarbon refrigerant presents a high risk of flammability and explosion, these substances will not be often used as refrigerants comparative with CO_2 or NH_3. On other advantage of these two substances represents the fact that they were used for a long time as refrigerants.

The European Partnership for Energy and Environment considers the HFC refrigerants as the best alternative for the refrigerant CFC and HCFC in most of the applications. The HFC refrigerants allow the use energetically efficient applications, offering significant benefits comparing with the existent alternatives. In average over 80% of the gases with green house effect used in cooling equipments have the indirect emissions as sources. The high energy efficiency resulted by the use of HFC refrigerants balances in a great measure the global warming potential.

There are cases with more options for an alternative refrigerant and the problem is to choose the economical variant. The replacement of some refrigerants with other nonpolluting influences the operating conditions of the cooling installations, by a rapid degradation of components made from elastomers [2] or plastic materials [3], or it is necessary to replace mineral oils with some other oils adequate to the new refrigerants. Some problems of materials endurance and compatibility can be solved only during many testing, but the estimation of energetically performances and expenses that results by modification of operational characteristics when replacing the refrigerant can be solved with numerical modeling.

It is imposed a new conception in execution the refrigerating systems: it must be realized very tight, with refrigerants having a reduced atmospheric warming potential, but as possible efficient energetically.

REFERENCES

[1] Al Jeran, H.O. Khan, A.R. Intensity of ultra-violet as an indicator of ozone layer thickness in troposphere at gulf cooperation council, *WSEAS Transactions on Environment and Development*, no.1, vol. 5, 2009, pp. 34-43.

[2] ASHRAE, *Fundamentals Handbook*, American Society of Heating, Refrigerating and Air Conditioning Engineers, Atlanta, 2009.

[3] Berglöf, K. Methods and potential for on-site performance validation of air-conditioning, refrigeration and heat pump systems, *IEA Conference*, Las Vegas, 2005.

[4] Cavallini, A. and Steinle, F. Natural working fluids in a historic perspective, *Fluides actifs naturels*, *Conference de l'IIF*, Gustav Lorentzen, Oslo, 1998, pp. 37-42.

[5] Cavestri, R.C. Compatibility of refrigerants and lubricants with engineering plastics, *Air-Conditioning and Refrigeration Technology Institute Report*, Arlington, 1993.

[6] Chicco, G. Mancarella, P. Models and indicators for energy and CO_2 emission assessment of electric chillers and direct-fired absorption chillers, *Proceedings of 5th WSEAS Int. Conference on Environment, Ecosystems and Development*, Tenerife, Spain, December 14-16, 2007, pp. 163-168.

[7] Dragos, G. V. Dragos, R. Use of CO_2 in non-polluting refrigerating systems, *Proceedings of the 28th Conference "Modern Science and Energy"*, Cluj-Napoca, 2009, pp. 149-157.

[12] Hera, D. Ivan, G. Pîrvan, A. Use of azeotropic and zeotropic blends as substitutes of the R22, *Proceedings of the 20th Conference "Modern Science and Energy"*, Cluj Napoca, 2001, pp. 120-126.

[9] Iyer, G.V. Mastorakis, N.E. Experimental investigations on eco-friendly refrigeration and air-conditioning systems, *Proceeedings of the 4th WSEAS Int. Conference on Fluid Machanics and Aerodynamics*, Elounda, Greece, August 21-23, 2006, pp. 445-450.

[10] Ricardo, R.Q. Analysis of the behavior of ternary hydrocarbon mixture as substitutes of the CFC-12, *Proceedings of the 2th IASME/ WSEAS Int. Conference on Energy & Environment*, Portoroz, Slovenia, May 15-17, 2007, pp. 91-94.

[11] * * * http://www.arap.org/

[12] * * * *Proprietes thermodinamiques des fluides frigorigenes*, Dehon Service, 1977.

[13] * * * UNEP, *Handbook for the international treaties for the protection of the ozone layer*, United Nations Environment Programme, Nairobi, Kenya, 2003.

[14] * * * U.N. *Report of the refrigeration, air conditioning, and heat pumps technical options committee*, United Nations Environment Programme, Nairobi, Kenya, 1994.

[15] * * * MMGA, *Update of Country Programme for the Phaseout of Ozone Depleting Sub-stances in Romania*, Bucharest, 2004.

ECOLOGISATION OF SOCIAL DEVELOPMENT AND QUALITY

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ABSTRACT

Environmental policy as part of economic policy must become an integral part of all decision making processes in society. The issues of protection of environment is one of the fundamental problems of society. Like other counties, the Slovak Republic (SR) failed to avoid improper environmental development. The main cause of unfavorable condition in existing situation include the previous extensive preceding development, which prevailed in an effort to achieve economic results, regardless of the accompanying phenomena. The economy was not in accordance with the ecology. The aim of this article is to show on connection problems of quality of life and the environment in our conditions. We use the results of own analysis rely on the evaluation values of selected indicators, which support our efforts.

Keywords: the quality of life, the environment, indicators of quality of life, environmental

INTRODUCTION

Currently, the concept of quality of life associated with several possible approaches. This is an area where there are studies from various disciplines such as economics, environmental science, medicine, sociology, psychology, political science and demography. This multidisciplinary interest has result in problems of complexity and diversity of views on the quality of life, which enriches all concerned departments, but also causes various problems. The notion of quality of life is not very consistent, which lacks consensus about its meaning. [1] [2]

The quality of the environment means the quality of life. Increasing the quality requires the greening of social development, knowledge of all sections of society, legal and economic instruments, planning processes, but mainly industrial and other economic sectors, as well as the local economy. The priority at the corporate level remains the elimination of air and water pollution, as well as resolving problems of waste management and environmental risks. Increasingly it is required to apply environmental evaluation and assessment of environmental impact. [3]

The main influence here has the economic reproduction process, which is affected by poor quality of the environment (production and consumption). The industry and energy in the industrialization intensify their production regardless of the environment, giving rise to negative consequences in terms of economic phenomena - externalities. In this work we give our opinion the three most important indicators that affect the quality of life in today's society.

1. INDICATOR HDI

Human Development Report is published annually since 1990 by the UN Development Programme (UNDP). Main objective of this field study is the evaluation of quality of life in different countries according to the Human Development Index (HDI), which includes in addition to the economic social indicators (eg life expectancy, access to education, equal opportunities, pup mortality, access to drinking water, health care). Lead author for the year 2010 Jeni Klugman. Overall, the report states that human development is different from economic growth. 20th publishing of Report introduces three new indicators, and by all study documents the development of indicators abysmal inequality between countries and within the deep differences between men and women, as well as expansion of extreme, multidimensional poverty in South Asia and Sub-Saharan Africa. New indicators will focus on developing important factors that are not directly reflected in the HDI:

- *HUMAN DEVELOPMENT INDEX was adjusted about the disparity* - regulates progress of HDI to reflect differences in income, health and education.
- *GENDER INEQUALITY INDEX was adjusted about the additional parameters* - GII calculates the loss of national HDI for gender inequality, which includes maternal mortality rates and women's representation in parliaments, the most favorable GII value reached Netherlands, least favorable GII value reached Yemen.
- *MULTIDIMENSIONAL POVERTY INDEX has been modified by additional parameters* - MPI includes new multi-dimensional measuring poverty, poverty assessment to supplement the income using by a number of factors at the household level, the basic living standards, to access to education, clean water and health care. [4]

An overview of human development index values of selected countries is in Tab. 1.

Country	Rank	2008	2009	2010	2011
Norway	1.	0,937	0,937	0,938	0,943
Australia	2.	0,933	0,935	0,937	0,929
USA	4.	0,900	0,899	0,902	0,910
Czech Republic	27.	0,844	0,841	0,841	0,865
Slovakia	35.	0,816	0,815	0,818	0,834
Hungary	36.	0,804	0,803	0,805	0,816
Poland	39.	0,788	0,791	0,795	0,813
Serbia	59.	0,760	0,761	0,764	0,766
World	xxx	0,674	0,676	0,679	0,682

Tab.1 Ranking of selected countries by value of HDI (ranking 2011)
Source: http://hdr.undp.org/en/data/build/

As from Tab. 1 we can see, the Slovak republic is on 35th place in HDI ranking, but we check the rising trend of the values during last three yearspričom hodnoty HDI v posledných troch rokoch rastú, pričom v poslednom roku je badateľný výraznejší rast.

2. INDICATOR EPI

About the environment Environmental Performance Index (EPI) is also published - a proportion of 149 countries on 25 indicators tracked across six established policies in the following categories: health effects, air pollution, water resources, biodiversity and habitat, productive natural resources and climate change . EPI identifies broadly accepted targets for environmental protection and measures how close each country there is to this end. As a quantitative measuring instruments for pollution control and natural resource management provides results provides a powerful tool to improve policy and decision-making movement in the environment on firmer ground. [5] According to this index, Slovakia is located at 17th place - score 85, in the context of the 149 countries but in 2010 Slovakia was in 13th place - score 74.5, in the context of the 163 countries (online http://epi.yale.edu/Countries).

It follows that the largest decrease was recorded in Poland, largest increase was in Czech Republic and Slovakia. The comparison is shown in Fig. 1

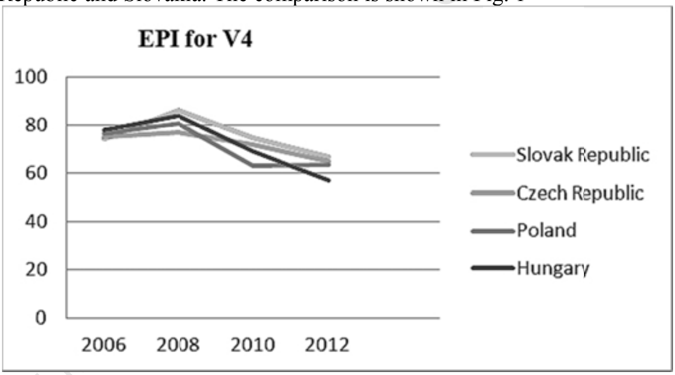

Fig. 1: Comparison of EPI in V4 countries

3. UNEMPLOYMENT

In this part of the article we give an analysis of development of the natural rate of unemployment in Slovakia for all ages together. The analysis is based on the theory of time series, where the goal was ultimately to estimate the natural rate of unemployment in 2012. Based on the processed data, we calculated the linear model describing the evolution of the average unemployment rate in Slovakia.

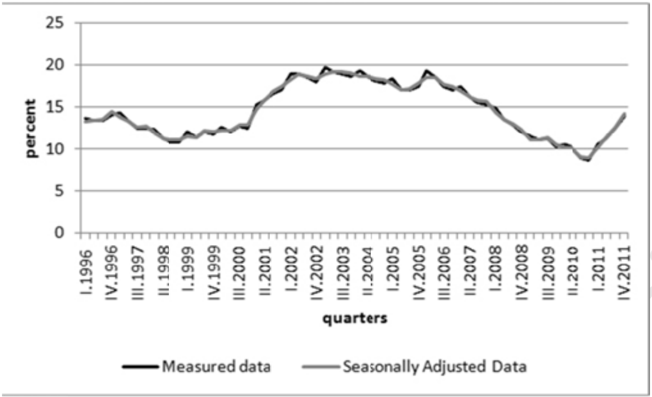

Fig. 2: Evolution of measured and adjusted unemployment rates

Linear Regression Model is calculated as: y= b0+b1.t = 14,86729-0,01037.t,where value t can be changed in any way, but subject to the same stepped changes.

In the following we will show the value of the natural rate of unemployment compared with the trend. Data for each year are seasonally adjusted.

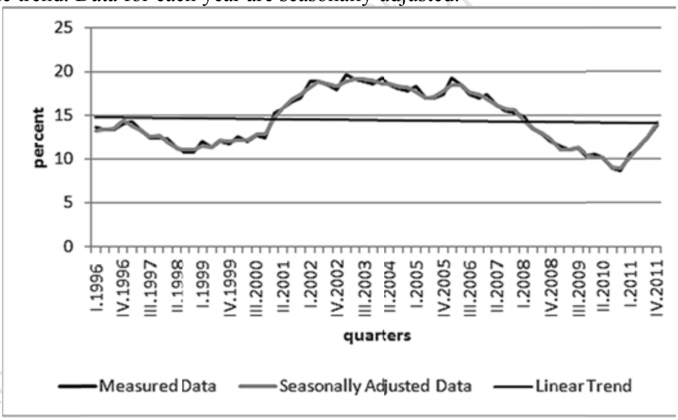

Fig. 3: The natural rate of unemployment compared with the trend

All data, whether measured or adjusted, are around the trendline. As for unemployment, influenced by many factors, it should be noted that the linear trend is inaccurate, recording long periods of time for which it is impossible to determine the changing conditions. For this reason, we have analyzed this problem in terms of micro-trends. From the measured data we have compiled a linear regression equation by which we determine micro-trends.

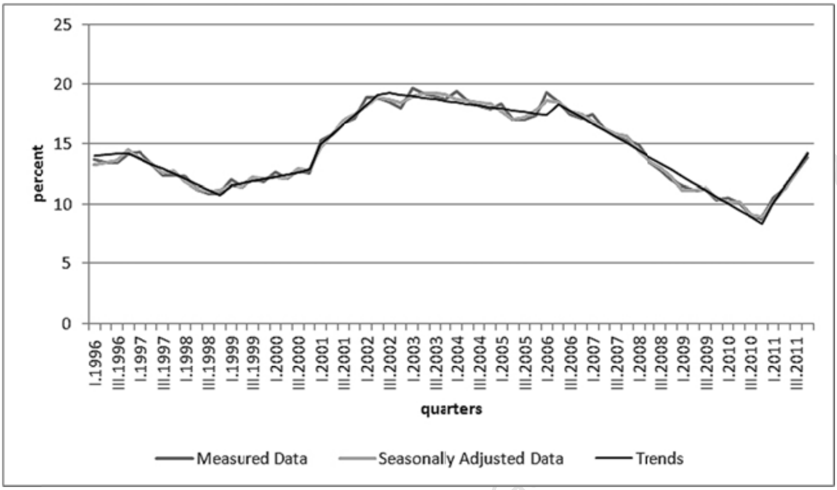

Fig. 4 Micro-trends

To estimate the future value of the natural rate of unemployment based on Statistical Office data, we arrive at the value the development of this phenomenon, Table 2.

t	Trend
I/2012	14,193248
II/2012	14,1828781
III/2012	14,1725081
IV/2012	14,1621382

Tab. 2 Forecast

Unemployment will be a phenomenon that affects the functioning of the state, its position in the world and to a large extent and quality of life for its citizens.

CONCLUSION

The paper deals with an indicator of quality of life that affect economic growth in contemporary society. Themes related to increasing the quality of life are mostly put the word "have" in various forms, reflecting ownership. HDI indicator, EPI, lack of jobs as well as the principles of sustainable development and improvement activities on the environment is one of the priorities of each government. Therefore, care about the environment is an integral part of all levels of management, both at the state level, both at local level and at enterprise level. It must become an integral part of all decision-making processes in society.

REFERENCES

[1.] ADÁMEK, P., NĚMEC, O.: Kvalita života a realizace principu rovných příležitostí na trhu práce. In: *Acta Oeconomica Pragensia - Kvalita pracovního života, rovné zacházení a řízení lidí XII, č. 8, s. 8-22*. Praha: VŠE, 2005. ISSN 0572-3043.

[2.] EURÓPSKA KOMISIA: Standard Eurobarometer 72/Autumn 2009 - TNS Opinion & Social. Dostupné na <http://ec.europa.eu/public_opinion /archives/eb/eb72/eb72_first_en.pdf>

[3.] GARVIN, D.A.: *Managing Quality: The Strategic and Competitive Edge.* New York: Free Press, 1988. ISBN 0-02-911380-6.

[4.] IRA, V.: Územná diferenciácia bytov v SR ako jednej z dimenzií kvality života. In: *České a slovenské regiony na počátku třetího milénia,* s. 20-26. Brno: Ústav geoniky AV ČR, 2003.

[5.] WATSON, D. - PICHLER, F. - WALLACE, C.: Second European Quality of Life Survey, Subjective well-being in Europe. Luxembourg: Office for Official Publications of the European Communities, 2010. ISBN 978-92-897-0862-3.

TABLES AND FIGURES

ELIMINATION OF THERMAL BRIDGES FROM THE RECONSTRUCTION OF HISTORIC BUILDINGS

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ABSTRACT

Recently, more and more often total reconstructions of historical buildings that have not been administered for years by anyone, have taken place. Their stage neither meets the current user standards, nor the technical ones. Historical buildings generally have no, or only have a passive protection of structures against the ingress of moisture in contact with soil. Materials embedded in structures of these buildings are often saturated with moisture. The acting humidity can be effectively removed, using ventilated air cavities. These are commonly used in connection with remedial treatments of damp masonry, especially in historic buildings. This article deals with the simple cases of elimination of thermal bridges in the realization of the most commonly used ventilated air cavities.

Keywords: Historic buildings, Ventilated air cavities, Thermal bridges, Airflow, Thermal protection

INTRODUCTION

A basic requirement with rising damp is the installation of a retrofitted horizontal damp proofing course with the essential accompanying treatments. Only once the cause of the moisture penetration into the masonry wall has been eliminated, the masonry will dry out. This reduction results from the evaporation of the moisture in the masonry, whereas the speed of evaporation depends on the thickness of the masonry, the degree of salinization and moisture penetration, on the climatic conditions around the facility and the airflow around the wall, as well as the make-up of the wall surface [1].

Air drains offer some potential to control damp by encouraging evaporation to occur at the lowest possible level. The evaporative zone can be lowered by excavating a trench against the building and exposing the bottom parts of the walls. The advantages of this measure include protecting valuable internal plasters or murals, and reducing underfloor moisture levels. This in turn reduces the risk to timbers from fungal rot, borer and termite attack [2].

Concepts of remedial treatments of historic buildings using ventilated cavities, with a few exceptions, are with considerable popularity preferred by the representatives of monument protection. The fact that they require small interventions in the masonry is of great benefit for compliance with the methodology of cultural heritage protection, as is the fact that such interventions do not compromise the structural analysis of buildings. These concepts have gained great popularity also because they can be considered kind of a "return" to historical example.

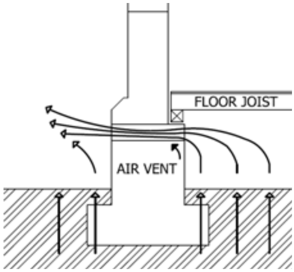

Figure 1: Well-ventilated underfloor space allows soil moisture to evaporate to the open air [2]

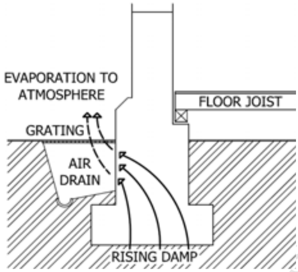

Figure 2: Air drains covered with a metal grating that allows good ventilation – a possible control measure [2]

This article shows the simplest possible solutions of problems with thermal bridges at historic buildings, which arise in realization of the most frequently used methods of removing moisture using the air flow (Figure 1, 2). In this article, ventilated air cavities shown in Figure 5 and Figure 13 will be analyzed.

BACKGROUND

When renovating a historic building using the ventilated air cavity, the main task is to remove the moisture utilizing the air flow. It is assumed that the cavity is properly designed and conducts away the moisture. An undesirable aspect in the realization of the implementation of ventilated cavities aspirated in exterior arises is that it adversely affects the surface temperatures inside the building. Therefore, the final task will be to eliminate this adverse effect.

The overall issues are how to apply energy efficient techniques without damaging buildings historical value, and whether sustainable design aspects or historic preservation aspects should be superior when it comes to making a design decision (otherwise if there is or should there be a hierarchy at all) [3].

Since comparing a historical building with a new one would be inadequate, the objective cannot be the achievement of the standardized value of critical surface temperature specified in the STN 73 0540-2 [4]. The task then will be to achieve at least the surface temperature similar to the surface temperatures at the original construction – the "minimum requirements".

At first, the initial state will be evaluated in order to determine the "minimum requirements" for construction. The second step then will be monitoring of the surface temperature decrease after the implementation of the air cavity. The ultimate goal is to eliminate the occurrence of thermal bridges whereby the simplest remedial solutions to achieve at least the "minimum requirements" will be explored.

As a model, a cross-section of a historical building is used where the exterior walls are made of full bricks. The wall thickness is 500 mm including plastering. A concrete floor is 100 mm thick. The underlying concrete under the floor is 150 mm thick. The foundations of the building consist of concrete 800 mm high and 700 mm wide. Depths of foundations vary, from which two different methods of realization of the ventilated air cavities will unfold (Figure 5, Figure 13).

In calculations, boundary conditions were applied according to the standard STN 73 0540-3 [5] ass follows: External temperature of air θ_e = –15 °C, relative humidity of external air φ_e = 84 %, internal temperature of air θ_i = 20 °C, relative humidity of internal air φ_i = 50 %, temperature of soil (deep of 3 m) θ_{gr} = 5 °C. STN EN ISO 10211 [6] and computational program AREA [7] for evaluation of all alternatives is used.

EXAMPLE NO 1

Initial state

In Figure 4 there is a progress of temperature fields in the initial construction of a partially cellared historical building. The temperature in the lower horizontal corner reaches 10.86 °C – the "minimum requirement".

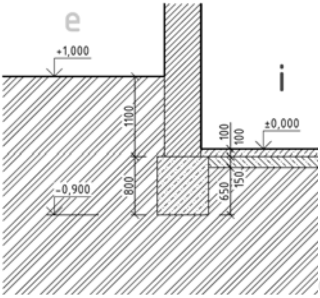

Figure 3: Scheme of initial construction of Example No 1

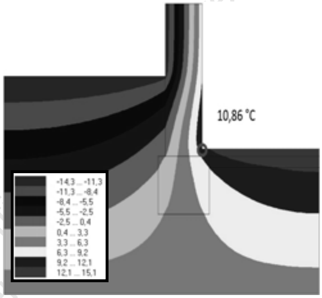

Figure 4: Progress of temperature fields of initial construction of Example No 1

Solution of Example No 1

Within such (Figure 3) and similarly cellared historical buildings it is apt, in order to remove the moisture by utilizing the airflow, to realize cavities made at the outer side of the exterior walls below the ground level (Figure 5).

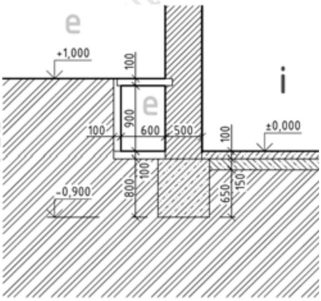

Figure 5: Scheme of Example No 1

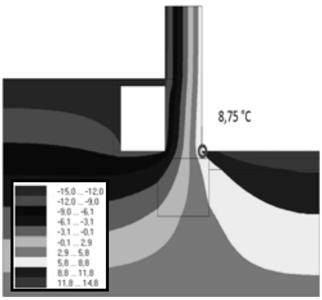

Figure 6: Progress of temperature fields of Example No 1

The air cavities around the outer walls below the ground level can be designed either as a closed system, as it is in this case (Figure 5), or as an open system (English yards –

Figure 2). In the closed systems, a prerequisite for ensuring the functionality of the system (moisture removal), is the correct design of the inhalation and exhalation openings. We assume that in the considered example, the extraction of moisture is secured by a system of ventilation openings with the inhalation and exhalation in the exterior and that it works correctly.

Thus realized ventilated air cavity adversely affects the internal surface temperature in the horizontal lower corner. External cold air entering the channel cools the surrounding structures (walls, floors) and the internal surface temperature decreases by a few degrees. Figure 6 shows that the surface temperature decreased from the original 10.86 °C to 8.75 °C. The change of temperature fields in the foundations of the building is also worth mentioning. While in the original construction, the front part of the foundation subsoil keeps being within the range of approximately 3 °C, after the implementation of Example No 1 it is in the area just above 0 °C – a threat of freeze.

In general, the role of the constructor in these and similar cases is, besides proper functioning of the system, to ensure the desired internal surface temperatures and also, to ensure temperatures above zero in the foundations. Utilizing a very simple solution, this is aimed at in the Example No 1a below.

Example No 1a

Since this is a historical building, any interference with the surface treatment is usually inadmissible [3]. As the simplest and often also the only acceptable solution for temperature increase on the inner surface, thermal insulation inserted into the bottom of the cavity will be used. In this case, the insulation is 100 mm thick (Figure 7). Such a simple solution partially eliminates the influence of thermal bridge on the inner surface of the horizontal lower corner and also the freezing of the foundations subsoil.

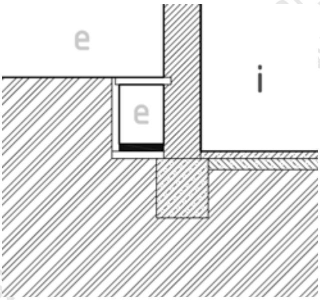

Figure 7: Scheme of Example No 1a

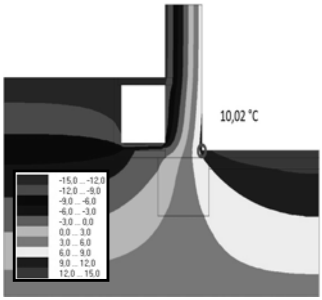

Figure 8: Progress of temperature fields of Example No 1a

The progress of temperature fields (Figure 8) shows that there was an increase in temperatures in the horizontal lower corner and the foundation subsoil. The internal surface temperature in the lower corner reached 10.02 °C. This number is nearly identical to the number found in the original construction and thus we achieved a status similar to the original construction conditions.

To achieve the "minimum requirement" = 10.86 °C in the horizontal lower corner, it is necessary to increase the thickness of the insulation, which in the end would prove ultimately ineffective and counterproductive. The fact is clearly depicted in Figure 9.

This required "minimal" temperature during the linear course will be reached at the thickness of the insulation 250 mm, which corresponds to the temperature of 10.81 °C ≈ 10.86 °C. The given solution is expensive and fundamentally wrong. The insulation in the cavity will cover nearly 1/3 of height of the cavity, which will restrict the air flow and thus the required evaporation of moisture from the masonry as well.

The simplest and most effective solution appears to be the thick insulation of 100 mm (Figure 7). At such thickness, satisfactory numbers of internal surface temperatures will be achieved and the evaporating surface will not be substantially limited. Adopting such a solution, temperature in the foundations will be achieved as similar to the temperature in the foundations in the original state.

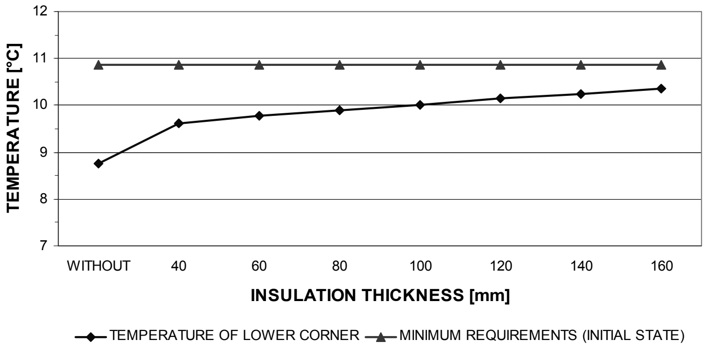

Figure 9: Temperatures of lower corner for different insulation thickness

EXAMPLE NO 2

Initial state

With historical buildings where the level of ground floor finds itself on the embankment (Figure 10), it is suitable, in order to remove moisture, to build a ventilated underfloor cavity (Figure 13). Maintaining the underfloor ventilation is an important feature of moisture control, as it allows moisture evaporation from the soil under the floor and its transfer out through the holes in the lower part of the wall. Without this ventilation, the moisture load on the wall would be much higher.

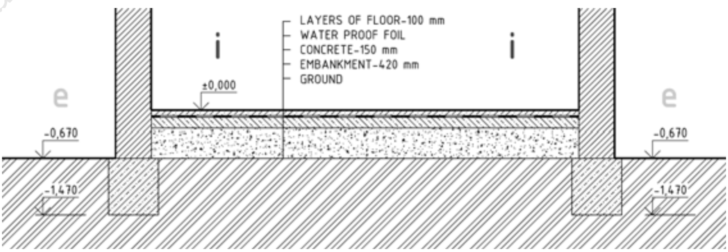

Figure 10: Scheme of initial construction of Example No 2

Figure 12 illustrates the temperature fields in the initial construction of a historical building found on the embankment. The temperature in the horizontal lower corner reaches 6.71 °C – the "minimum requirement".

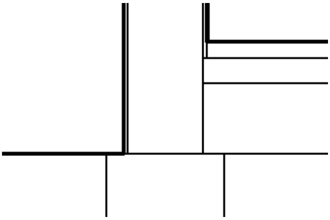

Figure 11: Scheme of initial construction of Example No 2 – detail

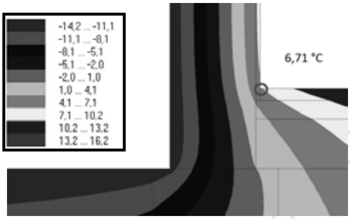

Figure 12: Progress of temperature fields of initial construction of Example No 2 – detail

Solution of Example No 2

Ceiling of the air cavity may be made out of the reinforced concrete ceiling planks, wooden beams and slabs, profiled steel sheets etc., whereby the manner of the ceiling process must respect possible historical spirit of the building.

Figure 13 shows the horizontal air cavity created by ceiling planks. The ventilated air gap is of 300 mm height and it is insulated by a 150 mm thick thermal insulation placed in the floor. The air circulation is secured by the system of the inhalation and exhalation openings placed on two sides of the building. Techniques to evaluation a naturally ventilated underfloor cavity have been used in other studies [8].

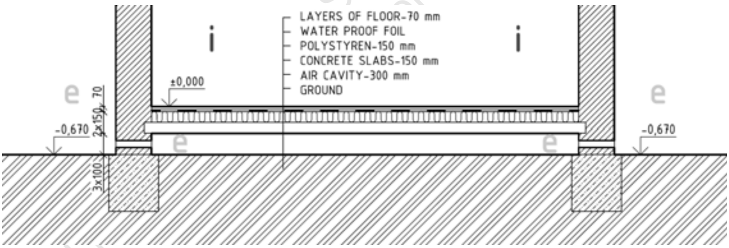

Figure 13: Scheme of Example No 2

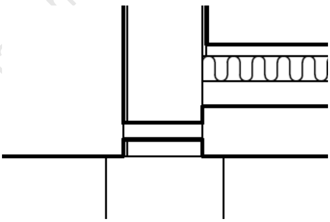

Figure 14: Scheme of Example No 2 – detail

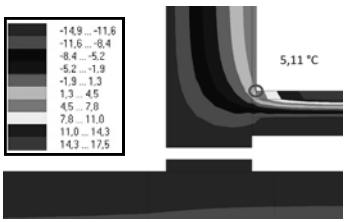

Figure 15: Progress of temperature fields of Example No 2 – detail

The result of calculation is shown in Figure 15. The Figure shows a 2D temperature field for a typical cross-section. The incoming cold air affects the surrounding structures (walls, ceilings) and their internal temperature drops by a few degrees. The temperature in horizontal corner reached 5.11 °C, a temperature of 1.6 °C lower than the numbers reached on the original construction.

Achieving the increase of the surface temperature in the horizontal corner will be realized by the remedial alternative with internal thermal insulation plaster – Example No 2a.

Example No 2a

In Example No 2 in Figure 16 there is an initial interior lime-cement plaster 25 mm thick, replaced by a new plastering having the improved thermal insulation features. By implementation of such a solution, the considered temperature reaches 9.88 °C (Figure 17). All the above-mentioned is based on the assumption that the respective Monuments Board authorizes such invasion in the structure of the building. Detailed methods to replace the initial plasters have been described in other studies [9].

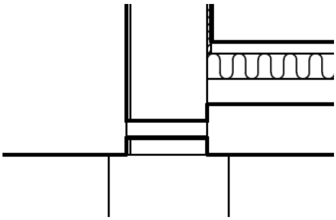

Figure 16: Scheme of Example No 2a – detail

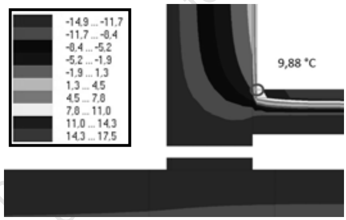

Figure 17: Progress of temperature fields of Example No 2a – detail

The calculated value of 9.88 °C includes space for reserve and meets the "minimum requirement" = 6.71 °C. Further increasing of the internal thermal insulation plaster thickness would be of no use. Dependence of the gradual increase in the considered internal temperature in relation with the thickness of the thermal insulation plaster is documented in Figure 18.

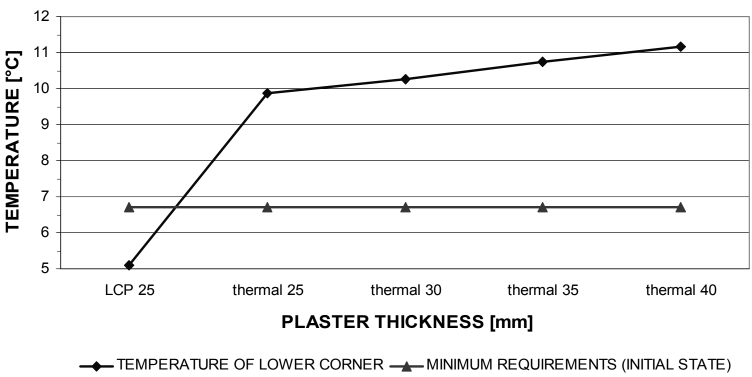

Figure 18: Temperatures of lower corner for different plaster thickness

CONCLUSION

Reconstructions of historic buildings require a comprehensive approach to design solutions and are financially very expensive. They include measures of renewal of waterproofing layers, or the realization of measures which shall prevent the entry of water into the building.

Remediation must respect the original architectural and layout design as well as the traditional solution of structures. Its priority is the selection of those remedial treatments, which, if not stop the spread of moisture, at least eliminate it. In all of that there is the emphasis on the methodology of preservation of historical monuments and constructional possibilities of historic buildings. Rationale for a particular choice must reflect the architectural-layout and the structural-technological solutions, technical condition of structures and future user mode of historic buildings.

While assessing the appropriateness and effectiveness of reconstruction of historic buildings, we must take into account that with conventional structures and materials the criteria according to standards of surface temperature and energy consumption cannot be generally reached. Therefore, reconstruction or rehabilitation of historic buildings we have to evaluate separately the failure to meet the criteria for assessing the buildings requirements. Comparing the state of a historical building after the rehabilitation with a "new" building, according to the criteria STN 73 0540-2 [4] as well as the evaluation of annual energy consumption according to the procedures STN EN ISO 13790/NA [10] would be inadequate.

ACKNOWLEDGEMENT

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REFERENCES

[1] Frössel F. Masonry Drying and Cellar Rehabilitation, Germany, 2007

[2] Young D. Salt attack and rising damp, A guide to salt damp in historic and older buildings, South Australian, 2008

[3] Polzer I. & Lang W. What can be changed when everything must stay the same? 10th REHVA World congress Clima, Turkey, 2010.

[4] STN 73 0540-2. Thermal performance of buildings and components. Thermal protection of buildings. Part 2: Functional requirements. Slovak Republic, 2002.

[5] STN 73 0540-3. Thermal performance of buildings and components. Thermal protection of buildings. Part 3: Properties of environments and building products. Slovak Republic, 2002.

[6] STN EN ISO 10211. Thermal bridges in building construction. Heat flows and surface temperatures. Detailed calculations. 2008.

[7] Svoboda Z. AREA 2002. Svoboda software 2002. Czech Republic, 2002.

[8] Kalousek M. & Šikula O. CFD simulation of ventilated air cavity. Building Simulation and Environmental Engineering 2008, 5. conference, Czech Republic, 2008.

[9] Fiala L. & Pavlíková M. & Pavlík Z. & Keppert M. & Pernicová R. & Mihulka J. & Benešová H. & Černý R. Chloride accumulation and transport in renovation plasters. Energodom, Proceedings of the 1st Central European Symposium on Building Physics, Poland, 2010.

[10] STN EN ISO 13790/NA. Energy performance of buildings. Calculation of energy use for space heating and cooling. 2010.

ENHANCEMENT OF SORBENT EFFICIENCY BY SONICATION

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ABSTRACT

The influence of ultrasound irradiation on adsorption properties of montmorillonite, from the Slovak deposit was studied. Cadmium, as a heavy metal ion, was selected for the adsorption experiments. The adsorption experiments were performed by a batch method using an ultrasound device and a rotary shaker. The montmorillonite adsorption properties were tested under different conditions such as pH of the solution, contact time, initial metal ions concentration and temperature. It was observed, that the sonication markedly influenced the adsorption capacity of the montmorillonite, its value increased approximately at 40 % in comparison with a conventional method. The adsorption process was exothermic and of spontaneous nature. No evident effect of temperature on its adsorption capacity was proved.

Keywords: montmorillonite, adsorption, ultrasound, cadmium

INTRODUCTION

Ultrasound is the wave at the frequency above 16 kHz. When ultrasound is irradiated through a liquid, an alternating adiabatic compression and rarefaction cycle of the medium occur. Several researchers studied the role of ultrasound in the adsorption and desorption processes [1-12]. The work [13] showed that the intensity of ultrasound as well as sorbate/sorbent concentration ratio were two important factors for removal of Cd(II) by adsorption process. Simultaneous removal of Cd(II) and Pb(II) ions from binary aqueous solutions in the presence of ultrasound were o studied in [14]. Discarded tire rubber was used as a cheap adsorbent for the removal of cadmium. The maximum metal adsorption capacity was found to be greater in the presence than in the absence of ultrasound [15]. Hamdaoui also showed that the amount of cadmium adsorption increased in the presence of ultrasound, where acoustic power was an important parameter for the enhancement of the adsorption. The combination of stirring and ultrasound led to an intensification of the process [16].

The work studies the possibility to enhance the adsorption properties of locally available clay by ultrasound irradiation. The influence of pH, contact time, initial metal ion concentration and temperature on the adsorption of Cd(II) was studied and compared with the results obtained from adsorption in a rotary shaker.

MATERIALS AND METHODS

Sorbent and adsorptive

Calcium – magnesium montmorillonite with crystalochemical formula: $[Si_{7.95}\ Al_{0.05}]$ $[Al_{3.03}\ Fe_{0.22}\ Mg_{0.75}]\ O_{20}\ (OH)_4\ (Ca_{0.42}Mg_{0.04}Na_{0.01}K_{0.01})$, originated from the Slovak deposit Jelšový potok [17] was used as a sorbent.

Analytical grade metal salt ($Cd(NO_3)_2 .\ 4H_2O$) was used without further purification. Stock solutions (1000 mg L^{-1} and 100 mg L^{-1}) of Cd(II) were prepared by dissolving the appropriate amounts of nitrate in de-ionized water. The stock solutions were diluted to obtain standard solutions containing 10 – 600 mg Cd(II) L^{-1}.

Adsorption procedures

Batch adsorption measurements were made at room temperature using the ultrasonic device and rotary shaker. The ultrasonic irradiation was carried out by the commercial device Kraintek K10E (Slovakia), operating at 40 kHz, equipped with a temperature regulator. A circulating bath was used to maintain a constant temperature during the ultrasound irradiation. Conventional experiments were performed in the rotary shaker with operating speed 30 rpm (conventional method). All experiments were carried out at pH 5 (except when the effect of pH was studied). The suspensions were sonicated or shaken for a given time period to reach equilibrium. The operating frequency and the rotation speed were kept constant. Supernatant solutions were analysed by the atomic absorption spectroscopy (AAS, Varian 240 RS/2400). The linearized Langmuir model was used for the analyses of the adsorption isotherms. Through the study, the contact time was varied from 5 to 80 minutes, pH from 2 to 9, initial Cd(II) concentration from 10 to 600 mg L^{-1}. The amount of sorbent mass was 1 g L^{-1}. Influence of the temperature on the adsorption was studied only under the sonication at 25, 50 and 70 °C.

RESULTS AND DISCUSSION

Effect of pH

The Cd(II) adsorption had similar behaviour during the ultrasonic assisted experiment as the adsorption in the rotary shaker, Fig. 1. The metal ion uptake did not markedly change in the pH range from 3 to 7, higher adsorbed amount was observed for the adsorption under the sonication. In the solutions with pH 8 and 9, the adsorption capacity of the montmorillonite increased, due to the precipitation of $Cd(OH)_2$ [18-20]. It followed from this experiment that the optimal pH for the next adsorption experiments is equal 5.

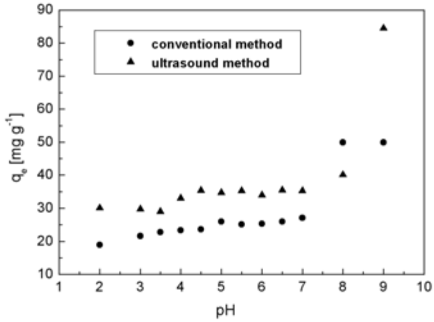

Fig. 1 Effect of pH on Cd(II) removal by montmorillonite using the conventional and ultrasound assisted method.

Effect of contact time and adsorption kinetics

The values of adsorbed Cd(II) amounts in selected times intervals fluctuated during the first minutes of the adsorption (not shown here). The equilibrium of the metal ion uptake was achieved after the 40 minutes for both methods. Short time necessary to reach the equilibrium indicated that the adsorption sites of the montmorillonite are well exposed. The Cd(II) removal was almost 40 % in the presence of ultrasound and 30 % in the absence of ultrasound.

The adsorption data were analyzed in terms of pseudo-second-order kinetic model, Fig. 2. The calculated q_e (amount of adsorbed metal ions at equilibrium) values agreed with the experimental values obtained from the sorption experiments, Table 1.

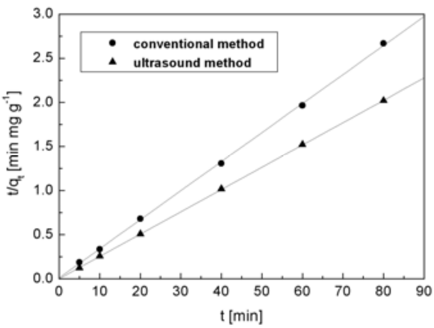

Fig. 2 Pseudo-second-order kinetic plots for the Cd(II) adsorption.

Table 1 Kinetic parameters of the pseudo-second-order kinetic model for the Cd(II) adsorption by montmorillonite

	k [g mg^{-1} min^{-1}]	q_e [mg g^{-1}] calculated	q_e [mg g^{-1}] experimental	R^2
Conventional	0.112	30.40	30.65	0.9996
Ultrasound	0.356	39.53	39.35	1

k - rate constant of the pseudo-second-order model for the adsorption process, q_e - amount of metals adsorbed at equilibrium, R^2 - coefficient of determination.

Effect of initial Cd(II) concentration and adsorption isotherms analyses

In initial stages of the adsorption the amount of the cadmium cations adsorbed at equilibrium increased rapidly with the increasing initial cations concentration, especially for the ultrasonic assisted adsorption, then slowly, until the saturation of the montmorillonite is reached, Fig. 3. The higher values of the equilibrium adsorption capacities were observed for adsorption under the ultrasound irradiation in the whole studied concentration range. The sorbent saturation was reached at the initial concentration 400 mg Cd(II) L^{-1} for both methods.

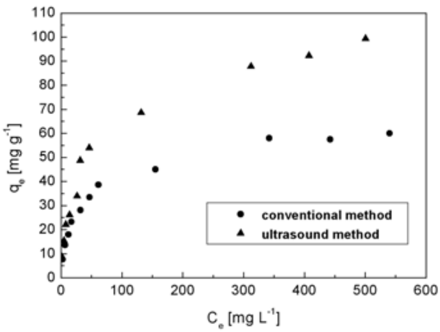

Fig. 3 Adsorption isotherms for the Cd(II) removal using the conventional and ultrasound assisted method.

Linearized Langmuir model was applied to process the adsorption data from the isotherms, Fig. 4.

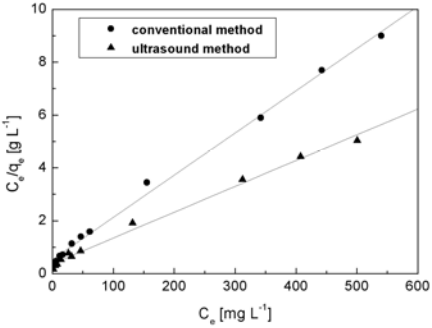

Fig. 4 Linearized Langmuir isotherms for the Cd(II) adsorption by montmorillonite using the conventional and ultrasound assisted method.

As it is shown in Table 2, the higher maximum adsorption capacity of montmorillonite was obtained in the presence of ultrasound irradiation. This indicates that under the sonication new sites of adsorption were appeared by disruption of sorbent particles.

Table 2 Langmuir constants for the Cd(II) adsorption by montmorillonite

	Q_o [mg g^{-1}]	b [L mg^{-1}]	R^2
Conventional	62.5	0.030	0.9963
Ultrasound	102.0	0.026	0.9927

Q_0 - Langmuir constant representing maximum adsorption capacity, b - Langmuir sorption equilibrium constant, R^2 - coefficient of determination.

Effect of temperature

There is no difference between the adsorption isotherms obtained at 25 and 50 °C, Fig. 5. The increase in the values of equilibrium adsorption capacities was observed only at 70 °C. Also, equal values (102 mg Cd(II) g^{-1}) of maximum adsorption capacities were calculated for the experiments carried out at 25 and 50 °C. For the adsorption process realized at 70 °C, maximum adsorption capacity 110 mg Cd(II) g^{-1} was calculated.

It can be stated that the amount of adsorbed Cd(II) was appreciably higher in the presence of ultrasound, hence the effect of the temperature was negligible. The sonication enhances the adsorption of the metal ions through the extreme conditions generated by cavitation bubbles. The non thermal effect is mostly produced by the microstreaming of the acoustic vortex, by the high-speed microjets and high-pressure shockwaves induced by acoustic cavitation.

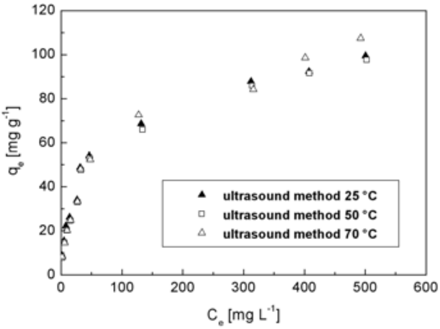

Fig.5 Adsorption isotherms for Cd(II) removal under the ultrasound assistance at different temperatures.

Thermodynamic parameters of adsorption

The value of Gibbs energy changes for the adsorption process at selected temperatures was calculated from the following equation:

$$\Delta G° = - RT \ln K, \quad (1)$$

R is gas constant, K equilibrium constant (its numerical value was calculated from the ratio of equilibrium concentrations of heavy metal cations on sorbent and in solute at temperature T).

The enthalpy ($\Delta H°$) and entropy changes ($\Delta S°$) of the adsorption were determined through the slope and intercept of the plot ln K vs. $1/T$ (Van´t Hoff equation).

The negative values of Gibbs energy indicated the spontaneous nature of the adsorption process, Table 3. Negative value of entropy suggested stable arrangement of adsorbed cadmium cations on the montmorillonite surface. The enthalpy showed the exothermic nature of the adsorption process [54-55].

Table 3 Thermodynamic parameters of Cd(II) adsorption by the montmorillonite under the sonication

T [K]	$\Delta G°$ [J mol^{-1}]	$\Delta H°$ [J mol^{-1}]	$\Delta S°$ [J mol^{-1}]
298	-381.3		
323	-303.4	-1279.7	-2.991
343	-250.4		

$\Delta G°$ - Gibbs energy changes, $\Delta H°$ - enthalpy changes, $\Delta S°$ - entropy changes

CONCLUSION

The possibility of using ultrasound irradiation in the adsorption process was studied. The results showed that the adsorption properties of natural montmorillonite could be enhanced by the sonication due to the cavitation process. The Cd(II) adsorption from the solution was fast and effective. The adsorption process provided in the ultrasound device was exothermic and of spontaneous nature. The obtained numerical value of the entropy indicated good stability of the adsorbed cadmium cations on the montmorillonite surface. No temperature effect on the adsorption properties of the montmorillonite was observed.

ACKNOWLEDGEMENT

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REFERENCES

[1] M. Breitbach & D. Bathen. Influence of ultrasound on adsorption processes, Ultrasonics Sonochemistry, Germany, vol. 8, pp. 277-283, 2001.

[2] M.H. Entezari & T.R. Bastami. Sono-sorption as a new method for the removal of lead ion from aqueous solution, Jornal of Hazardous Materials, Iran, vol. B137, pp. 959-964, 2006.

[3] M.H. Entezari & Z.S. Al-Hoseini. Sono-sorption as a new method for the removal of methylene blue from aqueous solution, Ultrasonics Sonochemistry, Iran, vol. 14, pp. 599-604, 2007.

[4] M.H. Entezari & T. Soltani. Simultaneous removal of copper and lead ions from a binary solution by sono-sorption process, Journal of Hazardous Materials, Iran, vol. 160, pp. 88-93, 2008.

[5] O. Hamdaoui & E. Naffrechoux. Adsorption kinetics of 4-chlorophenol onto granular activated carbon in the presence of high frequency ultrasound, Ultrasonics Sonochemistry, Algeria, France, vol. 16, pp.15–22, 2009.

[6] J. Laurent, M. Casellas & Ch. Dagot. Heavy metals uptake by sonicated activated sludge: Relation with floc surface properties, Journal of Hazardous Materials, France, vol. 162, pp. 652–660, 2009.

[7] D.D. Milenković, P.V. Dašić & V.B. Veljković. Ultrasound-assisted adsorption of copper(II) ions on hazelnut shell activated carbon, Ultrasonics Sonochemistry, Serbia, vol. 16, pp. 557–563, 2009.

[8] O. Hamdaoui, M. Chiha & E. Naffrechoux. Ultrasound-assisted removal of malachite green from aqueous solution by dead pine needles, Ultrasonics Sonochemistry, Algeria, France, vol. 15, pp. 799–807, 2008.

[9] M. Karimi, M.H. Entezari, & M. Chamsaz. Sorption studies of nitrate ion by a modified beet residue in the presence and absence of ultrasound, Ultrasonics Sonochemistry, Iran, vol. 17, pp.711–717, 2010.

[10] O. Korkut, E. Sayan, O. Lacin & B. Bayrak. Investigation of adsorption and ultrasound assisted desorption of lead (II) and copper (II) on local bentonite: A modelling study, Desalination, Turkey,vol. 259, pp. 243-248, 2010.

[11] G. Jing, Z. Zhou, L. Song & M. Dong. Ultrasound enhanced adsorption and desorption of chromium (VI) on activated carbon and polymeric resin, Desalination, China,vol. 279, pp. 423-427, 2011.

[12] O. Hamdaoui. Intensification of the sorption of Rhodamine B from aqueous phase by loquat seeds using ultrasound, Desalination, Algeria, vol. 271, pp. 279–286, 2011.

[13] M.H. Entezari & T.R. Bastami. Influence of ultrasound on cadmium ion removal by sorption process, Ultrasonics Sonochemistry, Iran, vol. 15, pp. 428-432, 2008.

[14] M.H. Entezari & T. Soltani. Cadmium and lead ions can be removed simultaneously from a binary aqueous solution by the sono-sorption method, Ultrasonics Sonochemistry, Iran, vol. 16, pp. 495-501, 2009.

[15] M.H. Entezari, N. Ghows & M. Chamsaz. Ultrasound facilitates and improves removal of Cd(II) from aqueous solution by the discarded tire rubber, Journal of Hazardous Materials, Iran, vol. B131, pp. 84–89, 2006.

[16] O. Hamdaoui. Removal of cadmium from aqueous medium under ultrasound assistance using olive leaves as sorbent, Chemical Engineering and Processing, Algeria, vol. 48, pp. 1157-1166, 2009.

[17] K. Jesenák, Ľ. Kuchta, L. Guller & J. Fúsková. Physico-chemical Properties of Bentonite "Stará Kremnička - Jelšový potok": I. Particle Size Distribution, Mineralia Slovaca, Slovak Republic, vol. 29, pp. 439-442, 1997.

[18] V. Arámbula-Villazana, M. Solache-Ríos & M.T. Olguín. Sorption of cadmium from aqueous solutions at different temperatures by mexican HEU-type zeolite rich tuff. Journal of Inclusion Phenomena and Macrocyclic Chemistry, Mexico, vol. 55, pp.229–236, 2006.

[19] Y.-n. Chen, D.-ch. Zhang, M.,Chen & Y.-ch. Ding. Biosorption properties of cadmium (II) and zinc(II) from aqueous solution by tea fungus, Desalination and Water Treatment, China, vol. 8, pp. 118-123, 2009.

[20] A. Özer & H.B. Pirinççi. The adsorption of Cd(II) ions on sulphuric acid-treated wheat bran, Journal of Hazardos Materials, Turkey, vol. B137, pp. 849–855, 2006.

[21] T. Shahwan & H.N. Erten. Thermodynamic parameters of Cs^+ sorption on natural clays, Journal of Radioanalytical and Nuclear Chemistry, Turkey, vol. 253, pp. 115-120, 2002.

[22] D. Xu, X.L. Tan, C.L. Chen & X.K. Wang. Adsorption of Pb(II) from aqueous solution to MX-80 bentonite: Effect of pH, ionic strength, foreign ions and temperature, Applied Clay Science, China, vol. 41, pp. 37-46, 2008.

SOLUTIONS FOR FISH MIGRATION UPSTREAM OF MUNTENI DAM LOCATED ON THE IAD RIVER, B.H. CRISUL REPEDE

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ABSTRACT

At present, the connectivity of watercourses is globally recognized as a fundamental property of the aquatic ecosystems, and the emphasis is on *hydrological connectivity* as it is, unquestionably, a defining feature of all riparian ecosystems.

In Romania, the need for lateral and longitudinal connectivity of watercourses and hence the issue regarding the fish migration have been established by implementation of the Water Framework Directive (WFD) 60/2000 into the national legislation represent an important hydromorphological quality element of the Projects for Management of River Basins.

This paper sugests two solutions to ensure the migration of aquatic fauna upstream Munteni overflow dam located on the Iad River, a left tributary stream of Crisul Repede River. The dam is part of a hydro-energetic development on the Crisul Repede river, situated between other two dams (downstream from Bulz Dam and upstream of Lesu Dam).

Located in the grayling area where there are three species of migratory fish: Danube gudgeon (*Gobio uranoscopus*), barbel (*Barbus Barbus*) and the common nase (*Chondrostoma nasus*) and framed by two other dams, the Munteni Dam is an obstacle to migrating fish species on the analyzed river.

The solutions suggested in this paper (development of close-to-nature-type fish migration on the left bank of the Iad River and also a technical solution near the dam body) have a *high applied value*, helping to restore aquatic habitats and to recover natural ecosystems and water quality.

Reconstruction of longitudinal connectivity of Iad River near Munteni Dam area would provide the habitat reconnection on the studied river section situated between the two mentioned dam, creating optimal conditions for the development of aquatic fauna.

Keywords: longitudinal connectivity, fish migration, fish passes, ecosystem, water course.

INTRODUCTION

The need for longitudinal and lateral connectivity of watercourses requires a partial ecosystemic recovery of energy flow and biomass. Blocking the watercourse means creating two ecosystems: lotic and lentic. The overflow dam on the Iad River valley is a major barrier to upstream – downstream migration of various species of fish (*Gobio uranoscopus, Barbus Barbus, Chondrostoma nasus*) and invertebrates present in the river ecosystems.

STUDY AREA

Study area is part of the Iad River basin having one of the most largest basins, length and flow, being a right tributary stream of the Crisul Repede River. The Iad River has 46 km long and the valley looks young with numerous rapids and sills. Catchment area has a 220 km^2 surface. The overflow dam Munteni, subject to analysis of this paper, is located approx. 1.5 km from the confluence between Iad and Crisul Repede rivers (Figure 1). Munteni accumulation has an area of 148 ha and a volume of 27.10 million m [1].

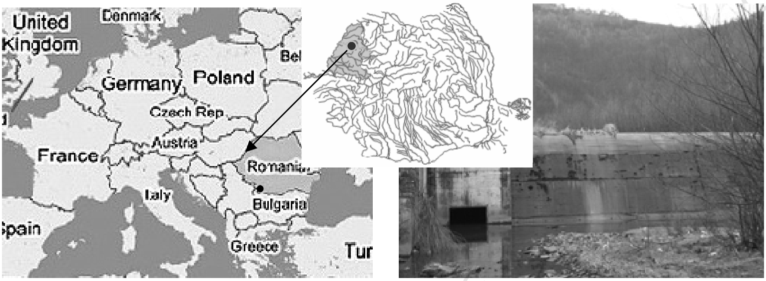


Figure 1. Munteni Dam location (Picture: E.Luca).

The analyzed dam is located in the grayling fish area where there are three species of migratory fish: Danube gudgeon (*Gobio uranoscopus*), barbel (*Barbus Barbus*) and the common nase (*Chondrostoma nasus*) [3].

METHODS

This paper sugests two solutions to ensure the migration of aquatic fauna upstream Munteni overflow dam located on the Iad River, a left tributary stream of Crisul Repede River. The dam is part of a hydro-energetic development on the Crisul Repede river, situated between other two dams (downstream from Bulz Dam and upstream of Lesu Dam).

First solution

First technical solution suggested to ensure fish migration has the following components: an oval linear channel carved into the upper part of the dam, a water basin for rising the level and a basin for collecting fish situated on the dam. The linear channel will be drilled into the upper part of the dam so that the upstream end of the channel to be at the minimum rate of water (or of the accumulation behind the dam) (Figure 1a).

Figure 1. Munteni Dam (Picture: E.Luca).

A metal semicircle shaped pile will be fastened at the upstream end of the oval channel in order to allow the activity of drilling into the dam. Drilling works will be performed using modern technology to avoid crackings into the dam body and to diminish or to affect its resistance.

The oval channel will be drilled into the slope, following the average slope of the river in the dam area (Figure 1 b), to ensure the migration of fish and invertebrates present into the studied river.

The downstream end of this channel will be located next to a basin for raising water levels in order to facilitate access to the oval channel and create a resting place for migratory fish. The oval channel will be perfectly finished inside and also its two ends in order to not hurt the fish. To facilitate fish access through the oval channel upstream of the Munteni Dam an attraction flow not more 2 m / s should be ensured, suitable both for migratory fish species concerned (popular name), and for other fish species present in the area.

Throughout its length, the oval channel will be equipped with a ventilation system consisting of a series of tubes drilled from place to place which will also ensure brightness (Figire 2). At high water levels, these „light wells" will act as for an overflow system.

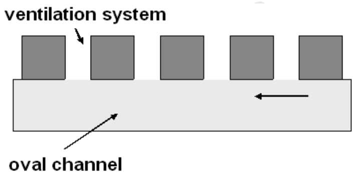


Figure 2. The ventilation system of the oval channel, transversal section – indicative scheme

At the upstream end of the oval channel a folding roof for water flow blockage will be built to ensure security during maintenance works performed in the oval channel. To prevent floating elements entering the channel, a hinged grill mesh 10x10 cm fixed in the dam body will be installed (Figure 3).

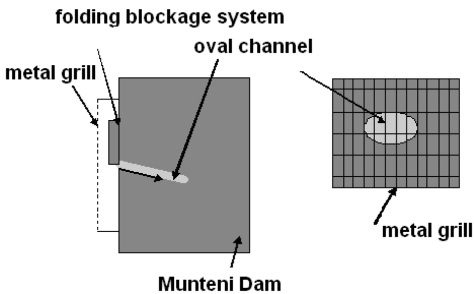


Figure 3. Anti-clogging system of the oval channel – transversal section – indicative scheme

Oval tube or channel described above is designed to capture water and transport it towards the basin for raising the water levels located at the end of the tube or channel, at about 1 m from the crest of the overflow dam (Figure 4).

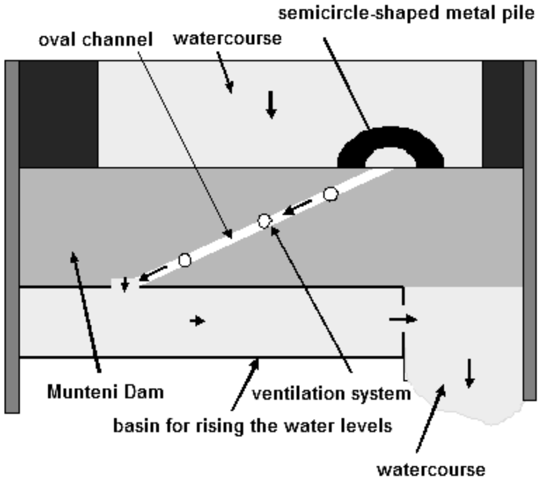


Figure 4. Longitudinal connectivity system components - indicative scheme

The basin for raising the water levels will have three built areas; the fourth area is the overflow dam (Figure 5).

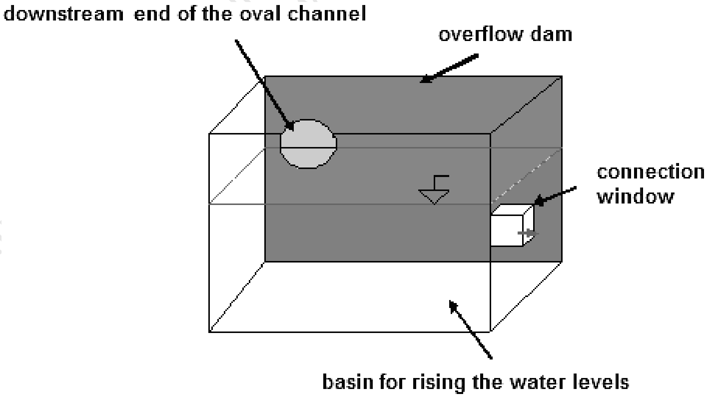


Figure 5. Basin for raising the water levels downstream from the overflow dam – Indicative scheme.

Beside the concrete surface of the dam, the other three areas will be made of concrete and glass to provide natural lighting of the basin and to facilitate the fish access inside it.

In its upper part, the basin for rising the water levels is provided with a series of crenels (Figure 6), that help water dissipate when floods.

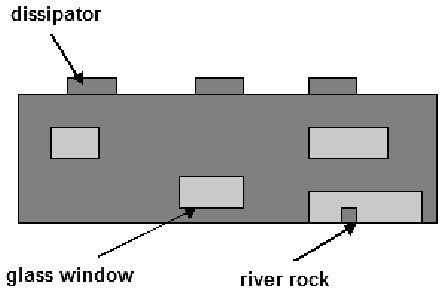


Figure 6. Wall of the basin for rising the water levels – indicative scheme

This basing for rising the water level will be provided with a submerged rectangular window at the bottom (Figure 7), making the connection with the river bad n next to it (Figure 8).

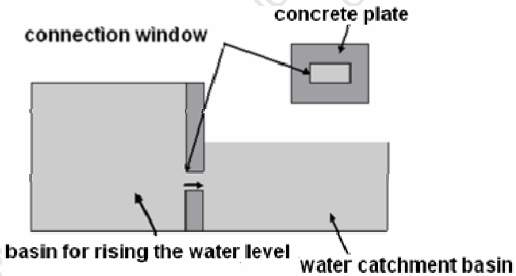


Figure 7. Connection between the basin for raising the water level and the water catchment basin – indicative scheme

The water catchments basin will be arranged near the left bank, right on the corner between the overflow dam and the support wall by deepening the bed to provide fish an easier access to the basin for rising the water level (Figure 8). This basin will look like a natural pond located in the river.

In order for this technical system designed to ensure fish migrations to be functional, the inflow into the basin for raising the water levels has to be equal to its diffluent flow, which exits through the window of access / contact.

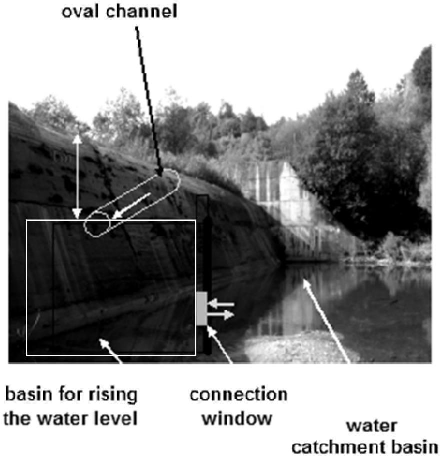


Figure 8. Transversal section of the oval channel and the basin for rising the water levels – indicative scheme (Picture: E.Luca)

In order to stabilize the basin for raising the water levels attached to the overflow dam, support poles will be built on the two side edges of the basin (Figure 9).

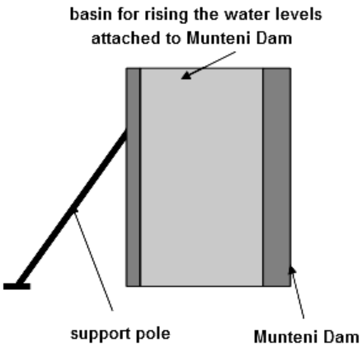


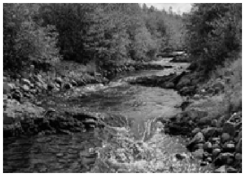
Figure 9. Support system of the basin for rising the water levels – indicative scheme

Second solution

The second solution suggested for providing migration of fish fauna upstream of the Munteni overflow dam is a natural solutions, part of a nature-like fishways category represented by a bypass channel, which could bypass the studded dam in the form of a natural looking channel that mimics a natural river. These types of fish passage structures (step-pool bypass, pool-type bypass, a riffle-pool bypass or mixed type bypass channel) can be designed to pass many species of fish (Figure 10).

However, they can require large areas of land since they often have to overcome substantial elevation differences above and below the dam.

Step-pool bypass on the Wupper River, Buchenhofen, Germany Picture Source: [10]



Pool-type bypass on the Siikajoki River, Finland. Picture Source: [3]

Riffle-pool bypass channel on the Traisen river, St. Poelten, Austria. Picture Source: [10]

Figure 10. The bypass channel types of fish passage structures

Location of the bypass channel is designed for the left bank of the Iad River, on the right side of the Munteni dam, profiting of the available space at that location. A possible path of this channel is outlined in Figure 11. This by-pass channel will be constructing around the dam in order to create a channel that has riffles and pools as well as stream channel bottom and riparian habitat that mimics the natural system as closely as possible.

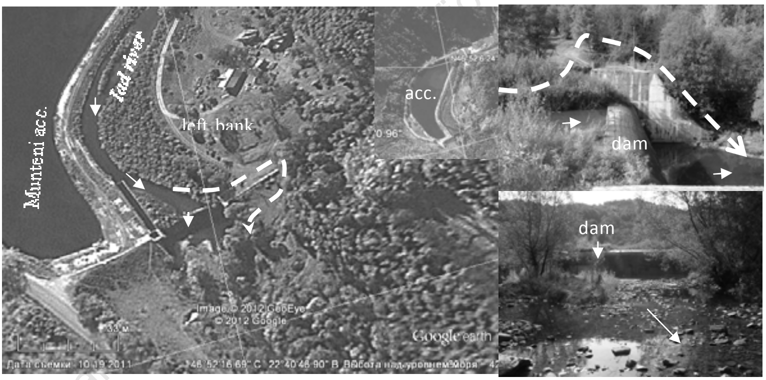


Figure 11. Possible location of the bypass channel
(Picture Source: Google earth, 2011 (left) E.Luca (right))

The average slope of the land in the Munteni Dam area is of 22 ‰ and the average altitude of 420 m. The flow necessary for arranging the bypass channel for fish migration is assured by Munteni accumulation next to the Munteni Dam. The bypass channel slope for migrating fish should be slow (max. 1:20) for providing resting area for the fish, and the flow should not exceed 2 m / s (for the targeted fish species). Different species of fast growing native plants (fescue, sedge, willow, alder, etc..) will be planted on the trapezoidal channel banks providing favorable conditions for the habitat and preventing the erosion.

CONCLUSIONS

The solutions suggested in this paper (development of close-to-nature-type fish migration on the left bank of the Iad River and also a technical solution near the dam body) have a high applied value, providing at the same time available habitat to aquatic fauna.

The technical solutions suggested do not require special technical knowledge and engineering, making them feasible from this point of view. The solutions are neither radical nor invasive preserving the property owned by Hidroelectrica S.A.. The cost of execution for each project is low, but may increase due to the price of land.

Resulting design plans for two proposed fish passes will have to be easily translated, in a following stage, into construction plans by specialists, and can be relatively easily built, it does not require large financial and energy costs, it can be easily maintained, it durable over long periods of time and, if it is no more necessary or it loses its utility, it can be easily removed preserving the initial state of the dam. The solution does not present any technical inconvenient and can be successfully applied to small dams.

Restoring the longitudinal connectivity of the Iad River on the Munteni Dam area would provide the recovery process on the river studied, for the reach from the confluence of Iad River to Lesu dam upstream (about 24 km length) creating optimal conditions for the aquatic fauna development.

REFERENCES

[1] Atlas Water Cadaster of Romania, Environment Ministry, Aquaproiect S.A., Bucuresti, 1992 (in Romanian).

[2] Banarescu, P. Fauna of P.R. R.. Academy Edition, Bucharest ,1964. (in Romanian).

[3] Dam, fish and fisheries – opportunities, challenges and conflict resolution. Environmental issues, dams and fish migration by Michel Larinier, CSP CEMAGREF GHAAPE, 2001, Toulouse, France.

[4] Diaconu S., Water courses. Planning, Impact, Rehabilitation. Publishing HGA –, - FAO/ DVWK, Bucharest, 1999. (in Romanian).

[5] Ecohydrology studies, support for achieving the environmental objectives stipulated in Water Framework Directive. Study realised by NIHWM, Bucharest, Romania, 2009. (in Romanian).

[6] Environment Agency, Fish Pass Manual, 2010. http://publications.environment-agency.gov.uk

[7] Google earth, 2011. www.earth.google.com

[8] National Institute of Hydrology and Water Management, Dates from NF of Hydrology.

[9] Photos and field collected data, July and September 2011.

[10] Wildman L., Parasiewicz P., Katopodis C., Dumont U., An Illustrative Handbook on Nature-Like Fishways - Summarized Version, 2000. www.americanrivers.org

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ENVIROMENT PROBLEMS CAUSED BY CEBECİ AGGREGATE QUARRIES AND REHABILITATION WORKS

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ABSTRACT

16 Agregate quarries are working in Sultangazi district, Cebeci Aggregate Quarries zone. It is detected that as a result of blasting in these quarries, a high amount of vibration and noise occurred in these regions; dust emission resulted from rock crushers, crushing, sifting and conveyor lines as well as irregular stock piling and transportation; as a result of lack of space, it is observed that open quarry layers could not be established and deep holes were opened as a result; also as a result of upper layer of earth and cover molding taken irregularly, uncontrolled and applied without a project in order to mine inside or outside of the permitted area resulted in rise of ground level and visual pollution.

Thanks to rehabilitations applied in the facilities, adjustments in level of drilling and blasting operations and blasting level are made and problem of vibration or noise resulted from blasting are solved. Lines, sifters and crushing equipment in quarries were covered and with pulverization systems with water support, along with covering roads with asphalt, leveling and forestation in the region, cleaning and washing roads are also applied in order to reduce dust emission partially.

Keywords : Quarries, Enviromental Problems, Rehabilitation

1.INTRODUCTION

In the city of Istanbul, increasing population and economic activities resulted in an increasing pressure on natural resources and in urban areas, on social and environmental infrastructure. It is necessary to improve the city as a healthy center when solving these problems resulted from above mentioned pressures and complicated interactions. Sustainability is based on improving quality of life in the city and protecting natural resources feeding the city. Water reservoirs, forests and open spaces are in coal, sand and stone quarry zones. For this reason, surface water resources are threatened by physical, chemical or biological pollution. As a result of activities of quarries working in the places where water resources should be protected; wrong use of explosives, uncontrolled piling of raw materials, facilities working without protection or necessary technology to protect environment, deep holes created as a result of lack of engineering services, wrong and uncontrolled piling and transportation affected people living nearby negatively.

Cebeci agregate quarries zone, as a result of uncontrolled growth and urbanization of the city, is today in the middle of settlement places, which makes this zone the place where environmental problems are faced the most. As a result of excessive use of blastings, dust, noise, and ground vibrations, people living in Sultangazi district, Cebeci neighborhood are disturbed. Number of people affected by dust increase day by day, as they get lung diseases as a result and people complain that authorities do not act in order to protect them, as they themselves are not capable of acting. Though quarries had been working in these areas since 1960's, as a result of uncontrolled urbanization of the region, in the last 15 years, people started to settle in these places and life in these settlements were affected negatively by dust, noise and ground vibration. As a result of activities of quarries, especially during summer, houses in this region get dust on their windows and balconies. As Marmara regions expects an earthquake anytime, little quakes resulted from blasting opeations by quarries affect people in this region negatively psychologically. During these quakes that scare even grown up people, children's psychologies are affected negatively. It is important for our future to establish organizations in the region in order to solve environmental problems resulted from mining activities and taking precautions in order to reestablish mining regions and integer them back to nature, as well as arising environment sensitive understanding when conducting mining activities.Cebeci agregate quarries are in Sultangazi district, which has Habipler village on its west, Sultançiftliği neighborhood on its south, Gazi neighborhood on its southeast, Yayla and Pirinççi villages on its north, Cebeci village on its northeast and Alibeyköy dam on its east.Among quarry facilities, Cebeci and Malova rivers run, into Alibeyköy dam lake.16 facilities active in the region, 2 of which are 1-1,5 kilometers away from Alibeyköy dam lake, when the others are 3-5 kilometers away. From settlement places to Cebeci village, 2 of the quarries are 1 kilometers away, when most of the others are 2-4 kilometers away. Again some of the quarries are 2-3 kilometers away from Yayla and Sultangazi.

There are Paleozoic and Cenozoic old rock types are seen, creating oldest rock form of carboniferous Tracian Formation. Inside Tracian formation covering most of the area, Cebeciköy limestone members are differentiated. Cebeciköy Limestone has spread sparit veins, hard, layered and solid, dark grey and blue-like colored biomicritic limestone (Altunbulak, 2000).

Economic reserve of Cebeci Stone Quarries zone is consisted of 1,5 km.s wide, 5,5 km.s long and 300 m.s deep limestone. There is sandstone in the rest of the above mentioned area. The area where agregate is produced actively is approximately 250-300 ha.s. According to today's production level, there is aggregate reserve that can be produced for 20-25 years. Agregate used for concrete and asphalt production (crushed stone and stone dust) is way over average standards and there is no other agregate reserve in this quality in any place near Istanbul.Qualifications of an agregate used in concrete, like its perdurability, porosity, mineral build, shape of units, surface roughness of units, gradation, module of elasticity, thermic dilation coefficient, presence of clay in agregate, cleanliness of agregate, are important elements when durability of concrete is concerned; Cebeci Agregate Quarries have all these qualities (Erguvanlı, 1975).

Again, a good quality agregate should not contain silicate (SiO2). Silicate may result in cracks and damages in concrete as it gets into reaction with alkaline in cement. A good agregate stone should not be acidic. Otherwise, acidic stone cannot be adhered to cement and bitumen and as agregate leaves bitumen, segregation may occur. Cebeci calcares (limestone) are very good quality stones in terms of silicate and acid level.

As agregate produced in Cebeci quarries have a high level of strength, almost no water emission, adherence with cement is very high and level of stickiness to bitumen, they are commonly used when making concrete and asphalt (İpekoğlu and others, 1999).

2.ENVIRONMENTAL PROBLEMS CAUSED BY AGREGATE QUARRIES AROUND CEBECİ DISTRICT

Quarries working around Cebeci basin work as open quarries and production are processed as taking out aggregate stone with opening holes and explosion. Taken out stones are crushed with hydrolic crushers and later given to crushing sifting facility.

When opening holes, Tomrock, Vagondiril, Trucdrill drilling systems are used. And during blasting, non-delayed capsules had been used until 2006, and level of mirror, distance between holes, hole radius, amount of explosives were not calculated and blasting were conducted directly. During drilling and blasting, a great amount of noise, vibration and dust were seen. Noise vibration could affect settlements as far as 1.2 km.s. There had been complaints from people living in close buildings. In order to protect people and environment around Cebeci quarries, a change of working habits and taking precautions are necessary. [1]

As a result of activities of stone quarries around Cebeci district;

1- Vibration and Noise Caused by Blasting

2- Dust Emission Caused by Crushing, Sifting and Loading

3- Dust Emission Caused by Piling and Transportation

4- Dust and Visual Pollution Resulted from Irregular Piling of Excess Earth and Stones

During the drilling and blasting of rocks in agregate quarries a heavy dust cloud appears and this dust cloud affects both plants and people in the area, threatening both plant and human health. The same blasting may also cause fear in surrounding areas.

Dust is given out from Crushing – Sifting Facilities working in the area as theye are mostly open systems. According to location of sifting facilities, this dust may be carried to far away areas by wind. Noise and vibration also created in Crushing – Sifting Facility. Yet, effects of these noise and vibration are low in further areas.In quarries where stones are taken, as a result of digging, water pools appear. Some companies give this water to factories to be used after a while. Yet, most of these quarries give this water into Cebeci or Malova rivers. Though this water can be absorbed by earth in warm seasons, during winter this water may reach Alibeyköy Dam Lake. This water, if not controlled, my result in pollution. [2]

As a result of agregate quarries' activities, topographic structure is damaged and little lakes are created in deep holes. From time to time people have lost their lives in these lakes. As a result of slippery earth after rain and flood near hillsides created, lost earth and erosion can result in losses of lives or materials. Dust may also be created during loading and disloadging actions. If vehicles are not covered well during transportation, dust may be spread. In addition to traffic problems caused by lorries, noise and dust on the streets of surrounding areas caused during transportation may affect people's health negatively.Roads can be covered with mud as well as cracks on roads because of heavy lorry traffic. These transporting lorries affect local traffic negatively. [3]

In order to take out aggregate rock with drilling and blasting, earth should be removed from its surface first. This removed earth, if not piled accordingly, may cause dust or mud and can affect environment in some quarries (İBB, 2008).

Illustration 1 **Illustration 2**

Quarries are observed to conduct their production activities vertically;Step,bench system is not successfully applied in most of the quarries, some risks have occurred in terms of bevel sensitivity;Illustration Visual Pollution Caused by Uncontrolled and Irregular Piling of Excess Earth and Stones.

3.REHABILITATION STUDIES AROUND CEBECİ STONE QUARRIES REGION

3.1-Noise and Vibration Caused by Blasting

In order to prevent noise and vibration caused by explosions, non electrical delayed capsules should be used during blasting,Taking up bench system in open pit quarry mining,Blastings conduction by professional companies according to a plan that prevents conflicts with a calendar, under control and estimations are required. [4]

3.2- Dust Emission Caused by Crushing – Sifting and Loading

In order to prevent dust emission caused by crushing – sifting and loading,Covering sifters, crushing equipment and bands in facilities,Establishing pulverization systems with water or closed systems,Moisturizing products during loading.

3.3- Dust Emission Caused by Piling and Loading

In order to prevent dust emission caused by piling and loading,Piling in the most appropriate area without overloading,Moisturizing products when loading,Sending lorries out with bale cloth on and under set limits of carrying,Making lorry bodies leak proof

3.4- Dust and Visual Pollution Caused by Uncontrolled and Irregular Piling of Excess Earth and Stones

In order to prevent dust and visual pollution caused by uncontrolled and irregular piling of excess earth and stones,It is informed to facility authorities that excess stone and earth should be stored within areas of quarries after hearing municipality mayor's opinion.Drilling, blasting, distance between holes, radius of hole, height of disc, type and amount of explosive will be under control of a committee consisting of members from cooperatives and official enterprises, and nonel type non electrical capsules will be used during small explosions.Blastings will be conducted after wetting the area of blasting with water.

Blastings should be conducted by experienced and authorized personnel (with official license of exploding) contracted by companies. [5] Blastings should be conducted with non electrical nonel delayed system in order to decrease vibration and air shock Agregate quarries close to dwellings designated by the commission will prepare vibration report to authorized establishments according to rules of Management and Assessment of Environmental Noise Regulations.A report will be prepared for each explosion and one copy will be distributed to each member of commission. [8]

As a result of works of a facility, a great dust emission occurs. In order to prevent dust in facilities, pulverization system is used. Pulverization is applied by applying water on spots where dust is seen. The most important precaution to prevent dust is covering units that create dust.Facilities are covered;

Illustration 3

Illustration 4

Watering Systems are established in Crushing-Sifting Facilities.Watering Systems are established in Crushing-Sifting Facilities and watering with pressured water is applied in every step of production.

Illustration 5

Illustration 6

Storing units are established inside facilities and enclosed appropriately in order to make enough room for storage only inside facilities.Water jets are established on stored products in order to prevent dust.Vehicles will be covered before they exit facilities, they will not be overloaded and their bodies will be checked in order to prevent spreading products or dust. After dislodging product, vehicles will be kept covered in traffic.All the roads inside or connected to facilities are covered with asphalt or concrete and they are periodically watered and cleaned.

1. CEBECİ ROAD BEFORE

Illustration 7

1. CEBECİ ROAD NOW

Illustration 8

Roads leading to quarries and main connecting roads are constantly watered and cleaned. They are cleaned constantly by cleaning trucks.Roads are periodically cleaned.Control locations will be picked on three main roads leading to quarries district and vehicles will be controlled via cameras in order to see whether they obey the above mentioned rules.Lorries and products are moisturized with water at the exits of quarries.

During rehabilitation works conducted according to environmental precautions and walking parkour planned through Cebeci stone quarries road by Sultangazi Municipality is completed by removing piles of excess stone and earth on the right side of 1. Cebeci road, ight infront of Mehmet Cıngıl Primary School, and the area is forested. Also side of the road is covered with a wall and this area is also filled and forested. Also the road between . Cebeci road and Cebeci village as well as 2. Cebeci road is covered with asphalt. Also a plan of watering roads is scheduled inside facility roads and each stone quarry waters roads. On going works are under observation of Municipality.

ROAD ENVIRONMENT ARRANGEMENT

BEFORE

Illustration 9

AFTER

Illustration 10

4. ROAD SIDE FORESTATION WORKS

Also, possible dust emissions from quarries are observed 24 hours a day by 6 cameras.Blastings in the area are measured by 2 vibration measurement devices (İBB, 2008). The two devices are placed as one in Veysel Karani Mosque and another in bread factory.Blastings in quarries are carried on under the Vibration Controlled Blasting Project conducted by Istanbul Municipality Environment Protection Unit, Quarries Cooperative (Cetok) and Okan University.Blastings are recorded by two vibration measurement devices (brought from Canada as a part of the project) 24 hours a day. [9]

Blastings are done with controlled and delayed ignition system and reported. Vibration and air shock values are detected to be under the “Highest Permitted Amount of Ground Vibration Created Outside of the Closest and Most Sensitive Area of Use by Vibrations Resulted from Explosions in Mine and Stone Quarry Areas” regulated by Management and Assessment of Environmental Noise Regulations. [6]

Legal Actions to be Taken Against Facilities that Does Not Fill Their Responsibilities

1-Legal actions are taken against companies that did not fulfill necessities mentioned before according to “Municipality Law Number 5216”.2- Facilities that did not get their licenses from local governments according to related lines of License for Opening and Running a Working Place published on Official Newspaper on 10.08.2005, number 25902.3-Companies that did not get their necessary permissions according to Mining Law numbers 3213-5177 and related regulations, or did not inform their permissions to related Ministry’s lost their permissions.4-Legal actions are taken against facilities not working according to set rules that are detected by supervisions or cameras according to Environment Law number 2872. [7]

5. RESULTS

Dust, vibration and noise are common problems seen in all quarries under inspection. As most of the quarries are close to settlements, these problems are environmentally greater. Though most of the dust on the roads can be controlled by watering, it is hard to fight against dust created in crushing-sifting facilities. During actions taken by our Municipality about rehabilitation of stone quarries in return of people’s complaints about dust and noise coming from stone quarries, as they are close to settlements .With regulations on explosives and blasting regulations, noise and vibration problems are solved.Dust emission is partially solved by covering crushing and sifting facilities and adding water pulverization system, as well as cleaning roads inside facilities and covering them with asphalt.Area is controlled by 6 cameras set by our Municipality.Blastings are measured by 2 set vibration measurement devices and kept under control.Control should be established by local security forces in order to control vehicles’ tonnage, body control and bale cloth before they set to traffic as mixers and loaded lorries are using roads around the area and creating a heavy traffic.As permitted areas of quarries licensed by General Directories of Mining Affairs are very limited, quarries work either out of their permitted areas or inappropriately vertically. In order to solve this problem, the area should be considered as a whole and modern facilities should be established as one on it.The area is not well planned and parcellation is not done. The area should be planned and divided as mining zone according to Zoning Law’s 18^{th} line.Stone quarry production activity as a service of an underground resource to the public is a mining management. A mining management process includes searching, project, investment, production and marketing. As each of these steps belong to specialty of mining discipline, production activities should be processed and planned with other related work fields.It is impossible in our century to conduct any economic activity by ignoring environment, as in mining. A decision like choosing between environment or mining is not in development process of a country. It is not possible to ignore effects of mining on environment. Yet, the more environment friendly technologies and techniques are used, the better the sector will develop as well as protecting environment.

REFERENCES

[1] Kahriman, A. Ozer, U. Karadoğan, A. Aksoy, M. Adıgüzel, D. 2007. Evaluation and Measurement of Ground Vibrations Induced by Blasting Excavation at Cebeci Quarries. Project Report. Engineering Faculty, Istanbul University, Istanbul. , pp.12–25

[2] Kahriman, A. Ozer, U. Aksoy, M. Karadogan, A. 2006. Environmental impacts of bench blasting at Hisarcik Boron open pit mine in Turkey. International Journal of Geosciences Environmental Geology, Springer Press, DOI 10.1007/s00254-006-0274-5, pp.1015–1023.

[3] Kahriman, A. 2004. Analysis of parameters of ground vibrations produced from bench blasting at A Limestone Quarry. Soil Dynamics and Eartquake Engineering, 24, Elsevier, London, U.K, pp. 887-892.

[4] Ozer, U. Kahriman, A. Aksoy, M. Karadogan, A. 2008. The Analysis of Ground Vibrations Induced by Bench Blasting at Akyol Quarry and Practical Blasting Charts. Environment Geology, Springer Press, DOI 10.1007/s00254-007-0859-7, 54:737–743.

[5] Ozer, U. Kahriman, A. Aksoy, M. Karadogan, A. 2007. The Investigation of Ground Vibrations Induced by Bench Blasting at Different Quarries at Çatalca District in Turkey, The Thirty-Three Annual Conference on Explosives and Blasting Technique, January 28 -31, 2007 Nashville, Tennessee, USA. Volume I. pp 241-253.

[6] 21.06.2005 time ve 25852 legal laws (21.04.2007-26500) Minning Procedure

[7] 14.07.2005 time ve 2005/9207 Goverment laws (03.07.2011-27983) Work Laws in Mines. , pp.152-165

[8] Kahriman, A. Ozer, U. Karadoğan, A. Aksoy, M. Adıgüzel, D. Özdemir, K. 2007. Evaluation and Measurement of Ground Vibrations Induced by Blasting Excavation at Cebeci Quarries. Project Report. Engineering Faculty, Istanbul University, Istanbul. , pp. 9-20

[9] SPSS, Statistical Software, SPSS 13.0 for Windows.

ENVIRONMENTAL IMPACT OF ASH AND SLAG DEPOSIT CEPLEA VALEY OF ENERGETIC COMPLEX TURCENI

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ABSTRACT

In our country is generated millions tons of industrial wastes annually. These wastes are stored in industrial wastes deposits which occupied the large surface of soil and also affects the environmental quality, in specially the quality of groundwater and surface water. The thermoelectric power plant Turceni is design as a basic power plant of Energetic National System, with 2310 MW installed capacity. From born process of fuel in energetic boiler results ash and slag which are exhausted by hydraulic system to two deposit: one deposit of slag and ash no.1, which are used in normally function regime, situated in Ceplea Valey at 3,3, km distance from thermoelectric power plant. An ther deposit is deposit no. 2, which are used as reserve and damage deposit. It is know, by analyzes, about the presence of chemical compounds such as: SiO_2; CaO; MgO; Fe_2O_3; Al_2O_3, and also of heavy metals. In this situation, the most important factors of environmental are affected. These and also possible effect of them are present follow.

Keywords: industrial wastes, ash and slag, water and soil pollution, heavy metals, radioactivity

INTRODUCTION

In Romania, the problem of wastes management appears actually more stringent because of the increasing amounts and quality of the wastes, which have a negative impact on the environment. Despite remarkable progress made in the recent years in all industries concerning ecological efficiency, still remains a great effort to be done until we will reach sustainable standards. One of the key methods for meeting this challenge is through technological development and to consider problems from the overall environmental point of view air, water, soil and natural resources, together. The waste framework Directive (WFD) has a great importance for Romania taking into account the difficulties and costs encountered by this sector. WFD has been widely transferred into the Romanian legislation through: (i) Government Ordinance 78/2000 on wastes regime approved by Law 426/2001, modified and completed by Government Ordinance 61/2006, approved by Law 27/2007; (ii) Government Decision 856/2002 on wastes inventory. The national Strategy of Wastes Management and National Plan for Wastes Management assure the implementing of EU legislation within our country.

Fossil fuels are widely used in modern power stations throughout the world to produce electricity. Besides energy, a variety of by-products of different king are also obtained from combustion of coal, such as fly ash, bottom ash, flue gas desulfurization sludge and so on. The inorganic residue, made-up of tiny sphere-shaped glassy particles that remain after pulverized coal is burned, is called fly ash. The diverse chemical, mineralogical and morphological properties of fly ash offer an opportunity to process it and recover various fractions with particular attributes. Every year huge quantities of potentially usable by-products of coal combustion are obtained in electric power stations. According to a crude estimation, more than 300 billion tonnes per year of fly ash are produced in the world.

While hydroelectric and gas fired power stations generate almost no solid waste, large quantities of bottom ash and fly-ash are generated by coal and lignite fired power stations. The increasing demand of energy production leads to the world production of about 600 million tonnes of ashes in the thermal power plants, and this value will increase in the near future. As an example, a 1000 MW power plant uses about 12,000 tonnes of coal and produces about 2000 tons of ashes per day. According to the data from ECOBA, the annual production of ash in Europe is approximately 45 Million tons and the cost of its disposal varies from 150 € to 500 € per tonne [1].

THE GENERATION OF ASH AND SLAG IN THERMAL POWER PLANTS

In Romania, the energy industry generates yearly great amounts of slag and ash which claims a lot of work for transport and storage by landfill. Ash and slag resulting from steam power plants require approximately 1.2 ha storage space for every million tonnes. Currently, a great number of ash and slag dumps exist (108) which cover about 2800 ha, the greatest amount (about 800 ha) being in Gorj and Dolj (neighbouring county with about 400 ha) [2].

In Gorj county is produced electricity in two thermo power plants: Turceni, with 2310 MW installed capacity and Rovinari with 1320 MW installed capacity. Both thermo power plants use the lignite as fuel extracted from mining basin of Oltenia. The field of electricity production by burning of fossil fuels represents the activity with the most important percentage among the big polluters of the environment. We refer here to atmospheric pollution through release of large volume of greenhouse gas, acidifying gas, dusts or it is about of large amounts of wastes (ash and slag) deposited in landfills which are occupying large areas of land. Electricity production in thermal power plant generates the important amounts of ash and slag which are characterized through low contents of organic substance when the burning process has a high performance. In this case, the resulted wastes can be used in different purposes in the building field. Currently, new highly cost technologies are foreseen to be applied as the dense water sludge disposal. The principle of “dense sludge technology” consists in continuous mixing with waste water of the coal burning by-products: dry ash from the electrofilters, slag from Kratzer and eventually the desulfurization by-products, by intense hydraulic circulation, with a rate solid/liquid over 1. This process activates the chemical substances of cemented type existent in fly ashes with the creation of a dense, homogenous sludge, which is pumped in deposit, where, it solidifies after 24 hr. Thus, results a huge solid deposit. The inertization technology transforms the ash and slag in an inert waste. But, the main problem remains not solved, because of the long term soil pollution. The composition of the ash varies substantially between producers and depends on the quality and the composition of fossil fuels that are used in modern power plants, as well as on combustion conditions. The main constituents are Al_2O_3, Fe_2O_3, CaO, MgO and in smaller quantities Na_2O and K_2O. Most of the CaO and MgO are bound in sulfates and mixed oxides with SiO_2 and Al_2O_3. Based on the ASTM standards fly-ash is classified according to the content of its major elements (Si, Al, Fe and Ca). ASTM C 618 defines Class F which comprises ash produced from anthracite or bituminous coal combustion with at least 70% SiO_2, Al_2O_3 and Fe_2O_3 and class Class C which comprises ash produced from lignite or sub-bituminous coal combustion with at least 50% but less than 70% SiO_2, Al_2O_3 and Fe_2O_3. Class F fly-ashes usually contain less than 5% CaO, while fly-ashes belonging to Class C contain a large proportion of CaO (10 – 35%) [5].

The sterile which is contained in lignite is partly melted during the burning process and transformed in very fine particles with the various forms which are carried by flue gases current. The coal from which is produced the ash, is a typical earthy coal, crushed at a finesse like a Portland cement: it passes in 80% through 74 µm sieve and 50% through 300 µm sieve. The organic component of the coal burns quickly while the inorganic component suffers some changes which are different from a particle to another according to the following factors: the mineralogical and chemical composition of the inert material, the temperature from furnace, the stationary time in burning area, the speed cooling, the grain of the crushed coal, the type of dedusting installations. In the burning process, the ash is carried by flue gases to chimney. The ash retention is realized in many areas along the route of the fuel gases. A sequence of chemical reactions which take place in furnace includes dehydration, decomposition with formation of gases CO_2, SO_2 and SO_3 and volatilization of alkalis. The rough particles, partly melted, are deposited at inferior part of combustion chamber like a clusters with size of 0,02-30 mm (accidentally can have size over 200 mm), constituting ash and slag furnace. The rest of the particles remained in air current suffers melting, the drops of liquid suspension being spherical form. Engaged quickly to out of hot area they are cooled suddenly, at solidification status they are keeping almost spherical contour and amorphous structure. Some particles which are cooled slowly, can suffer partly recrystallizations. The fine particles engaged by air current are settled through mechanical separator (cyclones) due to mechanical effect produced through the changes of direction and pressure from the lower part of boiler under air heating. The major part of ash (over 75%) is collected at the electrostatic dedusting (electro filter) which is located at the upper part of gas circuit.

THE INFLUENCES OF CHARACTERISTICS OF THE ASH AND SLAG ON THE ENVIRONMENT

The minerals which compose the ash and slag are silicates, carbonates, sulfates, sulphides, aluminum oxide, iron oxide, calcium, magnesium, potassium and sodium. In table no.1 are presented the percentages of the oxide compounds in ash and slag comparative with the percentages of the oxide compounds in the argillaceous soils [3].

Table no. 1. The oxide compounds in ash and slag and the oxide compounds in argillaceous soils.

Oxide compounds	Ash and slag	Argillaceous soils
SiO_2 (%)	47,7	50,20
Al_2O_3 (%)	21,65	17,00
Fe_2O_3 (%)	11,70	7,60
CaO (%)	10,97	5,13
MgO (%)	2,65	7,00
SO_3 (%)	1,65	0,4

The ash and slag which are resulted from burning lignite in thermal power plant of Energy Complex Turceni, produce negative effects on the quality of soil in the neighbor areas, on the vegetation growth and on the human health due to the toxic potential of some chemical elements which can be found in the composition of the ash. In table no. 2 are presented the results of chemical analyses of ash sampling and in table no. 4 is presented the heavy metal content of ash (parts per million) [3]. In table no. 4 are presented the physical proprieties (the grain size) of ash which are resulted from burning coal.

Table no 2. Chemical analyses of ash sampling

Chemical elements	The result of analyze (%)
SiO2	45,53 – 56,2
Al2O3	16,78 – 25,63
Fe2O3	3,04 – 6,76
CaO	1,73 – 8,26
MgO	1,64 -6,51
K2O	0,52 – 2,10
Na2O	0,17 – 0,52
pH	8,07
N total (%)	0,204
P total (%)	0,041
P mobil (ppm)	71,1
K mobil (ppm)	226
C organic (%)	13,50

Table no 3. Heavy metals content of ash sampling (ppm)

Heavy metal	Concentration (ppm)
Zn	111,3
Pb	26,8
Co	24,2
Ni	60,7
Cd	1,76
Mn	194
Cu	67,1
Cr	41,4

Table no. 4. The grain size analyzes of ash sampling (%)

2÷0,2 mm	0,2÷0,02 mm	0,02÷ 0,01 mm	0,01÷ 0,002 mm	< 0,002mm
8,7	68,2	10,3	8,7	4,1

Although ash and slag are resulted separately they are mixed together and hydraulically transported to the dump like a mixture water-ash and slag 1:8, 1:10. The slag and ash content is high and, moreover, soluble sulfates are present in variable concentration which depends of sulfur content of coal.

ASH AND SLAG DEPOSIT OF ENERGY COMPLEX TURCENI

From born process of fuel in energetic boiler results ash and slag which are exhausted by hydraulic system to two deposits: one deposit of slag and ash no.1, which is used in normally function regime, situated in Ceplea Valey at 3,3, km distance from thermoelectric power plant (figure no 2). The area of land affected by compartment no 1 is about 52,64 ha, the volume of deposited ash being of 13.034.470 m3. The area of land affected by compartment no 2 of the same deposit is about 45,4 ha, and the volume is 10.825.795 m3 [4].

Figure no. 2. Ceplea Valley deposit of Energy Complex Turceni

Another deposit is deposit no. 2, which is used as reserve and damage deposit. The deposit is formed through decanting of solid part (ash and slag) under the gravitational effect, on behind of basic dykes and of cant dykes. The technological decant water and meteoritic water from the compartments of the deposit are collected through collecting water intake with variable level, then gravitationally the water is transported through recirculating collected pipes to thermal power plant and reinserted in hydro technic circuit. It is known, by analyses, about the presence of chemical compounds such as: SiO_2; CaO; MgO; Fe_2O_3; Al_2O_3, and also of heavy metals. In this situation, the most important factors of environment are affected. These and also other possible effects of them are presented as follows. For the environment protection against contamination with ash or other substances are taken the following measures:

- the application of the sodium silicate solution realizes the fixation of the surface of the deposit. On the surface of the deposit is formed a solid film with 2-3 mm weight, which spread the dissipation of the ash by wind. Also, the fixation of surface of

- the deposit can be realized through planting of several plants. In absence of these measures, the ash from the surface of the deposit with a fine grain, is dissipation, as can be seen in figure no. 3.


Figure no. 3. The ash and slag deposit in a blustery day

- in the running compartment the circulation of the means of transport is realized on watered ash,

- the protection of the soil and subsoil is realized through sealing works which consist in the execution of drainages on ash to the slope in order to reduce the hydrostatic pressure from the ash deposit situated on the sealing system. The infiltration water came from the slag and ash deposit Ceplea Valley and has specific pollutants which can influence the quality of underground waters from the nearby zones. The most important features of the deposit waters are presented in table no. 5 [3].

Table nr. 5. The features of the deposit waters

Nr.crt.	Element	UM	Value
1	PH		7,1….9
2	CO2 free	Mg/l	17….30
3	Alkalinity « p »	Milival/l	0

4	Alkalinity « m »	Mg/l	1,4… 2
5	Bicarbonates (HCO3)	Mg/l	80…130
6	Temporary hardness	Mg/l	3,9….6
7	Permanent hardness	G	60…80
8	Calcium (Ca 2+)	Mg/l	400....460
9	Magnesium (Mg 2+)	Mg/l	70....115
10	Chlorides (Cl-)	Mg/l	150....190
11	Sulfates	Mg/l	1100...1500

CONCLUSIONS

Ash and slag deposits cover large surface of land having the negative impact on the environmental because of different reasons, that we can to summarize as follows:

Ash powder, entrain by wind from dry surface of deposit affects all environmental factors: water, growth, living bodies, soil, human settlement. Ash powder with fine grain affects animal bodies and plants even far from deposit. Are affect, also, digestive and respiratory tract of human and animals. Ash powder with medium or high grain recover surface of soil and plants near the deposit.

The flora from deposit area both the spontaneous and the cultivated, specially, suffer negative effects by the fine fractions fly ash which will lead to reduced plant vitality and crop production. Another effect of pollution is accumulation of increased quantity of heavy metals (chrome, plumb, arsenic, molybdenum) to toxically level with implication for consumers.

Because of absence of impermeability and inappropriate drain of deposit tank, the infiltration from deposit affects ground water sheet. These has as effect increased mineralization of ground water sheet and soil salinization considering the cumulative aspect. In the case of damage and other incidents by overflowing of water or hydro mixture of water and slag and ash is affected quality of surface water.

From these reasons but as well as to implementation of community regulations in environmental field, we study within the LIFE project **„New building materials by eco-sustainable recycling of industrial wastes”,** co financed by European Commission the possibility of use ash, drilling slurry and metallurgical slag together in order to produce new composite materials that can be use in material building industry.

Having a valuable oxides composition such as SiO2, Al2O3, CaO, Fe2O3, the ash could replace up to 30-50% from the natural sand used in the process of ceramic products manufacturing. With an average price of 40 €/tone of raw materials used for building bricks manufacturing (clays + clay sands), the valorisation of about 500.000 t/year fly ashes and about 100.000 t/year drilled solids, could involve a decrease of the production costs up to 30 mil. €/year, considering that the transport of the raw materials to the utilization place will be done by the wastes suppliers, and the wastes involve NO cost.

REFERENCES:

[1]LIFE Focus is the six-monthly journal of the LIFE III programme (2000-2004). A cleaner, greener Europe: LIFE and the European Union waste policy

[2]*New building materials by eco-sustainable recycling of industrial wastes*, project LIFE+ Environment Policy and Governance 2010

[3]*Studiu privind evaluarea riscurilor de mediu după închiderea Depozitului de zgură şi cenuşă nr.1 – Valea Ceplea,* contract de prestări servicii de cercetare ştiinţific 1301/16.12.2010, beneficiar Complexul Energetic Turceni

[4]*New building materials by eco-sustainable recycling of industrial wastes*, Life 10/ENV/RO/729, Inception Report, March – 2012

[5] E. Volceanov, G. Predeanu et al, Metallurgical Research Institute - Bucharest, Romania Thermal power plants ash for lightweight ceramic composites, Proceedings EMCC6, 2010, Ankara, Turkey

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ENVIRONMENTAL AND SOCIO-ECONOMIC PROBLEMS IN A FORMER MINING AREA FROM ROMANIA

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ABSTRACT

In Romania, in the process of mining restructuring, that was initiated after 1990, many ineffective and unpromising excavations - mines and blow-hole - were closed. This action has led to layoffs of staff from mining field with negative consequences on socio-economic life in the area. A very delicate problem represents the mining waste such as tailings pond and waste dumps, their revegetation and reintegration into the local landscape in order to protect the environment and to achieve a local sustainable development. This paper presents the current socio-economic issues in the area and the results of laboratory analysis regarding the heavy metals content in contaminated soil samples. The studies conducted in this paper led to proposed measures for reducing the negative effects of the waste dumps and tailings pond on the environment and for improving the quality of life for the population from the studied area.

Keywords: environmental protection, socio-economic analysis, tailings pond, former mining area

INTRODUCTION

Nowadays, countries all over the world follow the sustainable development principle that seeks a long-term harmonization between production and consumption, on one hand, and protection of a favorable environment on the other hand, also marking the shift from corrective to preventive measures. [1]

The problem of rural decorating and development is one of the most complex themes of the contemporary world, because, in its essence, it requires a balance between the need of conservation of the rural economic, environmental, social and cultural space, on one hand, and trend of modernization of rural life, on the other hand. [2]

Ecological reconstruction of areas degraded from mining activities is the first measure that should be taken into consideration before other actions concerning the sustainable rural development. Restoring degraded landscapes by tailings ponds and waste dumps is an attribute of concept for sustainable development and can provide a natural environment favorable to human society evolution.

In Romania, mining became an extensive activity only after the Second World War although mining activities started far earlier than that. After the Second World War, during the communist period, until 1990, a sustained activity of bringing to light new deposits and of mining-exploration started all over the country. Metallic mineral ores, mineral fuels and non-metallic substances were intensively and extensively exploited. Thus the largest productions in the history of Romanian millennial mining were obtained in the eighth decade of the twentieth century.

Economic development strategy, based on securing mineral resources and promoted by the communist regime, required opening and exploitation of all known deposits, though, most of them, were not economically feasible. At that time, mining operations and efforts were directed mainly to increase production, regardless of cost and of environmental consequences. Therefore, in the communist period, in Romania, mining sector was much more developed than it would be economically justified. In 1989 in Romania there were 278 active mines and quarries, operated 70 plants and facilities for preparation, including 30 in the minerals sector, 34 in the non-metallic substances and 6 in the coal mines scattered in 41 mining wells located on the territory of 23 counties. At that time, the mining sector annually produced about 160 million tons of coal, metal ores, chemicals and metallic salt [3].

In the process of mining restructuring, that was initiated after 1990, according to Government Decision no. 615/2004, many ineffective and without prospects excavations (mines and blow-holes) were closed.

In this paper, the case study is Sasca Montana commune where a copper mine was closed in 1998. Sasca Montana commune is located in the South-West of Caras-Severin county, in the mountain area of southern Banat at the interference of Mountains Locvei to the West, Almaj Mountain to the east and Anina Mountains to the north-east. The entire Sasca Montana commune together with villages belonging to it (Sasca Romanian, Slatina Nera, Bogodinţ and Potoc) covers an area of approximately 1980 hectares and is located in Beusnita - Nera National Park buffer zone.

Mining sector restructuring has led to many layoffs of staff, the total number being about 65% jobs destroyed, both in mining and the related fields. Practically in almost all areas of employment the number of occupied population dropped. Most of the active population, occupied and unoccupied population, of Sasca Montana commune was employed in the agriculture field (about 50%) (table 1), followed by persons engaged in mining, meaning 42 people. [4]

Table 1. Employment of occupied population in Sasca Montana area

Activity fields	Number of persons
Agriculture	238
Forestry	28
Fishing	0
Extractive industry	42
Manufacturing	30
Electricity, heat, gases and water	13
Construction	13

Wholesale and retail sale	26
Hotels and restaurants	3
Transport and storage	6
Post office and telecommunications	9
Financial, banking and insurance activity	0
Real estate transactions	2
Public administration	20
Education	18
Health and social assistance	8
Others services activities	24
Other personnel working in private households	0
Extraterritorial organizations activities	0
Total	480

Note: *data from Census 2002

Economic potential. The total area of the inside land, illustrated for each village, it is presented in Table 2.

Table 2. Total area of the inside land

Locality	Sasca Montană	Sasca Romană	Slatina Nera	Potoc	Bogodinţ	TOTAL
Area (ha)	98,53	60,43	63,63	73,38	28,12	324,9

Economic units that exist on the range of Sasca Montana commune are: one is specialized in production-bakery, one in production-sawmill, five economic units of agri-tourism and 18 work in commerce field. On the commune area there are no S.M.E. (small and medium enterprises), no credit unions, no banks. In this area, there only are 2 representatives of assurance societies in Sasca Monatana village. [4]

In the Sasca Montana commune, mining was the main occupation. Currently this job has disappeared. In Sasca Montana there is a family that deals with braids of twigs, making different baskets, even small furniture: tables, chairs etc., which they sell on the Friday of each week at the local fair. Other traditional handcrafts are pottery and furriery.

In 2011, a Gallup poll on a representative sample of people in Sasca Montana commune with questions about education, profession, occupation, mother tongue, foreign languages, religious affiliation, owned properties, financial standing and housing facilities was done.

In figure 1, the education of the persons over 18 years in Sasca Montana is illustrated:

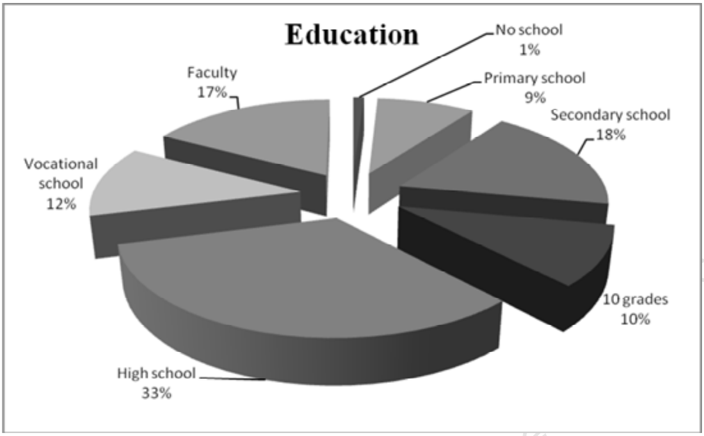

Figure 1. Population distribution on educational criteria

It is observed that 62 percent have faculty, vocational school or high school education, but the problem is that few young people and less qualified personnel in almost all sectors are present.

The weaknesses of education, human resources and labor market sector is the low complexity of rural education and lack of qualified personnel in education and of incentives for the integration of young teachers in rural education. On the other hand, the opportunities for education, culture, human resources and employment are: creation of clear and attractive programs to attract young people into rural areas where they can develop a business in tourism or agriculture. Appropriate investments in schools and cultural centers, and attracting qualified young people in schools or in other sectors must be done. The major threats of this sector are: general situation of education in the whole country with major difficulties attracting qualified young people, and delay and difficulty of implementing medium and long term programs of rural development. [5]

In figure 2, the actual occupation of people in the studied locality is illustrated:

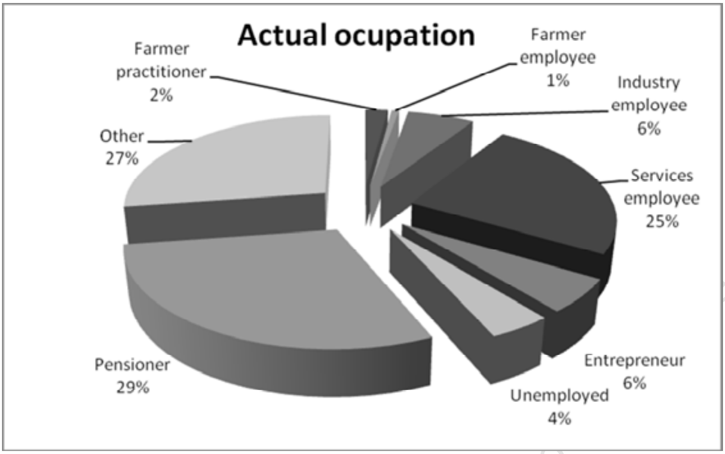

Figure 2. Population distribution according to actual occupation

The aging of population (29 percent of pensioners) and 31 percent of

day laborer or unemployed persons is observed in figure 2. Furthermore, although Sasca Montana commune is an area with agricultural potential (especially biological agriculture, beekeeping, medicinal plants culture), only 3 percent of population are farmer practitioners or employee.

In what concerns the mining waste such as tailings pond and waste dumps, their revegetation and reintegration into the local landscape in order to protect the environment and to achieve a local sustainable development is a very delicate problem. By revegetation, the pollutants that leak by levigation from the mining waste deposits are retained in plants by phytoconcentration. Thus, pollution of surrounding ecosystems is avoided. [6]

The majority of old mining exploitations have been placed in mountain areas, in or near some protected natural areas. The pollution from these deposits has a negative impact on biodiversity and development of tourism in parks and natural reserves nearby.

The waste dump are formed of raw material (rocks and big rocks) represent still waste deposits. On the other hand, the tailings pond are formed of very fine particles of close sand and they represent the biggest pollution problem. The air currents raise these fine particles and they form a diffuse pollution on extended areas including the neighbouring areas of the tailings pond.

Soils in the neighbourhood of tailings pond have low fertility due largely to sterile deposits and contamination of surface soil horizons in which a significant reduction of microbiological processes is registered. Therefore, surfaces contaminated from tailings areas are always tens or even hundreds of hectares and they are unsuitable for conventional agriculture. [7]

The sterile, formed of fine particles, from the tailings pond, is more difficult to be revegetated as it has zero fertility, due to the lack of organic matter and biological activity of heterotrophic micoorganisms.

In this paper case study, studies concerning the heavy metals content of soil and vegetation samples contaminated as a result of mining activities in Sasca Montana locality have been done. These studies have been done by drying, mineralization of soil samples. The heavy metals content has been determined by atomic absorption spectrophotometry using the VARIAN Spectr AA 280FS spectrophotometer.

1.Sampling. For this study sampling from the tailing pond area has been done. A first set of samples consists of 3three sterile samples, each sample being representative for the superior part (P1), the middle part (P2), respectively the lower part (P3) of the tailings pond. These samples have been taken into consideration for phytoremediation.

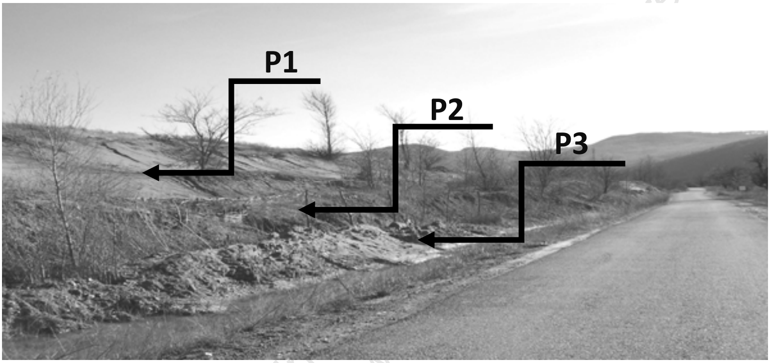

Figure 3. Sampling of sterile soil

As you can see on this image, the sterile mass has exceeded the storage limit of the tailings pond due to its excessive discharge.

2.Determination of heavy metals pollution. The content of heavy metals in soil degraded by mining activities samples and in vegetation from this area is presented in table 3.

Table 3. The heavy metals content from dry soil (d.s.) samples

Parameter		P1*	P2**	P3***
pH	Maximum admitted value	6.5-8.5		
	Experimental value	8.1	8.4	8.7
Pb^{2+}, mg/Kg d.s	Maximum admitted value	20		
	Experimental value	77.7	77.1	83.8
Cd^{2+}, mg/Kg d.s	Maximum admitted value	1		

	Experimental value	<0.1	<0.1	<0.1
Cu^{2+}, mg/Kg d.s	Maximum admitted value	20		
	Experimental value	843	1912	1514
Zn^{2+}, mg/Kg d.s	Maximum admitted value	100		
	Experimental value	150	151	172
Ni^{2+}, mg/Kg d.s	Maximum admitted value	20		
	Experimental value	87	139	187
Cr^{n+}, mg/Kg d.s	Maximum admitted value	30		
	Experimental value	211	101	55.3

* - sterile samples taken from the superior part of tailings pond;

** - sterile samples taken from the middle part of tailings pond;

*** - sterile samples taken from the lower part of tailings pond.

The mining activities degraded soils have a high level of heavy metals content, far exceeding the maximum permissible concentration, especially the copper content.

Due to the fact that Sasca Montana commune is located in Beusnita - Nera National Park buffer zone, tailings pond reconstruction and greening is necessary in order to protect population health and ecosystems in the area.

CONCLUSIONS

In this paper, socio-economic implications of closing the copper mine in the studied area were highlighted together with environmental problems of mining waste resulted from mining exploitation.

As a conclusion, although the population is aging and the mining sector disappeared from the Sasca Montana commune, chances of recovery are very high because the commune has a great potential in other sectors such as agri-tourism, exploitation biomass, traditional crafts, organic farming etc. As a member of European Union, Romania has the possibility of accessing funds for projects that aim at recovering social, economic, cultural and tourism aspects of the studied area.

Regarding the environmental protection in case of tailings pond in the area, based on studies concerning the heavy metals content from soil, heavy metals pollution in the tailings pond area was found.

Therefore leaching tests were conducted in order to establish the waste category in which the existent sterile from tailings pond will fall. All the three samples fall in non-hazardous waste class. Thus, they need to be deposited in special spaces for non-hazardous waste. Due to the fact that the sterile is a non-hazardous but not inactive waste, a study concerning the possibility of reconstruction for greening and stabilization by phytoremediation is required.

In order to achieve sustainable rural development, we should aim at increasing the competitiveness of agriculture and forestry, improve quality of life in rural areas and diversify the rural economy by business development and tourism, and also by environment protection and biodiversity conservation on the agricultural and forest lands, natural resource management in agriculture and forestry and the promotion of ecological agriculture.

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REFERENCES

[1] K.Bruckmeier & H. Tovey Rural sustainable development in the Knowledge society published by Ashgate Pub. Co. in Burlington,V.T., 2008.

[2] A.Shepherd Sustainable rural development, Macmillan Press Ltd. Basingstoke,U.K., ISBN 0-333-66484-1, 1998.

[3] F.Dumitru, Pagini din istoria mineritului, Infomin publishing company,Romania, ISBN9738613183, 2005.

[4] Agricultural Register - Population Register of Sasca Monatana Hall, 2007.

[5] G. Gherman & T.E. Man & V.D.Gherman SWOT analysis of Sasca Montana commune, Scientific Report of „Politehnica" University from Timişoara, Hidrotechnical engineering issue, „Politehnica" publishing company,Timişoara, Romania,ISSN: 1224-6042, fascicola 2, pp.39-42, 2011.

[6] G. Gherman & T.E. Man & Vasile D. Gherman Environmental protection in the context of sustainable rural development for former mining areas, Proceedings XXVI. microCAD International Scientific Conference ,University of Miskolc, Hungary, ISBN: 978-963-661-773-8, 2012, pp.9;

[7] B.J. Alloway Heavy metals in soils, Blackie Academic Professional, pp.34, 1995.

ENVIRONMENTAL ASPECTS AND TREATMENT OF MILK INDUSTRY

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ABSTRACT

Becoming more concerned with improving environmental quality and human health protection, large or small organizations, given the potentially increasing importance of activities, products or services on the environment. Environmental management is part of an organization's management system. A dairy removes large amounts of wastewater resulting from their work. The volume and composition of water varies depending on the plant profile, equipment and working methods used. In this study is presented a research on the impact of wastewater treatment plants on the environment and dairy products.

Keywords: dairy, environmental management, plants, wastewater

INTRODUCTION

Milk industry wastewater contains high concentrations of COD, BOD5 and TKN of up to 11,000, 5900 and 720 mg/l, respectively [11, 13] . Most of the wastewater produced in the dairy industry results from cleaning of transport lines and equipment between production cycles, cleaning of tank trucks, washing of milk silos and equipment malfunctions or operational errors [6]

Dairy wastewater has been extensively treated using coagulation/flocculation and a sedimentation process. The main disadvantages of this method are due to the high coagulant cost, high sludge production, and the poor removal of COD dissolved [12]

Environmental considerations are receiving increasing priority upon political, social, and economic agendas, especially when related to agriculture [3] . Disposal of improper treated wastewater often pose risk to the environment and ecology. Using advanced technology to mitigate risk by refined wastewater treatment is a key issue in meeting legislative guidelines, e.g. EU Water Framework Directive [14].

The adoption of environmental management systems (EMS) as frameworks for integrating corporate environmental protection policies, programs, and practices is growing among both domestic and multinational companies around the world [8] . EMSs are strategic management approaches that define how an organization will address its impacts on the natural environment[7]. An EMS provides order and consistency for organizations targeting their concerns in environment by allocating resources, allocation of responsibilities and going evaluation of practices, procedures and processes.[1]

The substantial nature of environmental protection costs implies that strategies that affect these costs are an important determinant of a firm's competitive position [4].
Environmental management was generally regarded as having a function operationally linked and often health and safety at work, while environmental and safety activities include making necessary costs in the business, recognizing that firms that implementing an environmental management system have strategic function and help define the entire business strategy, product design, financial and information systems design [5] . Like any economic activity, food ends with the human needs and the country's progress. Satisfaction normal consumption of the entire population depends mostly on the domestic production of food. Currently Romanian agriculture and food industry can ensure domestic food needs for a population of two, three times larger than currently existing [9]
The problem of food security is an essential component of life safety, it is putting both quantitatively (especially for poor products) and qualitatively (consumption of protein food, food with high content in vitamins and minerals) and the terms of the degree of industrial processing, price and environmental criteria [10]
A major coordinated agricultural policy in Europe and worldwide is the implementing of concrete measures to value the positive benefits of the development of food industry, under increasing demands from the environment. A coordinated system of rules and regulations on national and international limits the negative effects of intensification and modernization of production processes [2]

MATERIAL AND METHODS

Role of a wastewater treatment plant is to hasten the process by which water is purified. In a treatment plant, wastewater is generally processed in several stages: mechanical treatment - in this stage, the solid material removed from water. Disposal is done using floating bars, grills, site or fine cutting biological treatment - in this stage; microorganisms degrade organic matter and in some configurations are deleted nutrients (pollutants). There are different biological treatment techniques, best known as activated sludge treatment, or microorganisms (mainly bacteria) "dealing" with the degradation (i.e. oxidation) of organic matter, chemical treatment - chemicals acting on suspended solids, bacteria, reservoirs dosing, mixing and flocculation, disinfection - this step is chlorination and neutralization of pathogenic organisms, sludge treatment - in this stage is the anaerobic digestion of sludge.

Characterization of wastewater: Batch reactor system (BRS) consists of a single pool in the cyclic processes occurring treatment. Is an activated sludge basin occurs: equalization, aeration and decanting. BRS allows removal of nitrogen and phosphorus by mixing anaerobic during (fill) and start / stop during its electric blowers (REACT FILL) and (REACT). All are easily programmed automatic control system.

The components of BRS system

Aeration System: The component of the aeration system produces oxygen aeration system to facilitate removal and nitrification organic. BSR is equipped with speakers' flexible membrane fine bubble aeration or bubble aeration large speakers mounted fixed head or removable configurations. Other options are available for a variety of mechanical aeration devices.

Mixer: Supernatant homogenizing mixer with aeration closed out. The mixer has an important role in nutrient removal e.g. mixture made anaerobic for anaerobic denitrification and mixing to remove phosphorus. Enhance nitrification and denitrification chinetica mixers.

Decanter: Settler settling is designed to prevent entry of suspended solids during the non-settling processes (REACT FILL, Settat and AERATOR). If, however, suspended solids entering the settler during the non-settling, they will sit on the bottom of the settling vessel and will be eliminated in the first minutes of AERATOR process through special devices such as linear or solenoid acuatorul gaskets do not leak inside the reaction tank. Both devices are submerged in the non-settling during settle. The system virtually eliminates the chance of settling discharge untreated waste water. Settling also contains a float that maintains the liquid surface overflow throughout the entire process.

Excess sludge: Excess activated sludge generated by biochemical reactions in BRS is released during or after the settling process using excess activated sludge pumps. Occasionally the head differential available sludge is removed by mechanical valve opening (or manually) and gravity discharge to the aerobic digestion tank, sludge drying beds or other treatment processes.

Programmable Control Panel (PCP): The whole process of treatment, recycling and disposal of sludge is controlled by a microcontroller CFP acting on the following components: phase and sequence of process wastewater influent mechanical valves, air valves in the circuit, blowers, mixers, activated sludge pumps and systems for liquid level control. BRS Automatic operation allows the operator to concentrate on routine visual, mechanical inspections and laboratory analysis of samples, controlling processes through simple keyboard strokes.

Additionally Control and Data Acquisition System (CSASD): CSASD will allow treatment plant operator to monitor, print, and to record daily events that occur over time during operation processes. The system will display real-time graphics state of wear of the various parts and control equipment operating parameters.

Table 1 Technical general dates

Field of use of BRS systems	Materials used to make components of the sewage tanks BRS	Working temperature range

• Municipal wastewater treatment plants up to 100,000 inhabitants
• Sewage plants and farm animals agro objectives
• Wastewater treatment plants for industrial wastewater
• Sewage systems pretreatment for the above objectives which discharged into municipal sewers
	• Steel panels lined with insulating glass corrosion including edges, connected with screws and waterproof lining
	• Reinforced concrete waterproof
	• Fiberglas
	• Sewage flows into the BRS systems:
	  ○ min. 100 cm / day
	  ○ Max. 20,000 cm/day
		• min -30 ° C
		• max +50 ° C

Statistical analyze method: Each experiment was repeated at least 3 times. All the data were subjected to two-way analysis of variance (ANOVA) using IBM SPSS software for Windows Version 20. Statistical significance was tested using least significant difference (LSD) at the $p<0.05$ level.

RESULTS AND DISCUSSIONS

Characteristics and basic parameters

The wastewater is collected from the factory and is being run by the state system sewage sludge by gravity. Purified effluent is discharged into the river.

Table 2 Capacity cleaning station

Flow	Daily total loads
• Average daily flow 20 m^3/day	• Loading mass CBO5 28,5 kg/day
• Average hourly flow 2 m^3/h	• Loading mass CCOCr 92,5 kg/day
• Maximum hourly flow 4 m^3/h	• Loading mass MTS 54,7 kg/day
• Period of working 10 hours / day	• Fat mass loading 0,568 kg/day

Parameters of effluent wastewater and spen

Table 3 Parameters wastewater influent

Concentration				Wastewater temperature	
CBO_5 (mg/l)	CCO_{Cr} (mg/l)	MTS (mg/l)	Fat (mg/l)	Min (^0C)	Max (^0C)
1425	2392	590,25	28,4	15	35

Parameters of quality to treated water

Purification technology by primary treatment process and guarantee the biological values of these concentrations for-purification that the purified water.

Table 4 Wastewater parameters after static grill.

Parameters	**Influential (mg/l)**	**Efficiency (%)**	**Effluent (mg/l)**
CBO_5	1425	5	1353,75
CCO_{Cr}	2392	5	2272,4
MTS	590,25	10	531,225

Table 5 Water quality for-purification after secondary treatment

Parameters	Influential (mg/l)
CBO_5	25
CCO_{Cr}	125
SS	60

Effluent quality is in compliance with Romanian legislation under NTPA 001/97- limits for pollutant loads wastewater discharged into natural receivers.

Technological process parameters

Table 6 Actual volumes during hydraulic retention basins

Basin / useful reactor	Useful volume (m^3)	The hydraulic retention time (h)
Grease	0,932	0,47
Outdoor equalization and homogenization	3,2	1,6
Reactor with sequential functioning	118	59
Outdoor storage secondary sludge	26,71	13,36

The treatment plant sewage treatment plant is designed to work automatically. Operations routine servicing, maintenance and supervision require the presence of qualified and trained operators for several hours a day.

CONCLUSIONS

Were carried out research on milk received for processing by SC Lacto Sibian SA, making analysis in terms of sensory, physical, chemical and microbiological. Also were analyzed by flow technology and finished products, namely: pasteurized milk, acidic milk (yogurt, Sana), fresh cow cheese, butter, cream. In addition to these tests were followed hygienic conditions that maintained and operated facilities and the impact on the environment by them.

Thus, following laboratory tests and by observation of dairy technology flows obtained from this unit reached the following conclusions:

- Currently the amount of milk processed daily design capacity is less than the company, which is due to decreased number of milk cows in the country.
- Providing facilities and hygiene standards in general - technology, although some sections are very old plants.

- In all respected polling technology flows, except drinking milk is pasteurized section where pasteurization takes place prior to normalization. Collection points are equipped with refrigerating
- Following research shows that a unit containing sections of the dairy processing must turn its attention to provide unit with modern facilities to make the best conditions for all stages of the technological flow.
- Resume or increasing the flow control when there is an increase in microbiological examination parameters.
- We should not forget the final exam milk products because it is the last inspection carried out before the entry of products.
- Therefore, he must complete both in terms of organoleptic and physico-chemical and microbiological point of view to ensure that products produced are healthy and they do not pose a risk to those who consume them.

REFERENCES

[1] Bănăduc A.M., Agro-food quality, University "Lucian Blaga "Sibiu Sibiu, 2003.

[2] Bănăţeanu I.-A. &I. Ţeveloiu, Cerinţe sanitare veterinare privind proiectarea, construirea şi dotarea întreprinderilor pentru industrie alimentară : industria cărnii, peştelui, laptelui, Ceres, Bucuresti, 1987.

[3] Capper J. ;R. Cady, &D. Bauman, The environmental impact of dairy production: 1944 compared with 2007, J Anim Sci, 87, pp. 2160-2167,2009.

[4] Christmann P., Effects of" best practices" of environmental management on cost advantage: The role of complementary assets, Academy of Management Journal, pp. 663-680,2000.

[5] Constantin B. &V. Camelia, Procesarea Industriala A Laptelui, Editura Tehnica, Bucuresti, 1999.

[6] Danalewich J. ;T. Papagiannis ;R. Belyea ;M. Tumbleson &L. Raskin, Characterization of dairy waste streams, current treatment practices, and potential for biological nutrient removal, Water Research, 32, pp. 3555-3568,1998.

[7] Darnall N. ;G.J. Jolley, &R. Handfield, Environmental management systems and green supply chain management: complements for sustainability?, Business Strategy and the Environment, 17, pp. 30-45,2008.

[8] Melnyk S.A. ;R.P. Sroufe, &R. Calantone, Assessing the impact of environmental management systems on corporate and environmental performance, Journal of Operations Management, 21, pp. 329-351,2003.

[9] Patrascu C. &A. Patrascu Laptele Aliment Si Materie Prima, Editura Tehnica, 1984.

[10] Popa G. ;N. Popescu, &V. Stănescu, Determinări fizico-chimice de laborator pentru produsele alimentare de origine animală, Ceres, Bucureşti, 1986.

[11] Sirianuntapiboon S. ;N. Jeeyachok, &R. Larplai, Sequencing batch reactor biofilm system for treatment of milk industry wastewater, J Environ Manage, 76, pp. 177-183,2005.

[12] Tawfik A. ;M. Sobhey, &M. Badawy, Treatment of a combined dairy and domestic wastewater in an up-flow anaerobic sludge blanket (UASB) reactor followed by activated sludge (AS system), Desalination, 227, pp. 167-177,2008.

[13] Works D.O.I., Fundamental of Pollution Prevention (Cleaner Technology) for Dairy Product and Drinking Milk, in D. o. i. works, ed., Ministry of Industry, Thailand, 2001, pp. 1-1-5-102001.

[14] Wu J. ;Y. Yang, &J. Lin, Advanced tertiary treatment of municipal wastewater using raw and modified diatomite, Journal of Hazardous Materials, 127, pp. 196-203,2005.

ENVIRONMENTAL BENEFITS OF CONCRETE STRUCTURES

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ABSTRACT

Concrete plays a double role in the development of a sustainable future. First, concrete, in form of plain, reinforced or pre-stressed concrete, is the most frequently used man-made construction material. Second, concrete structures have a potential to obtain a very long life span. For this reason, it is important to explore the many beneficial properties of concrete during its service life. The paper presents some studies regarding the environmental property of concrete to reabsorb CO_2 by carbonation. It can lead to the enhancement of the carbon footprint of concrete structures.

Keywords: concrete, environment, carbonation, CO_2 uptake

INTRODUCTION

Concrete plays a double role in the development of a sustainable future. First, concrete, in form of plain, reinforced or pre-stressed concrete, is the most frequently used man-made construction material. According to [1], the estimated consumption of concrete was between 21 and 31 billion tonnes in 2006. It is the second most consumed material on Earth after water [2]. The production of brick structures is only about one-tenth of the amount of concrete by weight and wooden structures are built less than 5% of the annual concrete production in the world, measured by weight basis [3]. Second, concrete structures have a potential to obtain a very long life span. For this reason, it is important to explore the many beneficial properties of concrete during its service life.

Concrete is considered a non-ecologic material, due to the great amount of CO_2 emissions related to the manufacturing of cement. These emissions appear through the burning of cement clinker, when CO_2 is liberated during limestone de-carbonation (60%) and through fuel combustion and electrical power (40%). The main solution to reduce emissions is to partly replace cement with industrial by-products as fly ash, blast furnace slag or silica fumes. They reduce emissions and also contribute to a good waste management. Unfortunately, standards restrict the overall amount of additions that can be used. Further enhancement of concrete's carbon footprint is related to the CO_2 sink by carbonation. A study made by the authors [4] showed, that a typical flat block in Romania with precast reinforced concrete large panel system, exposed for 75 years, can re-absorb up to 28% of the initial emissions. The uptake can be much higher in secondary life, if concrete is crushed and reused.

It is not documented in what way and to what extent the carbonation can be taken into account in assessments of concrete CO_2 emissions, e.g. in life cycle assessments etc. Specifically there is a lack of knowledge about the carbonation of demolished and crushed concrete. This will have a significant influence on the public CO_2 policy, criteria for environmental labelling and for the selection of materials from principles of environmental correct design. A comparison of the environmental impacts from different building materials (e.g. wood and steel) is at present unfair because of the lack of documentation of the CO_2 uptake in concrete. For this reason, the authors proposed an experimental program in order to determine the carbonation capacity of different types of concrete, prepared with two types of cement. The experimental program and some preliminary results are presented.

EXPERIMENTAL PROGRAM - CO_2 UPTAKE BY CONCRETE CARBONATION

EXPERIMENTAL PROCEDURE

The experimental programme is based on the carbonation mechanism of concrete. When gaseous CO_2 react with the hydration products of the cement paste, calcium carbonate precipitates, which is a solid product, and water is unbounded, which can evaporate. The more carbonate ions are absorbed, the calcium carbonate precipitate. Carbonation gives rise to volume and mass changes [5]. Based on these principles, the experiment involves the following main steps:

- Preparation of different concrete samples;
- Weigh of the samples in the initial phase with a high precision balance;
- Drying of the samples in a furnace, until they reach a constant mass, eliminating the free, unbounded water;
- Weigh of the dried samples and introducing them in water for rehydration;
- Introduction of the samples in a chamber with high carbon dioxide concentration for carbonation;
- Re - drying and reweighting of samples after specific periods of time in order measure the increase of mass trough carbonation;
- Split of the carbonated samples and determination of the carbonation profile;
- Determination of the CO_2 uptake

SAMPLE PREPARATION AND PRE-TREATMENT

In order to cover a large variety of mixes, seven concrete mixes were prepared, casting cubic and prism specimens. The variable of the concrete mixes were: cement type and cement dosage, obtaining concrete with different strengths, as shown in Table 1.

Table 1. Variables of the concrete mixes.

	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6	Mix 7
Cement type	C 1*	C 2**	C 2**	C 2**	C 2**	C 1*	C 1*
Cement dosage [kg/m3]	340	340	250	300	400	300	400
Compressive strength at 28 days [MPa]	35.35	38	31.5	29	42.7	25	30.77

* CEM II/A-LL-42.5R; ** CEM I - 42.5R

The preparation of the concrete samples was realized in laboratory conditions, according to CP 012/ 1: 2007 [6]. The washed, dried and sorted aggregates were thoroughly mixed with the cement, then water was added gradually and mixed until a uniform paste was obtained. The paste was cast in lightly oiled moulds, put on a vibrating table and compacted (Figure 1).

Figure. 1 Preparation of the concrete mixes.

After 24h the samples were demoulded and placed in a water tank for hydration at 22±2°C. After 7 days of water curing, the samples were covered in polythene foils, to be protected from atmospheric CO_2 until being placed in the carbonation chamber (Figure 2).

Figure. 2 Curing of the samples in water and covered with polythene foils.

At the age of 28 days, in order to determine the composition of the cement and concrete, powdery tests have been drawled. The test samples were analysed with Energy-dispersive X-ray spectroscopy (EDAX), an analytical technique that uses characteristic x-ray radiation for compositional analysis. Scanning Electron Microscopy (SEM) has been done for very high-resolution images of the sample surfaces, revealing details less than 1 nm in size (Figure 3). The elementary compositions of the cements CEM II/A-LL-42.5R and CEM I - 42.5R, determined with EDAX are shown in Table 2.

Table 1 Cement compositions based on EDAX

CEM II/A-LL				CEM I			
Elem	**Wt %**	**At %**	**K-ratio**	**Elem**	**Wt %**	**At %**	**K-ratio**
C	12.04	20.62	0.0292	C	14.59	24.1	0.0379
O	40.84	52.52	0.0559`	O	42.01	52.12	0.0591
Mg	0.80	0.67	0.0030	Mg	0.72	0.59	0.0027

Al	2.10	1.60	0.0105	Al	2.54	1.87	0.0127
Si	7.85	5.75	0.0496	Si	6.65	4.7	0.0416
S	2.43	1.56	0.0187	S	1.69	1.05	0.0132
K	1.84	0.97	0.0173	K	0.85	0.43	0.0081
Ca	30.92	15.87	0.2838	Ca	29.61	14.66	0.2753
Fe	1.18	0.44	0.0100	Fe	1.34	0.48	0.0113
Total	**100.00**	**100.00**		**Total**	**100.00**	**100.00**	

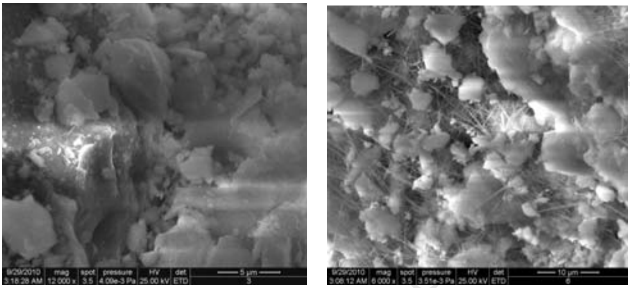

Figure 3 SEM image of the cement and concrete microstructure

ACCELERATED CARBONATION TEST

In normal environmental conditions (CO_2 concentration of about 0.03% to 0.1%) the evolution of the carbonation depth, including the CO_2 – uptake requires an extremely long period. Therefore an accelerated carbonation test has been realised. The carbonation setup consists of 3 separate chambers, each with a storing capacity of 15 cubes [7]. The chambers were kept in a laboratory, at a constant temperature of 17°C±2°C and RH=55%±5%. They are closed airtight and filled with CO_2 up to 50% concentration. Because of the decrease of CO_2 concentration due to carbonation, but also due to minor leaks, the chambers were refilled with gas after every measurement. Measurements on CO_2 concentration have been done 2 times a day in each chamber. On Figure 4 the variation of the CO_2 concentration on a period of 120 days can be seen.

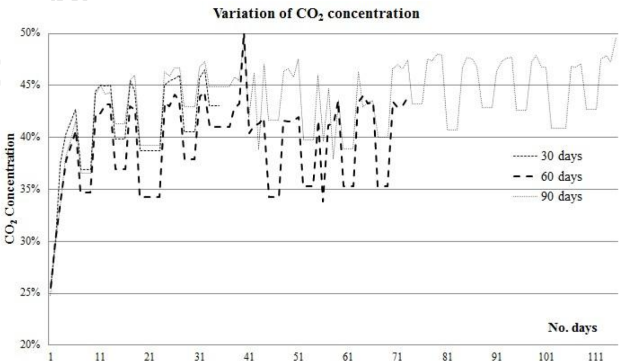

Figure 4. Variation of CO2 concentration on a period of 120 days

PRELIMINARY RESULTS

In the first phase of the research samples from mix 1, mix 2, mix 3 have been investigated after 30, 60 and 120 of accelerated carbonation to determine the increase of weight and the carbonation profile, to finally obtain the CO_2 uptake.

For the drying process all cubes were placed in an electrical heated furnace, with resettable program modes. They were heated up to 150°C and kept at this temperature for a specified period of time, when they were weighted with a high precision balance (Figure 5). The process has been repeated until all cubes reach to a constant mass.

Figure 5. Weighting and drying of the samples.

To favour the mechanism of carbonation, the dried samples were put back in water to rehydrate, until they regained their initial water content. The drying process has been repeated after 30, 60 and 120 days, in order to see the increase of mass due to carbonation. The relative weight changes are shown in Figure 6 for samples from mix 3.

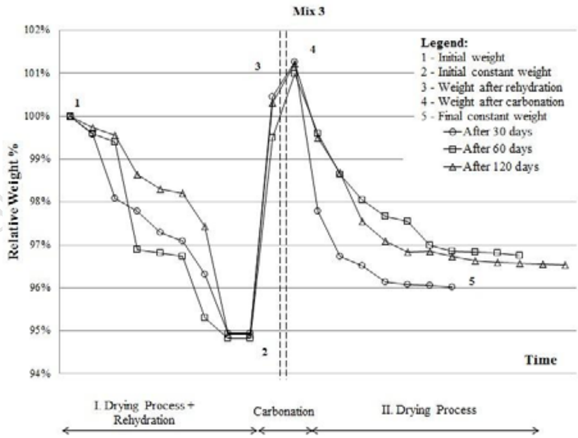

Figure 6. Relative weight change of samples from mix 3 during the experiment.

It can be observed that during the first drying process, the samples have lost about 5% of their initial weight, eliminating free water, while after carbonation this value is much lower. This is due to the fact, that after carbonation calcium carbonate has precipitated, which is a solid product that cannot evaporate under the given conditions. The differences in mass represent the CO_2 uptake, but without their correlation with the carbonated concrete volume they are unusable.

In order to determine the volume of the carbonated concrete, the samples were split in two parts and sprayed with a 1% phenolphthalein solution. This solution leaves the surface clear when the pH is less than 9 (carbonated) and turns magenta when the pH is above 9 (not carbonated). To determine the carbonated area with a high accuracy the image of each concrete surface was scaled and edited with image processing software, as shown in Figure 7.

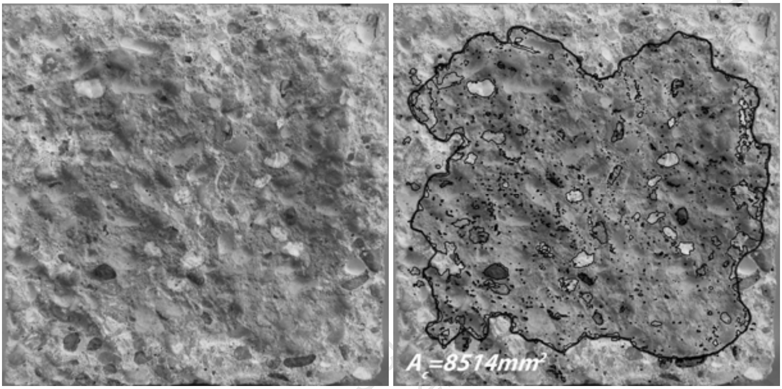

Figure 7. Carbonation profile of the split specimen by image processing.

Correlating the mass increase with the carbonated volume of the specimen, the CO_2 uptake has been obtained for mix 1, mix 2 and mix 3, as presented in Figure 8. It is visible that concrete can absorb a great amount of CO_2, depending on its composition.

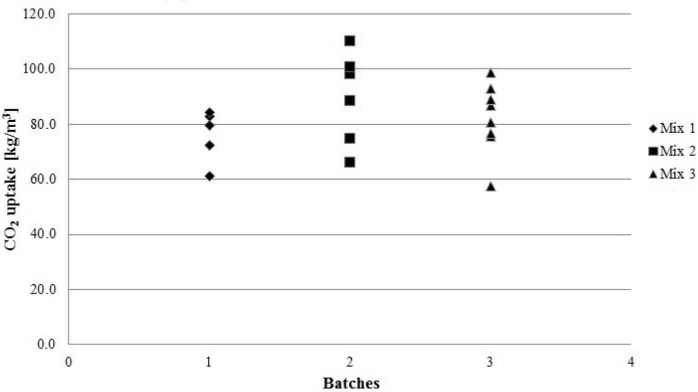

Figure 8. CO_2 uptake through carbonation.

CONCLUSION

The paper outlined some important properties of concrete which can change the public opinion that concrete structures are un-ecologic and with great environmental impacts. The use of cement replacement materials, the recycling of concrete and the use of special additives are just few of the many benefits of concrete structure which can be explored.

The authors proposed and partially performed an experimental program, which intend to quantify the important property of concrete to absorb and to bind CO_2 from the atmosphere through carbonation. Considering this property, the greatest environmental weakness of concrete, which is the manufacturing of cement, can be balanced in a positive way.

Based on preliminary results, concrete can absorb up to 80 – 100kg CO_2 /m^3, depending on its composition and exposure conditions. Further experimental determinations are needed to establish the influence of the cement dosage, cement type and environmental conditions on the absorption capacity of concrete, but also on the carbonation rate.

Acknowledgement

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REFERENCES

[1] World Business Council on Sustainable Development. Concrete Recycling - A Contribution to Sustainability, Draft version, 2008.

[2] ISO, ISO/TC 71, "Business Plan, Concrete, Reinforced Concrete and Pre-Stressed Concrete", 08/07/2005.

[3] Guy, A. G. Essentials of Materials Science, McGraw-Hill, 1976, 457 pp.

[4] Dencsak T., Bob C. Consideration of the CO_2 uptake through carbonation in the life-cycle assessment of RC structures, Proceedings of The 7th Central European Congress on Concrete Engineering, Innovative Materials and Technologies for Concrete Structures, Balatonfured, Hungary, 2011, pp. 199-203.

[5] Verbeck, G. J., 1958, February. Carbonation of Hydrated Portland Cement, Research and Development Laboratories of the Portland Cement Association, Research Department, Bulletin 87, Development Department, Chicago, Illinois, U.S.A.

[6] CP 012 / 1: 2007 – Code of practice for the manufacturing of concrete, Ministry of Regional Development and Housing, Bucharest, 2008.

[7] Bob C., Dencsak T., Balcu I., Sustainability of RC Structures, Proceedings of *fib* Symposium, Concrete Engineering for Excellence and Efficiency, Prague, Czech Republic, 8-10 June, 2011, ISBN: 978-80-87158-29-6, pp.1033-1037.

ENVIRONMENTAL CONCERNS IN PROTECTING HUMAN RIGHTS. PRESENT NEEDS FOR DEVELOPMENT MUST NOT COMPROMISE THE NEEDS OF FUTURE GENERATIONS. CASE ALBURNUS MAIOR

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ABSTRACT

The nature of environmental and human rights problems is similar in all the states of the world. Such common concerns includes land based pollution (rapid industrialisation, mining, logging, firewood collection, livestock grazing, land degradation, hazardous waste, waste water disposal). Environmental deterioration could eventually endanger life of present and future generations Therefore the right to life has been used in a diversified manner. It includes, inter alia, the right to survive as a species, quality of life, the right to live with dignity and the right to livelihood. Right to life guaranteed by all Human rights declarations and international documents includes the right of enjoyment of pollution-free water and air for full enjoyment of life. A significant number of decisions at the national and international levels have identified environmental harm to individuals or communities, especially indigenous peoples, arising as a result of violations of the rights to health, to life, to self-determination, to food and water, and to housing. Particularly in the European system, a clear connection has been made between a violation of the right to privacy and life and the right not to be subject to pollution, including the right to know whether pollution is likely to affect a particular individual or community.

Nevertheless, industrial development is also important for survival and making jobs for the people, in order to protect their right to life by creating jobs for them. It is important to find a balance between the right to a clean environment and the needs of people for jobs, for exploitation of earth's resources in order to live from it's goods, and finally survive. The kind of environmental concerns that can be raised include destruction of plants and animals, pollution, loss of jobs and small businesses and property values. Government must make sure that development which meets present needs must not compromise the needs of future generations.

Keywords: human rights problems, human right to a clean environment, industrialization, mining, needs, environmental concerns, Alburnus Maior.

INTRODUCTION

International concerns with human rights, health and environmental protection have expanded considerably in the past several decades. In response, the international community has created a vast array of international legal instruments, specialized organs, and agencies at the global and regional levels to respond to identified problems in each of the three areas.

Is it necessary or useful to include the right to a safe and healthy environment among human rights guarantees? Or is this simply “devaluing the currency” by unnecessarily adding desires and claims to the catalogue of accepted guarantees? The UN General

Assembly set forth criteria for adding to the network of international human rights standards in resolution 41/120 (Dec. 4, 1986). The resolution recognized the value of continuing efforts to identify specific areas where further international action is required to develop the existing international legal framework.

Does it seem that the right to environment is widely accepted as a justiciable right? What does it contribute to human rights or to environmental protection? It is true that a legal framework about environmental human rights will not absolutly save the world. Indeed, recognition of the environmental dimension of human rights does not create new obligations for states or for others. It does call for reassessment of existing obligations, however. Environmental human rights provide a framework for addressing domestic and international environmental problems. They both have the potential to advance protection of human rights and the environment. . . .

Some 130 constitutions in the world, including the overwhelming proportion of those amended or written since 1970, include a state obligation to protect the environment or a right to a safe, healthy, ecologically-balanced (or other adjective) environment. About half the constitutions take the rights-based approach and the other half proclaim state duties. For instance, the French Constitution was amended in 2005 and now includes a Charter of the Environment ("Charter") [1]. The Charter affords all citizens of France the right to live in a "balanced environment, favorable to human health"[2].

2. THE CONCEPT OF SUSTAINABLE DEVELOPMENT IN INTERNATIONAL LAW

Sustainable development is an evolving concept of international law. Broadly speaking its evolution can be traced to the 1972 Stockholm Conference. That Conference stressed the relationship between development and the protection of the environment, in particular, the need "to ensure that development is compatible with the need to protect and improve [the] environment for the benefit of their population" [3].The principles which were proclaimed at this conference provide a setting for the development of the concept of sustainable development [4]. Since then the concept of sustainable development has received considerable endorsement by the international community [5]. Indeed in 2002 people from over 180 countries gathered in our country for the Johannesburg World Summit on Sustainable Development (WSSD) to reaffirm that sustainable development is a world priority [6].

But it was the report of the World Commission on Environment and Development (the Brundtland Report) which "coined" the term "sustainable development" [7]. The Brundtland Report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". It described sustainable development as - "in essence … a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development; and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations".

Commentators on international law have understandably refrained from attempting to define the concept of sustainable development. Instead they have identified the evolving elements of the concept of sustainable development [8]. These include the integration of environmental protection and economic development (the principle of integration);

sustainable utilisation of natural resources (the principle of sustainable use and exploitation of natural resources); the right to development; the pursuit of equity in the use and allocation of natural resources (the principle of intra-generational equity); the need to preserve natural resources for the benefit of present and future generations (the principle of inter-generational and intra-generational equity); and the need to interpret and apply rules of international law in an integrated systematic manner [9]. The integration of economic development, social development and environmental protection implies the need to reconcile and accommodate these three pillars of sustainable development. Sustainable development provides a framework for reconciling socio-economic development and environmental protection. This role of the concept of sustainable development as a mediating principle in reconciling environmental and developmental considerations was recognised by Vice-President Weeramantry in a separate opinion in *Gabčíkovo-Nagymaros*, when he said - "The Court must hold the balance even between the environmental considerations and the development considerations raised by the respective Parties. The principle that enables the Court to do so is the principle of sustainable development" [10].

3. THE CONCEPT OF SUSTAINABLE DEVELOPMENT IN INTERNAL LAW

As in international law, the concept of sustainable development has a significant role to play in the resolution of environmentally related disputes in our law. It offers an important principle for the resolution of tensions between the need to protect the environment on the one hand, and the need for socio-economic development on the other hand. In this sense, the concept of sustainable development provides a framework for reconciling socio-economic development and environmental protection. Sustainable development does not require the cessation of socio-economic development but seeks to regulate the manner in which it takes place. It recognises that socio-economic development invariably brings risk of environmental damage as it puts pressure on environmental resources. It envisages that decision-makers guided by the concept of sustainable development will ensure that socio-economic developments remain firmly attached to their ecological roots and that these roots are protected and nurtured so that they may support future socio-economic developments.

4. THE RELATION BETWEEN HUMAN RIGHTS AND THE ENVIRONMENT

In 1994, Fatma Zohra Ksentini, Special Rapporteur of the former Sub-Commission on the Prevention of Discrimination and Protection of Minorities (later called the Sub-Commission for the Promotion and Protection of Human Rights), released a Final Report ("Ksentini Report") examining the relationship between human rights and the environment, excerpted below. One of the most striking conclusions of the Ksentini Report is that there has been a "shift from environmental law to the right to a healthy environment" and that this right is part of existing international law and capable of immediate implementation by existing human rights bodies [11]. The Report elaborates that the right is comprised of a number of elements including the right to life, health, development, public participation, and access to information and judicial remedies [12].

5. CASE "ALBURNUS MAIOR"

Alburnus Maior is an NGO based in Rosia Montana. It represents the interests of over 250 families from Rosia Montana and 100 families from Bucium. Local property owners opposing the involuntary resettlement that Gabriel's project entails founded this association in September 2000. Alburnus Maior objects to Gabriel Resources' Rosia Montana mining proposal on social, environmental, cultural and economic grounds.

Gabriel Resources Ltd. ('Gabriel') formed Rosia Montana Gold Corporation S.A. (RMGC), a Romanian incorporated company that holds the exploration concession title to the Rosia Montana project [13]. Through a joint venture agreement, the state-owned enterprise, Minvest S.A., holds a 19.3 percent interest in RMGC. Other investors collectively hold 0.7 percent, and Gabriel Resources, Ltd. has an 80 percent interest with preemptive rights to the other 20 percent [14].

a) Legal risks. Open cast mining at four pits and the construction of a tailings pond with a 180 meter high dam will seriously mutilate the region's landscape and contradicts European legislation [15] . Gabriel's development will destroy the archaeological zone of Alburnus Maior (Rosia Montana's Roman name), Romania's oldest documented mining settlement. It is of great cultural value and has a unique character. The mining development thus contravenes the Convention on the Protection of World Cultural and Natural Heritage adopted at UNESCO's General Assembly on 16. November 1972 - transcribed into Romanian law with decree 187/1990; Governmental Order Nr. 43 dated January 30, 2000 regarding the protection of archaeological patrimony as well as National Law 5/2000 which declared Rosia Montana a protected zone of national interest.

b) Recent archeological excavations at Rosia Montana have brought to light unique archeological treasures such as fortified buildings, thermae, a circular mausoleum and mine galleries dating from Roman and Pre-Roman times. According to the team of French mining archaeologists who have been excavating the galleries at Rosia Montana since 2000: "in Carnic, antique mining networks (from Dacian times, identified as such for the first time, and from Roman times as well) remain of a striking coherence and in a remarkable state of conservation ...."[16]. The reality of Rosia Montana is described in completely different terms, with no connection to the mining industry. The significance of the place lies in its natural beauty (nature, green, beauty, stillness) and historical value (history, patrimony, Dacia [17]).

Environmental risks. Gabriel Resources' intends to employ the cyanide leaching method, meaning that the tailings will contain cyanide. Importantly the tailings will also contain sulfur, lead, iron, mercury, copper, zinc, heavy metals, etc. and their byproducts. Gabriel's Rosia Montana project is situated along groundwater sources and the tailings are to be placed in an unlined pond in a valley riddled with rivers and rivulets; situated close to the town of Abrud [18]. According to a report entitled 'The Compatibility of the Rosia Montana Mining Project in Romania with the Principles and Norms of EU and EC Legislation' by Univ. Prof. Dr. Peter Fischer and Univ. Ass. Dr. Alina Lengauer, LL.M, from the Institute of European Law, Gabriel's mine development contravenes EU Council Directive 80/68/CEE [19].

The ore grade at Rosia Montana is extremely low; Gabriel estimates it at 1.52 grams of gold per ton of ore [20]. The ore would be processed using the cyanide-leaching method, which is controversial, because it has led to the contamination of rivers, streams and aquifers and to wildlife deaths and fish kills. If Gabriel Resources were to mine such low-grade ore using the cyanide process, the environmental consequences would likely be severe. According to Professor John Monhemius [21] who analyzed Gabriel's project as part of a PHARE Commission to advise on the European Union (EU) procedures and conditions that Gabriel's environmental impact assessment (EIA) would need to meet; this "is a very large mining operation. In full production about 26 million tons of ore and waste will be excavated per year or 500,000t/week. The tailings management facility (TMF) is sited immediately above the town of Abrud - potential for catastrophic consequences in the event of failure (…) [22].

c) Employment benefits. Gabriel claims that its operation will bring significant employment benefits to the region. However, labor requirements for mining and maintenance during mine life slowly rise peaking with 248 employees during optimal production (year 8) and decrease again thereafter. Salaried staff requirements including expatriates average 30 during mine life [23].

d) Civil society opposition to the project. The campaign to save Rosia Montana has given rise to the largest civil society movement in modern-day Romania. It enjoys the support of some of Romania's most prestigious institutions and is aided by a great number Romanian environmental NGOs. It is also endorsed by expert bodies, such as the Romanian Academy and Bucharest's Academy for Economic Studies.

5. CONCLUSIONS

The value of environmental human rights does not, however, rest exclusively on their legal foundation. Human rights affect official and private conduct in part because of the substantial moral weight they carry. Recognition of social values as “human rights,” at least where the recognition reflects genuine and well-considered judgment in a democratic society, erects a moral barrier to the contravention of those values.

Sustainable development does not require the cessation of socio-economic development but seeks to regulate the manner in which it takes place. It recognises that socio-economic development invariably brings risk of environmental damage as it puts pressure on environmental resources. It envisages that decision-makers guided by the concept of sustainable development will ensure that socio-economic developments remain firmly attached to their ecological roots and that these roots are protected and nurtured so that they may support future socio-economic developments

REFERENCES

[1] Legifrance, Charter for the Environment, art. 1, http://www.legifrance.gouv.fr/html/constitution/const03.htm; see, e.g., David Marrani, *The Second Anniversary of the Constitutionalisation of the French Charter for the Environment: Constitutional and Environmental Implications,* 10 ENV. L. REV. 9 (2008); James R. May, *Constituting Fundamental Environmental Rights Worldwide,* 23 PACE ENVTL. L. REV. 113, 113-14 (2005-2006). 3 [Legifrance, Id.]

[2] Legifrance, Id.;

[3] Principle 13 of the Declaration of the United Nations Conference on the Human Environment, held in Stockholm 1972, http://www.unep.org/Documents/Default.asp?

DocumentID=97&ArticleID=1503, accessed on 4 June 2007.

[4] Separate Opinion of Vice-President Weeramantry in Gabčíkovo-Nagymaros Project (Hungary/Slovakia) 37 I.L.M. 162 (1998).

[5] Id.

[6] Segger and Weeramantry (eds) Sustainable Justice: Reconciling Economic, Social and Environmental Law (Martinus Nijhoff, Leiden 2005) 561.

[7] Sands Principles of International Environmental Law 2 ed. (Cambridge University Press, Cambridge 2003) 252.

[8] Boyle and Freestone (eds) International Law and Sustainable Development: Past Achievements and Future Challenges (Oxford University Press, Oxford 1999) 4.

[9] Id.

[10] Gabčíkovo-Nagymaros Project (Hungary/Slovakia) 37 I.L.M. 162 (1998) 200 at para 140. In a Separate Opinion, Vice-President Weeramantry held that the concept of sustainable development is part of international customary law. See Separate Opinion at 204.

[11] Fatma Zohra Ksentini, Special Rapporteur, Draft Declaration Of Principles On Human Rights And The Environment , U.N. Doc. E/CN.4/Sub.2/1994/9 (1994), Annex.

[12] Neil Popović, In Pursuit of Environmental Human Rights: Commentary on the Draft Declaration of Principles on Human Rights and Environment, 27 Colum. Human Rts L. Rev. 487, 493-97 (1996).

[13] www.rosiamontana.org.

[14] Id.

[15] For example the European Landscape Convention ratified by Romania with law 451/2002; as well as EU directives No. 85/337/CC, 2001/42/CEE, 80/68/CEE, 94/43/EEC).

[16] http://www.britannica.com/EBchecked/topic/195896/history-of-Europe.

[17] The ancient province of the Dacians, conquered by the Romans at the beginning of the 2nd century A.D.

[18] www.rmgc.ro/Rosia-Montana.

[19] Evaluating Risk: Investors' Guide To Gabriel Resources' Rosia Montana Project, MINERAL POLICY CENTER ET AL., Budapest, Vorosmarty ter 1, November 2002.

[20] www.rmgc.ro/Rosia-Montana.

[21] AJ Monhemius, Ndlovu S, *The influence of crystal orientation on the bacterial dissolution of pyrite,* HYDROMETALLURGY, Vol:78, p. 187, 2005.

[22] Id.

[23] www.rmgc.ro/Rosia-Montana.

ENVIRONMENTAL IMPACT OF EROSION IN THE BARZAVA DRAINAGE AREA ROMANIA

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ABSTRACT

The paper contains data about the destructive effects of gully erosion on the environment. It provides general information about the gully erosion in several countries around the world including Romania and is considered a case study for a river basin located in the Semenic Mountains (Bârzava drainage area). To estimate the losses of soil erosion on slopes were developed various calculation models (Laflen 2003, Ruh-Ming 1973, Popovich 1991; Carvaiho 1994, Di Silvio 1998, Trott and Singer 1983, Wischmeier and Smith 1960, etc.).For modeling erosion processes on slopes and river beds of Bârzava river sub-basins were using two methods:
The estimation of the soil erosion in the Bârzava drainage area by physical modeling.
The estimation of solid leakage by applying WEPP model (Water Erosion Prediction Project).
The case study is based on the following assumptions: the presence of different soils types, constant rain intensity over the entire river sub-basins, land use is the same all over sub-basins, there are no works to combat soil erosion.The model was applied to each sector river bed (gully), by calculating the amount of lost soil depending on soil type.The sub-basin was divided into sub-basins related to river bed s sectors taking into account the direction of water flow. Let H sub-basins, and the C river bed s (river bed sectors). Each C corresponding to an H.The data entered in the program are: land use - forest, climate – the average monthly temperatures and precipitation, the soil characteristics, the sub-basins surfaces, the characteristics of river bed s: the average width of the river bed and river bed type (river bed channel in the forest area).

Keywords: gully erosion, exogenous factors, water erosion, anthropogenic factors, river basin, the calculation model

1. INTRODUCTION

In its evolution, the Earth has suffered and continues to suffer major changes due to the action and interaction between endogenous and exogenous factors.

Crust movements, caused by endogenous factors, lead to the activation of exogenous factors such as gully erosion.

In 1983, according to the estimates made by FAO in the world, an area of 5-7 million hectares of land were removed from the agricultural lands, due to the degradation processes (erosion, toxic chemicals, soil salinization, urbanization, etc.) the estimated losses at the end of year 2000, being of 100-140 million ha.

In Europe, an area of about 115 million hectares (about 12% of the Europe's surface) is affected by water erosion.

The most affected areas are the Mediterranean region and large areas in the central and eastern parts of the continent due to natural contributing factors (relief, climate, soil, etc.) and to anthropogenic factors (massive deforestation, improper practice of agriculture, overgrazing on the same area).

In Romania, taking into account the specific indicator of the erosion intensity (t/ha/year), counties in the bend area of the Carpathians Mountains (Buzau, Vrancea, with values of approximately 40 and respectively, 35 t/ha/year) are clearly different from the maximum allowable erosion of 4-6 t/ha/year. According to [4], Romania weighted average was of 16.28 t/ha/year. Gully erosion in the world has various effects on the environment, namely:

- In Russia, land area is degraded by approximately 500 thousand ha/year. Through water erosion, approximately 400 thousand gully erosion formations were formed, covering over 500 thousand hectares [1]

- In Pakistan, 75% of the country is affected by water and wind erosion and gully erosion affects 36% of the agricultural area of the country [1].

- Greece has about 40% of the total area of cultivated land affected by erosion, and over 800 active torrents transport over 30 million m^3 of solid material (Vousaros A. quoted by Băloiu V., 1986).

- China is affected by erosion - approximately 3.7 million km^2 (about one third of the country [3].

- In India, gully erosion affects 3.67 million hectares [3]

- In Lesotho, a country with an area of only 30,000 km^2, about 20-30 large thousand ravines occupy 4% of the arable area of the country [3].

- In Romania, a network totaling over 25,000 km of gully erosion in formations assets has been inventoried [3].

From an economic and environmental point of view, the development works of the gully erosion formations are of particular importance. The development of these formations causes damage primarily to agriculture, to socio-economic objectives, to silting of storage lakes and to water courses. If a storage lake has a calculated dead volume, which should be filled with silt in 80-100 years, there are cases when the storage lakes were no longer usable due to sealing, in only a few years or decades.

The annual volume of sediments transported by rivers in Romania is over 44 million tons (C. Diaconu, 1971), to which gully erosion contributes by 31% [4].

2. WORKING METHOD

In order to estimate the losses of soil erosion on slopes, various computational models have been developed (Laflen 2003 RUH-Ming 1973, Popovich 1991; Carvaiho 1994, Di Silvio 1998, Trott and Singer 1983, Wischmeier and Smith 1960, etc.).

In what follows, we treated soil losses through erosion and their impact on the environment in the Bârzava river basin (Romania) by two methods.

- *The estimation of the soil erosion in the Bârzava river basin by the physical* *modeling.*

Universal soil loss equation developed by [5] is based on the experimental technique applied by the two researchers. Subsequently, soil erosion assessment and prediction were improved by modeling techniques and by the elaboration of computer programs that allow separate treatment of the deployment processes of soil particles and fluid flow.

Thus, Trott and Singer (1983), using research with the rain simulator and measuring leakage, developed an equation of sediment production based on granulometric composition, for the forest soils in California (1):

$$SY= -9,391+25,298(P+A) – 0,2297(P+A)^2 – 12,551(Kaolinite) + 31,420 (Smectite) \quad (1)$$

Where:

SY = sediment produced in g/m^2;

P+A = dust percentage + clay percentage;

Kaolinite = kaolinite percentage present in the soil;

Smectit = smectite percentage present in the soil.

This equation was developed by Covaci, D. (2002) uses the erosion tester and by Rogobete Gh. and Grozav, A. (2006) uses the plot with the rain simulator, which gave the following equation(2):

$$SY= -9,391+ 25,298(P+A) – 0,2297(P+A)^2 – 12,551(Kaolinite) + 31,420 (Smectite)- 6,18(Humus)(2).$$

Where:

Humus = percentage of humus on the soil surface

- *The estimation of the solid leakage by applying the WEPP model*

The perimeter studied in her doctoral thesis by Grozav, A. [2], is located in the Semenic Mountains, near Gozna Peak (1444m), being the catchment basin of the Eagles' Bathroom's source.

The studied area has a mountainous terrain with altimetry values between 600 and 1400m.

The case study is based on the following assumptions:

- the presence of different soil types (aluviosol, podzol, prepodzol, histosol, districambosol)
- constant rain intensity over the entire river sub-basins;
- the land use is the same in all the sub-basins;
- there are no works to combat the soil erosion.

The model was applied to each area of the river bed sector (gully), by calculating the quantity of the lost soil depending on the soil type.

The sub-basin was divided into sub-basins corresponding to the river bed sectors taking into account the direction of the water flow. The sub-basins are noted with H and the river beds with C (river beds sectors). (Figure 2)

The data entered in the program are:

- land use - forest;

- climate - the average monthly temperature and precipitation;

- soil characteristics;

- sub-basins areas;

- characteristics of the river beds: the average width of the river bed and the river bed type (river bed channel in the forest area).

The scheme of the river sub-basin, resulting from the application of the WEPP program is shown in Figure 1 and the river network diagram in Figure 2. In addition to the quantities of soil loss, several graphs of variation of erosion and deposition processes on each slope and the maximum rate of entrainment of soil particles on each slope were also presented (Figures 3-7).

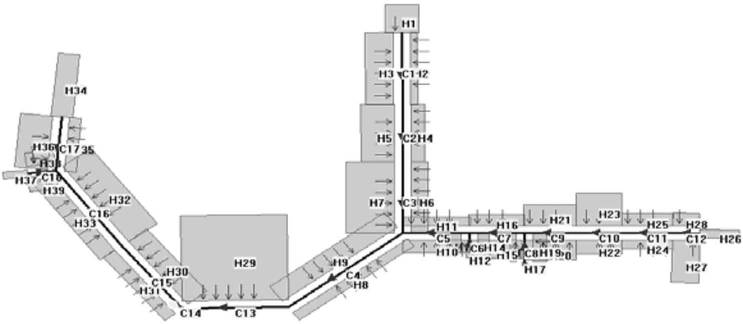

Fig. 1. The Bârzava river basin scheme using WEPP

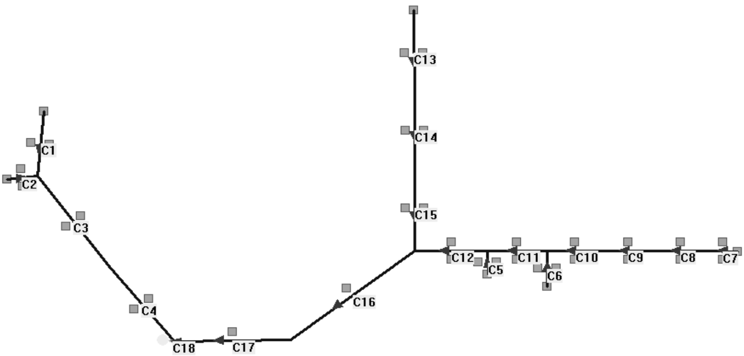

Fig. 2. The hydrographic network scheme in WEEP with associated river sub-basins
Graphs of variation of erosion and deposition processes

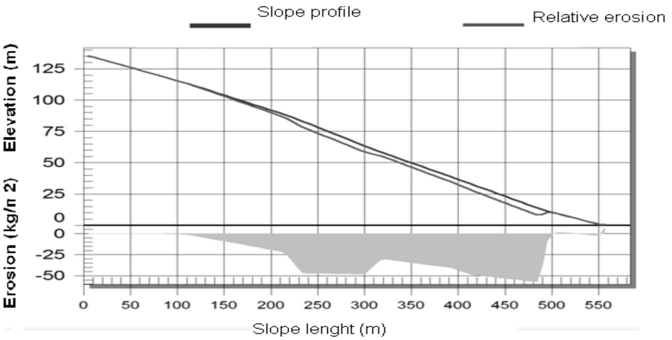

Fig. 3. The evolution of the erosion process on slope H2 (*Aluviosol*, maximum involvement of soil particles at 484m - 57.1 kg/m^2, the maximum deposit at 556m - 6.72 kg/m^2)

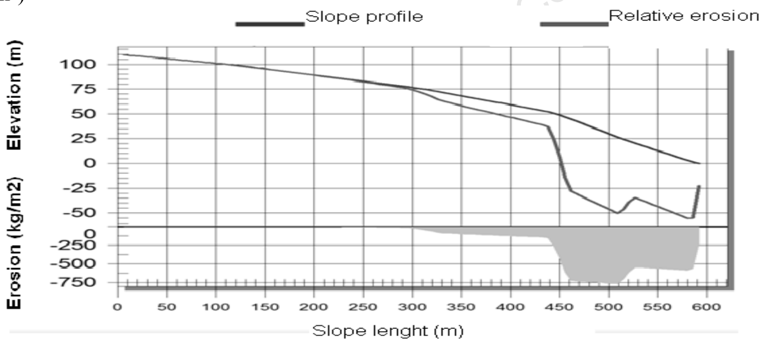

Fig. 4. The evolution of the erosion process on slope H8 (*Histosol*, maximum involvement of soil particles at 509m - 767kg/m^2, without deposit)

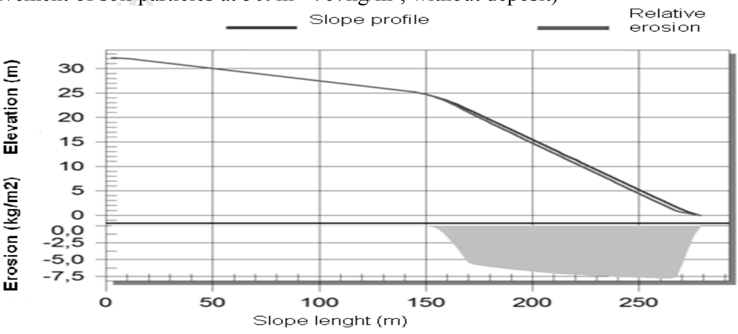

Fig. 5 The evolution of the erosion process on slope H26 (*Prepodzol*, maximum involvement of the soil particles at 264m - 7.79 kg/m^2, without deposit)

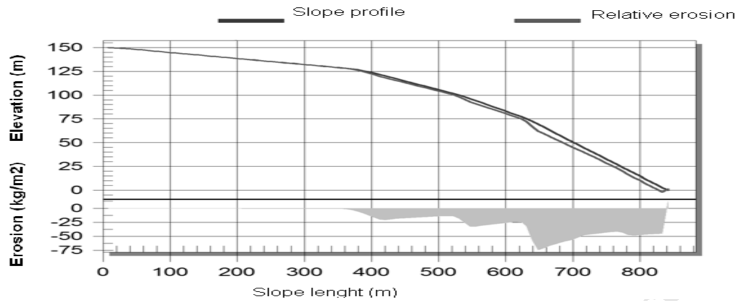

Fig. 6. The evolution of the erosion process on slope H29 (*Podzol*, maximum involvement of the soil particles at 648m - 74.2 kg/m^2, the maximum deposit at 842m - 11.5 kg/m^2)

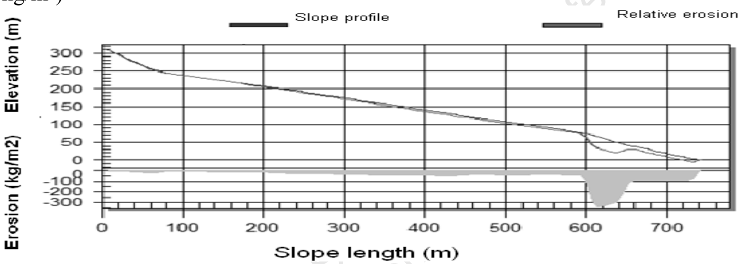

Fig. 7. The evolution of the erosion process on slope H6 (*Districambosol*, maximum involvement of the soil particles at 615m – 342kg/m^2, the maximum deposit at 741m – 10,5 kg/m^2)

Table 1. The results of the WEPP model on the whole river basin [2]

Number of slopes		Surface	Soil type	Leakage volume (m^3)	Lost Soil (kg)	Deposited sediment (kg)	Produced sediment (kg)
AutoCAD	WEPP	ha					
H1	Hill H8	10,663	Dystric Cambisol	460,9	1346,7	0,0	1346,7
H2	Hill H9	20,796	Aluviosol	1214,0	10023,3	0,0	10023,2
H3	Hill H7	44,586	Dystric Cambisol	0,0	0,0	0,0	0,0
H4	Hill H6	15,716	Dystric Cambisol	373,6	5104,9	0,0	5104,7
H5	Hill H4	10,295	Dystric Cambisol	324,9	4965,9	0,0	4965,7
H6	Hill H5	24,991	Dystric Cambisol	740,1	14470,4	20,4	14450,0
H7	Hill H2	6,587	Dystric Cambisol	422,5	3581,7	0,0	3581,7
H8	Hill H3	26,551	Histosol	656,9	2552,1	0,0	2552,1
H9	Hill H1	12,277	Dystric Cambisol	556,3	1249,9	0,0	1247,9
H10	Hill H10	10,909	Dystric Cambisol	300,6	3673,2	0,0	3673,2

H11	Hill H11	7,331	Dystric Cambisol	700,1	4944,1	0,0	4944,1
H12	Hill H13	2,725	Dystric Cambisol	253,7	2371,9	0,0	2371,8
H13	Hill H14	2,810	Dystric Cambisol	94,9	1180,5	0,0	1180,5
H14	Hill H12	0,516	Dystric Cambisol	28,4	187,1	0,0	187,1
H15	Hill H16	8,466	Dystric Cambisol	783,5	10908,9	0,0	10908,7
H16	Hill H15	12,837	Dystric Cambisol	261,2	5080,5	0,0	5080,7
H17	Hill H18	2,341	Dystric Cambisol	287,3	2698,3	0,0	2698,4
H18	Hill H19	5,306	Dystric Cambisol	176,7	3282,3	0,0	3282,3
H19	Hill H17	0,231	Dystric Cambisol	13,2	27,1	0,0	27,1
H20	Hill H20	12,922	Dystric Cambisol	251,0	4444,0	0,0	4444,0
H21	Hill H21	14,017	Dystric Cambisol	602,4	12516,5	1,5	12514,9
H22	Hill H22	8,302	Dystric Cambisol	229,2	3803,5	0,0	3803,6
H23	Hill H23	19,382	Dystric Cambisol	469,0	9368,2	24,2	9344,0
H24	Hill H24	5,929	Prepodzol	202,5	1942,6	0,0	1942,6
H25	Hill H25	8,193	Prepodzol	743,1	11672,9	0,0	11673,0
H26	Hill H27	14,721	Prepodzol	0,0	0,0	0,0	0,0
H27	Hill H28	4,340	Prepodzol	0,0	0,0	0,0	0,0
H28	Hill H26	4,578	Prepodzol	0,0	0,0	0,0	0,0
H29	Hill H34	17,575	Podzol	0,0	0,0	0,0	0,0
H30	Hill H35	8,356	Dystric Cambisol	262,9	2734,7	0,0	2734,7
H31	Hill H36	23,086	Dystric Cambisol	645,3	10983,9	6,9	10977,1
H32	Hill H37	2,269	Dystric Cambisol	36,2	563,1	0,0	563,2
H33	Hill H38	4,683	Dystric Cambisol	284,5	3656,5	0,0	3656,5
H34	Hill H39	4,050	Dystric Cambisol	117,9	1060,0	0,0	1060,0
H35	Hill H32	43,287	Dystric Cambisol	1017,1	15284,1	4,2	15280,2
H36	Hill H33	23,277	Dystric Cambisol	455,8	5305,6	0,0	5305,6
H37	Hill H30	25,003	Dystric Cambisol	782,0	5840,6	0,0	5840,6
H38	Hill H31	14,270	Dystric Cambisol	335,7	1706,7	0,0	1706,7
H39	Hill 29	58,027	Dystric Cambisol	0,0	0,0	0,0	0,0
TOTAL		*542,203*					

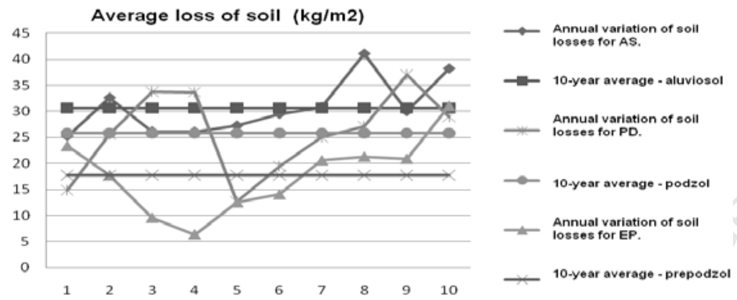

Fig. 8. Comparative values of different soil types in the Bârzava river basin [2]

3 CONCLUSIONS

- The emergence and development of the torrential gullies in the studied river basin evolved over time;
- The erosion values in this basin exceed the maximum allowable erosion;
- The muddy leakage produced on this river basin area also affects the downstream lake;
- The massive deforestation in the area, without reforestation in that area and without other works to combat the erosion of this river basin, leads to the environmental degradation with serious long-term consequences.
- Because are not allocated money (in present) for erosion control works cannot be a reason for the serious effects from the future.

REFERENCES

[1] Gardner, G. (Jane A. Peterson, editor) Shrinking fields: Cropland loss in a World of Eight Billion, Wordwatch Paper 131, Washington, 1996.

[2] Grozav, A. Soil and water pollution phenomena - a section of the Bârzava river basin study, PhD thesis; "Politehnica" University of Timişoara, Romania, 2011.

[3] Mircea, S. Evolution study of gully erosion formations in terms of arrangement and not arrangement in the Buzau area, PhD thesis, USAMV Bucharest, Romania, 1999.

[4] Moţoc, M., Vătău, A. Indicators of soil erosion, Environmental Review, vol III, No. 3 Bucharest, Romania, 1992.

[5] Wischmeier, WH., Smith, D.D. A universal soil-loss equation to guide conservation farm planning, Proc. Of. Seventh International Congress of Soil, 1960.

ENVIRONMENTAL RISK ASSESSMENT IN THE GALVANIZING OF STEEL SHEETS

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ABSTRACT

The starting point for optimization of environmental pollution prevention and occupational diseases in an organization is the risk assessment of that system. Risk assessment involves the identifying all risk factors from the analyzed system and the quantifying their dimension based on the combination of two parameters: event severity and the probability that it occurs.

The present paper emphasizes this aspect and presents some methods used for risk assessment and the steps to establish the risk levels. As example, the environmental risk assessment in a galvanizing unit is presented. The technology of obtaining zinc coatings steel, using a classic cleaning of surface, includes the following polluting operations: chemical degreasing, pickling, fluxing, preheating drying, hot dip galvanizing, cooling, final treatment. For the environmental risk assessment in the hot-dip galvanizing unit, the main identified hazards were established the severity class, the probability class and the resulted risk level.

It also presents technological and organizational measures to minimize environmental risk in the galvanizing of steel sheets.

Keywords: risk, environment, hot-dip galvanizing.

INTRODUCTION

Application of environmental risk management leads to multiple benefits for any organization such as: minimizing the organization's risk exposure, costs reduction for environment and workers affection, ensuring normal conditions for work development, obtain new approvals and environmental permits and last but not least improve the image and reputation of the organization [1].

Implementation of risk management in an organization requires the development of risk management programs corresponding to each organizational level and the risk management process should be integrated into other planning and management activities [2].

Environmental risk results from the interaction between human activities and environment [3]. Environmental risks can be classified into two categories [4, 5]:

- *Environmental risk* it self admits that the activities of an organization can generate some forms of environmental modification such as: flora and fauna, human health and economic welfare, social and cultural wellbeing of people, water, air and soil resources, energy and climate;

- *The risk for the organization, in terms of environmental issues which* includes the risk of non-compliance with legislation, remediation and litigation costs, firm reputation decreasing, losses recorded by the organization's business, difficulties to provide or maintain the possibility of conducting operational and development activities.

Risk assessment is performed by using analytical methods or by simulation. Risk assessment is carried out using qualitative and quantitative techniques. Qualitative risk assessment techniques are used when hazards can not be quantified or are not available sufficiently reliable information needed for quantitative assessment, or data collection is not efficient in terms of costs. Quantitative assessment techniques are used in more complex activities to complement qualitative techniques. Quantitative assessment is usually preceded by the qualitative one [5].

Risk assessment involves identifying all risk factors from the analyzed system and quantifying their size based upon the combination of two parameters: event severity and with which the event occurs.

Risk levels are thus obtained for each risk factor, respectively global risk levels for the whole analyzed system. It was shown that the risk existence in a system is due to risk factors presence (mechanic, thermal, chemical, electric, human, work environment, work load, etc.) which leads to risk of pollution of environmental factors, accidents risk and risk of occupational disease.

Consequently, risk assessment is required the following steps:
a - identifying the risk factors from the analyzed system;
b - determining the consequences;
c - determining likelihood of happening;
d - award risk levels depending on severity and probability of consequences of risk factors.

Risk can be identified using various methods:
- preparation of checklists that covering potential sources of risk, such as: environmental conditions, expected results, staff, changes to the objectives, errors and omissions in design and execution, cost and terms of execution estimations etc.;
- analysis of documents available in firm archive, for identification of problems that have arisen in situations similar to those current;
- use of direct productive staff experience.

For the severity of consequences we can determine several classes, the assessment being more accurate as their number is higher. In this paper it is proposed an environmental risk assessment using five classes of severity and the consequences specified:
- 1st class: negligible consequences (for people - insignificant effect; without emissions; to ecosystems - some minor adverse effects on weed species or parts of the ecosystem, short term and reversible);
- 2nd class: small consequences (for people - first aid necessary; for emissions - emissions immediately detained inside the target; to ecosystems: - minor damage, rapid and reversible);

- 3^{rd} class: medium consequences (for people - need medical treatment; emissions inside the target, retained with external support; to ecosystems: - temporary and reversible damage);
- 4^{th} class: high consequences (for people - important effects; emissions - off-site emissions without harm; to ecosystems - the death of animals, large-scale damage, damage to local species and extensive destruction of habitats);
5^{th} class: serious consequences (for people – death; emissions: - off-site emissions of harmful effects; to ecosystems - many animal death, destruction of flora, air quality requires evacuation, permanent and widespread contamination of soil).

In risk control, the severity is not easier to be controlled than the danger probability. Therefore the probability occupies an important place in the response to risk. From the efficiency point of view, is not possible to work with probabilities strictly determined for each risk factor. It is therefore appropriate for the probabilities to be established, usually, by prediction and to be grouped in intervals. For this reason, we use five intervals (classes), which we can order as follows
- 1^{st} class: extremely rare: $P < 10^{-12}$events/h;
- 2^{nd} class: very rare: $10^{-12} < P < 10^{-8}$ events/h;
- 3^{rd} class: rare: $10^{-8} < P < 10^{-6}$ events/h;
- 4^{th} class: slightly frequent: $10^{-6} < P < 10^{-4}$ events/h;
-5^{th} class: frequent: $10^{-4} < P$ events/h;

The risk, for each identified hazard, is calculated by taking into account the severity and probability class, according formula (1)

$$R= S \cdot P, \tag{1}$$

where: R- risk size, S- severity classes, P- probability classes.

According to the five classes of severity there were established five risk levels, in ascending order. The severity is a more important element in terms of environmental and labor protection and was admitted that it has a greater impact on the level of risk than the frequency. Risk levels are:
- N_1 - very small risk level, R=1-4;
- N_2 - small risk level, R=5-9;
- N_3 - moderate risk level, R=10-14;
- N_4 - high risk level, R=15-19;
- N_5 - extremely risk level, R=20-25;

If we consider all possible combinations between probability classes and severity classes, we obtain a risk matrix with five lines (severity classes), and five columns (probability classes), Table 1

Table 1. Risk matrix

Probability classes:	Severity classes				
	negligible	small	medium	high	serious
extremely rare	1	2	3	4	5
very rare	2	4	6	8	10
rare	3	6	9	12	15
slightly frequent	4	8	12	16	20
frequent	5	10	15	20	25

The global risk level (Rg) at the workplace is calculated as a weighted average of the risk size established for the identified risk factors.
The formula for calculating the overall risk level is as follows:

$$Rg = \frac{\sum_{i=1}^{n} \cdot R_i}{\sum_{i=1}^{n} i} \tag{2}$$

where: Rg = the global risk level on the workplace; R_i = risk size for the risk factor "i"; n = number of risk factors identified at the workplace.

ENVIRONMENTAL RISK ASSESSMENT IN A HOT-DIP GALVANIZING

Hot-dip galvanizing steel is still the most widely used anticorrosion procedure featuring the best quality/price ratio. In the world about 4 million tons of zinc (half of the world consumption) is used for the protection of 100 million tons of steel. The consumption of hot-dip galvanized steel keeps on growing by approx 5%/year. Considering this evolution it becomes important to investigate and evaluate the wastes resulting from the hot dip galvanizing process so as to assess their impact on the environment and their risk level.
The technology of hot-dip galvanizing steel, using a classic surface cleaning, includes the following operations: chemical degreasing, pickling, fluxing, preheating drying, hot dip galvanizing, cooling, final treatment. In figure 1 are shown the main pollutants and wastes from the production processes that have an impact on work environment [6].

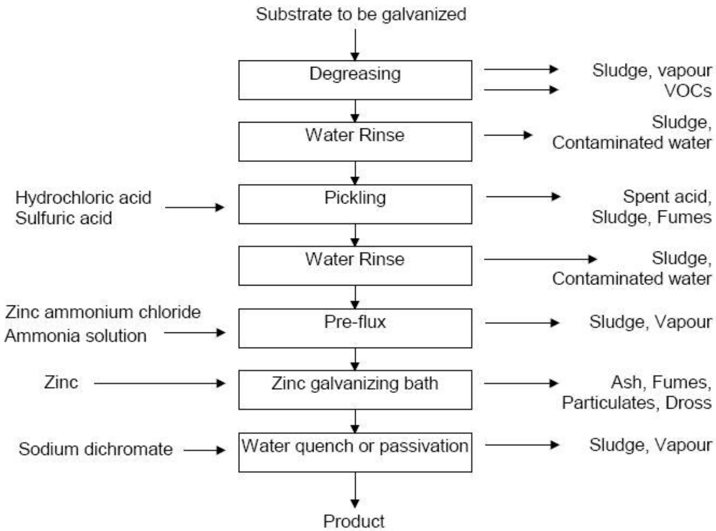

Figure 1. Waste resulting from classic hot dip galvanizing process (source: Emission Estimation Technique Manual for Galvanizing V1.1 by Environment Australia)

In Romania there are many small workshops for discontinuous galvanizing of different steel parts and steel profiles. In these workshops the baths for cleaning the steel support, heated at 60-90 ^{o}C and the zinc bath do not have hoods and adequate venting systems, the environmental aspects being neglected and the environmental risk factors not evaluated. In the environmental risk assessment, at the hot-dip galvanizing unit, for the main identified hazards were established the severity class, the probability class and the resulted risk level as presented in table 2.

Table 2. The severity class, the probability class and the risk for the environmental risk factors identified at the classic hot-dip galvanizing

Code	Risk factor	Severity	Probability	Risk size	Risk level
1.	Alkaline vapors in the air from the degreasing bath vicinity.	3	3	9	2
2.	Acidic vapors in the air from the pickling bath vicinity.	3	5	15	3
3.	Vapors and gases present in the air from the flux bath vicinity.	3	3	9	2
4.	Gases from the flux drying furnace.	3	5	15	4
5	Leakage of acids or soda to transport and storage.	3	2	6	2
6	Leakage of acids or soda to load in pickling and degreasing baths.	3	2	6	2
7.	High concentrations of toxic substances in washing water.	4	2	8	2
8.	Zinc and lead vapors in air inside the unit, near the galvanizing installation.	3	5	15	4
9.	Fine solid particles (PM_{10}) in the air unit, from inside the galvanizing installation.	4	4	16	4
10.	High concentrations of toxic substances in cooling water	4	2	8	2
11.	Droplets of zinc and wastes from the galvanizing bath.	3	3	9	2
12.	Presence of the toxic ion Cr^{6+} in the chroming bath.	4	3	12	3
13.	Solid wastes resulted from the galvanizing bath (slag, cinder, dross).	2	4	8	2
14.	High air temperature in the galvanizing bath vicinity.	2	4	8	2

The environmental risk diagram resulted after establishing the risk is presented in figure 2. In any risk assessment action, significance will be attributed to considerable risks with a great impact on environment and people (risk factor code 2; 4; 8; 9; 12) For these risks to be identified, a ranking is made of risks scale at the workplace, which gives the possibility of establishing a priority of prevention and protection, according to the risk factor with the highest risk level.

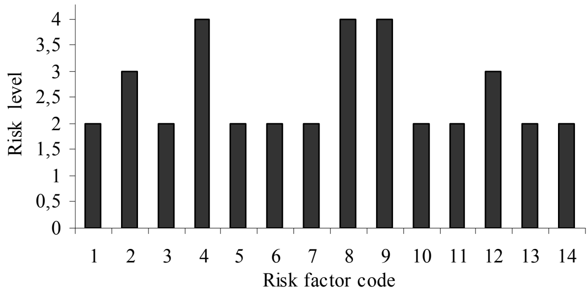

Figure 2. The environmental risk diagram for every identified hazard

The global environmental risk according to relation (1) will be 10.29.
From table 2 is noticed that five of the analyzed risk factors exceeds the global risk and will require supplementary reduction measures.

The reaction to risk. Risk management options applicable in this case study are as follows:
*Toleration***,** through which, no action is taken for risk mitigation, but a regular monitoring is done to see if that risk record significant increases or the exposure level is acceptable. In the case analyzed in this paper this category includes risk factors for which the determined risk level is 1 respectively 2.

Treating, that regulates the application of some measures so that unacceptable risks are reduced to an acceptable risk level. In the studied case the risk levels 3 and 4 will be treated through technological and technical measures, specific to hot-dip galvanizing sector. Limitation of emissions from the surface cleaning baths can be made by installing performed hoods and by replacing classical degreasing and pickling substances with new ones, existing on the market that realizes both processes simultaneously.

In the final treatment the galvanized new solutions, free of CrVI, will be used [7; 8]. This step of the galvanizing process generates the toxic emissions into waste water. The nontreated polluted waste water strongly affects groundwater and surface water [9].

Elimination of lead vapors, that it highly toxic for the human body, will be made by using high purity zinc (SHG) and replacing lead with bismuth (0,5-1%) for keeping the melt fluidity [10]. Limiting the formation of zinc vapors will be made by respecting strictly the galvanizing temperature and avoiding the accidental overheating of the galvanizing bath.

It is a basic activity in the risk management that needs to reflect on concrete actions defined through terms and responsibilities contained in the environmental management program. This management step ensures continuous improvement of activity with results in pollution mitigation and assuring safety at the workplace for employees.

CONCLUSIONS

In small units for hot-dip discontinuously galvanizing that made chemical preparation of the steel support surface, the environmental risk assessment is required.

Unacceptable air pollution risks near the tanks for preparing the surface of steel support can be diminished using new technological solutions that reduces the processes number and by increasing the ventilation capacity.

Eliminating the led vapors, highly toxic for the human body, will be made by using as feedstock high purity zinc (SHG) and replacing lead with bismuth (0,5-1%), for keeping the melt fluidity.
In the final treatment of galvanized parts new solutions, free of CrVI will be used.

The risks identified as acceptable will be permanently monitored to check for eventual rises and to maintain the level.

Monitoring and reviewing in the applied environmental risk management ensures continuous improvement of activity with results in pollution mitigation and assuring safety at the workplace for employees.

REFERENCES

[1]. Moraru R., Băbuţ G., Cadrul general al managementului riscului de mediu, Buletinul AGIR nr. 3/2006, iulie-septembrie, p. 103-107, 2006.

[2]. Băbuţ G., Moraru R., Environmental risk characterization principles, Proceedings of the 6th Conference on Environment and Mineral Processing, part. I, p. 17-21, VŠB-TU Ostrava, Cehia, 27 - 29.06, 2002.

[3]. Beer T., Ziolkowski F., Environmental risk assessment: An Australian perspective, Supervising Scientific report 102, Supervising Scientist, Canberra, Australia, 1995, (http://www.deh.gov.au/ssd/publications/ssr/102.html).

[4]. Moraru R., Băbuţ G., Environmental risk management in mining – An overall approach, Proceedings of the Third International Symposium „Mining and Environmental Protection", p. 22-27, Belgrad-Vrdnik, Yugoslavia, 21-23.05, 2001.

[5]. Ozunu A., Anghel C. I., Evaluarea riscului tehnologic şi securitatea mediului, Editura Accent, Cluj-Napoca, ISBN 978-973-8915-35-0, 2007.

[6]. ***; Emission Estimation Technique Manual, for Galvanizing version 1.1, National Pollutant Inventory, p. 7-9, feb. 2001.

[7]. Jean-Jacques Duprat, Cr VI Free Conversion Coatings on Zinc and Zinc Alloy Coatings, Coventya Symposium, November 2007.

[8]. Marie-Pierre Gigandet, Lionel Thiery, Traitements de conversion sans chrome hexavalent, Les Techniques de l'Ingénieur, M 1 559, 12 – 2004.

[9] G. Dragomir, S. Dragomir, M. Nicolau, C.E Tureac, E. Neculescu, Studies on Water Quality Discharged into the Lower Danube, SGEM 2011, 20- 25, June 2011, Bulgaria, Albena, Conference Proceedings Volume III, p. 631-638, 2011.

[10]. Radu T., Potecaşu F., Vlad M., Drăgan V., Research on obtaining and characterization of zinc micro-alloyed with bismuth coatings, Metal 2010, Czech Republic, 18-20.05, 2010.

EVALUATION OF REDUCTION THERMAL PROCESSING OF WASTE CAR WRECKS PARTS BY THE PYROLYSIS PROCESS

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ABSTRACT

This paper summarizes the results of laboratory experiments of the thermal reducing process of waste polymers and elastomers from the automotive industry, such as tires, color parts of lights and rubber windows seal, and also wood waste, primarily focused on monitoring the quality and composition of the resulting solid and gaseous products. The selected samples were analyzed for basic thermochemical properties (moisture content, ash, volatile matter, fixed carbon, elemental analysis, chlorine content, calorific value). The results of analyzes of these materials appears to be very suitable for pyrolysis, mainly due to the high carbon content and low value of moisture. For each process it was monitored balance of outgoing products (gaseous products, liquid products and solid residue). The gaseous product was analyzed by gas chromatography, the following components were monitored: methane, ethylene, propane, carbon dioxide, carbon monoxide and hydrogen. The solid product produced during pyrolysis process was submitted to analysis of sorption capacity through the iodine adsorption number determination.

Keywords: Pyrolysis, laboratory unit, pyrolysis gas composition, process conditions, a solid residue.

INTRODUCTION

Pyrolysis is the thermal decomposition of organic materials without oxygen-containing media (air, water vapor), which leads to generation of solid, liquid and gaseous fraction [1]. Pyrolysis can be used to convert the waste materials onto the gaseous and liquid fuels. Pyrolysis is also an important step in combustion and gasification [2].

The composition of plastic wastes produced in both the municipal sector and in various industrial sectors is currently very diverse and this diversity is increasing in recent years with the development of new plastic materials. Below are listed the results of research of the pyrolysis of selected types of polymer waste materials, which was first submitted to research of thermochemical properties, whose results are reported in table 1. The selected polymer wastes was submitted with the pyrolysis at 800 °C in laboratory. It was monitored the balance of generating products and evaluated the composition of the generated gaseous and solid phase.

EXPERIMENTAL

For the actual pyrolysis experiments under laboratory conditions the following types of wastes were used:

Sample 1: colored parts of lights (ABS)

Sample 2: tires

Sample 3: rubber seals of car´s windows

Sample 4: waste wood

It was necessary to prepare the samples before the experiment. For the actual experiments, it was necessary to adjust the grain size of samples on the laboratory knife mill. The particle size was below 10 mm. In addition, samples were also adapted to the analytical condition for the determination of fundamental thermochemical properties needed to define the process conditions.

For the individual samples parameters like moisture content, ash, volatile matter and fixed carbon were determined by thermogravimetric analysis on the thermogravimetric analyzer LECO TGA 601. To determine the elemental composition the samples were supplied in the anhydrous state with particle size below 0.2 mm. Elemental analysis was performed on EURO EA – 3000 analyzer, working on the principle of gas chromatogramy. It was determined mass percentage of nitrogen (N), carbon (C), hydrogen (H), sulfur (S) and oxygen (O) in individual samples. Values obtained characterize the sample in the anhydrous state, it was necessary to recalculate the values on the original condition. The gross calorific value of samples in the anhydrous state was determined on calorimetric apparatus LECO AC – 350. Net calorific value of waste samples has been calculated according to the formula for calculating the net calorific value at constant pressure according to CSN ISO 1928 [3] on the basis of laboratory-determined values of gross calorific value and content of hydrogen, oxygen, nitrogen and moisture. Total chlorine content was determined according to standardized procedure, the sample was burned in a bomb calorimeter, taken into solution and assayed total chlorine using ion chromatography on the ion chromatogram WATERS.

Table 1 The properties of observed materials

Parameter	Sample			
	Colored parts of lights	**Tires**	**Rubber seals of car windows**	**Waste wood**
Moisture content [mass %]	0,3	0,8	0,5	8,5
Ash [mass. %]	0,1	3,9	27,2	0,3
Volatile matter [mass %]	97,8	66,9	55,3	75,4
Fixed carbon [mass %]	1,8	28,4	17,0	15,8
Gross calorific value [kJ.kg^{-1}]	38 592	39 368	28 903	16 685
Net calorific value [kJ.kg^{-1}]	36 922	37 718	27 822	15 522
C [mass %]	83,3	87,1	63,5	35,4
H [mass %]	8,1	7,7	5,0	4,3
N [mass %]	5,2	0,5	0,2	0,1
S [mass %]	0,0	0,7	1,7	0,0
O [mass %]	3,0	0,7	22,0	51,4
Cl [mass %]	0,03	0,1	8,5	0,0

The results of the analyzes listed in Table 1 indicate that the selected materials are very suitable for thermal recovery especially because of the high energy content, expressed by the net calorific value and then because of the high content of total combustibles.

From the viewpoint of utilization of materials observed in reduction thermal conditions seems to be an interesting high content of fixed carbon of the sample like tires, with possible use for the production of pyrolysis coke and its use as a sorption agent for its high specific surface. The higher content of volatile matter in the colored parts of car windows substantially facilitates the fuel ignitron and stabilizes the fuel combustion process.

A series of input test experiments in reducing (inert) condition were carried out on the assembled laboratory thermal unit (see fig 1). Four samples were subjected to pyrolysis process. It was the color parts of lights, tires, ruber seals of car windows and wood waste.

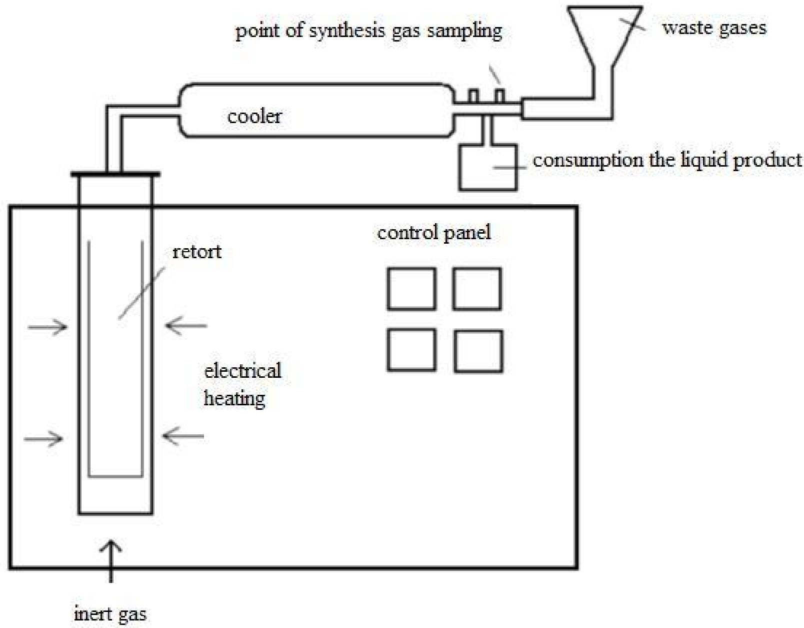

Fig. 1 Laboratory thermal unit

Test experiments were performed in a suitable material such as tires, rubber seals of car windows, colored parts of lights and the waste wood.

For experiments it was taken about 1 kg of each sample into the reaction space of retort. Before the experiments the furnace were blow with inert gas to crowd out all oxygen from the reaction space. Laboratory unit was heated up to a temperature of 800 °C, at a heating rate of 20 °C per minute. The gas fraction was collected in gas sample tubes at temperatures 450 °C, 550 °C, 650 °C and 750 °C. Such collected gaseous samples were immediately analyzed on a gas chromatograph Agilent 7890 A, which is located in the laboratory at the Centre of Environmental Technologies at VSB - Technical University of Ostrava.

Results of analyzes of gaseous products obtained from gas chromatography are summarized in the Table 3.

Through the weighing and measurement of the pyrolysis products was determined the thein balance for individual samples, as shown in Table 2.

Table 2 Balance of pyrolysis products

Sample	condensate [mass %]	solids [mass %]	gas [mass %]
colored parts of lights (ABS)	84,04	4,49	11,47
Tires	47,7	47,2	5,1
rubber seals of car windows	35,0	60,0	5,0
waste wood	57,0	23,0	20,0

Balance of products provides the values of solid and liquid products determined by weighing. The amount of gas is determined by calculation to 100 % of initial weight of each sample. From the results of the process mass balance shows that the highest proportion of condensate is generated by pyrolysis of colored parts of lights. The smallest amount of condensate is generated by pyrolysis of rubber seals of car windows. The maximum amount of solid products resulting from the pyrolysis of rubber seals of car windows, while the lowest yield of solid products gives the pyrolysis of colored parts of car windows.

EVALUATION OF GASEOUS PRODUCTS

In all pyrolysis tests the evolving gas was captured in sampling tube, which was analyzed by gas chromatography on selected component (methane, ethene, propane, hydrogen, carbon dioxide and carbon monoxide). The gas was collected in sampling tubes discontinuously, always in certain procedural temperatures. During one attempt always four gas samples were taken at the temperature 450 °C, 550 °C, 650 °C and 750 °C. Results of gaseous products composition is listed in the Table 3.

Table 3 The composition of gas generating in the pyrolysis process

Sample	Temperature [°C]	Analysis	colored parts of lights (ABS)	Tires	rubber seals of car windows	Waste wood
Methane [vol.%]	450	1.	0,29	3,74	0,39	2,43
	550	2.	0,16	8,95	6,13	8,48
	650	3.	0,36	8,56	2,21	5,48
	750	4.	3,61	2,94	3,19	4,62
Ethene [vol.%]	450	1.	0,22	1,85	0,80	0,26
	550	2.	0,15	2,94	11,78	0,73
	650	3.	0,20	1,95	3,20	0,32
	750	4.	1,07	0,58	3,41	0,20
Propane [vol.%]	450	1.	0,08	1,00	0,42	0,10
	550	2.	0,00	1,10	2,29	0,19
	650	3.	0,01	0,64	0,18	0,05
	750	4.	0,06	0,20	0,57	0,32

Sample	Temperature [°C]	Analysis	colored parts of lights (ABS)	Tires	rubber seals of car windows	Waste wood
H_2 [vol.%]	450	1.	—	—	—	6,56
	550	2.	—	6,24	5,64	6,88
	650	3.	—	6,26	5,12	7,36
	750	4.	6,56	4,14	5,25	8,40
CO [vol.%]	450	1.	0,35	23,21	2,68	9,01
	550	2.	—	45,02	15,26	20,49
	650	3.	3,05	44,27	8,62	16,77
	750	4.	23,98	22,03	12,38	14,93
CO_2 [vol.%]	450	1.	1,30	4,77	1,53	18,30
	550	2.	0,80	1,88	5,98	20,09
	650	3.	0,68	1,68	1,64	5,90
	750	4.	2,62	0,92	1,77	4,48

The above table shows the results of analysis of gas produced during the pyrolysis of selected samples at temperatures of 450 °C, 550 °C, 650 °C and 750 °C.

The thermoplastic (ABS) waste materials processing showed that the pyrolysis gas sampling temperature 750 °C seems to be as the best of all the selected temperatures, in terms of the maximum content of flammable components and therefore is suitable for potential use as an energy source.

In the case of thermosets, the situation is somewhat different, here is developed gas rich for flammable components in the temperature range from 550 °C to 650 °C, it can be confirmed by data reported in the literature. In this temperature range it is the most intense evolution of pyrolysis gas under atmospheric conditions. A similar trend also show data obtained by analyzing the gaseous fraction after pyrolysis of waste wood.

EVALUATION OF SOLID PRODUCTS

One possibility of material recovery of solid gasification products is their processing for the purposes of the adsorbent preparation. Adsorbents are highly porous materials (activated carbon, activated coke, etc.) with a developed internal surface and the relevant adsorption skills that are capable of capturing gaseous or liquid mixtures of certain substances. The high adsorption capacity of adsorbents is caused by a large number of pores of different sizes. They are mainly applied in the cleaning technologies [4]. In addition to natural sources of adsorbents (e.g. zeolites), producers are focused on adsorbents, prepared artificially, when the raw materials can be of different origin, usually of organic nature (brown coal, black coal, lignite, etc.).

The quality of the adsorbent is subject to the requirements that stem from their future use. The quality of the adsorbent is characterized by range of parameters and properties to be assessed. Among the main characteristics and parameters that can characterize adsorbents include bulk density, apparent and real density, specific surface area, pore volume of the adsorption, pore size distribution and iodine adsorption number. The results of iodine value determination shows the Table 4.

Table 4 Iodine adsorption number

Sample	Iodine adsorption number [$mg.g^{-1}$]
colored parts of lights	85
Tires	253
rubber seals of car windows	331
waste wood	301

From the results it appears that highest value of iodine adsorption number has the solid residue from the pyrolysis of rubber seals. The possibility of using solid products resulting from pyrolysis of colored parts of lights as the sorbent is very limited, the possibility of its use may be, for example in construction. Conversely solid residues generated during pyrolysis such as tires, waste wood and rubber seals of car windows can also be used as so-called single-use sorbent for the cleaning of waste water.

DISCUSSION AND CONCLUSIONS

The measured results discussion of the experiments is conducted in different parts of the paper describing the course of these measurements.

This paper summarizes the results of the research project, focused on research of pyrolysis of waste materials from the automotive industry. This paper summarizes the results of research on thermochemical properties of selected waste materials, construction of the apparatus used to perform measured experiments of the reduction thermal decomposition of selected waste materials, realization the series of measurements of selected waste materials in which gaseous and solid products were evaluated.

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REFERENCES

[1] Obroučka, K. Termické odstraňování a energetické využívání odpadů. Vyd. 1. Ostrava: VŠB - Technická univerzita Ostrava, 2003. 143 s. ISBN 80-248-0009-8.

[2] White, J.E; Catallo, W.J; Legendre, B.L. Biomass pyrolysis kinetics: A comparative critical review with relevant agricultural residue case studies. Journal of Analytical and Applied Pyrolysis, 2011, vol. 91, no. 1, p. 1-33.

[3] ČSN ISO 1928 Tuhá paliva – stanovení spalného tepla kalorimetrickou metodou v tlakové nádobě a výpočet výhřevnosti. ČSNI PRAHA, 1999.

[4] Buchtele J., Roubíček V: Uhlí, zdroje, procesy, užití. Ostrava: Montanex, 2002. 173 s. ISBN 80-7225-063-9.

EXPERIMENTAL PROPOSAL OF THE METHODOLOGY FOR A COMPREHENSIVE ASSESSMENT OF THE WORKING ENVIRONMENT QUALITY USING APPLICABLE MATHEMATICAL METHODS

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ABSTRACT

This contribution is devoted to the experimental proposal of the methodology for a comprehensive assessment of the working environment quality. Because recent development raises the need to know as much as possible about living and working environments, thoroughly learn the working conditions and all factors that affect health therefore is also necessary to select such evaluation procedures, which would reduce as much as possible the negative effects of these factors on workers. Health at work and healthy working conditions are among the highest rated assets of individuals, communities and states.

Keywords: proposal of the methodology, quality working environment, mathematical methods

INTRODUCTION

Risk assessment is the **process of qualitative and quantitative risk assessment** for occupational health and safety of workers. The more negative factors applied to the working environment, the greater the negative effects on the human organism. In assessing the working environment are used various methods and procedures designed to assess the possibility of harm. Therefore it is necessary to choose a suitable complex multi-criteria method, which, according to obtained information could determine the size of load of a man within the working environment. Selection criteria for assessment are not simple, because there are many indicators that characterize the working environment load. Before the assessment method is determined, it is appropriate to combine qualitative and quantitative assessment, thereby establishing a system for measurement of working environment, taking into account: **the nature of the impacts of the working environment parameters, duration of the impact, the range of risk factors operating simultaneously, and the magnitude of the impact of individual parameters of the working environment.**

With the mathematical formulation can be reached the target state, which is the idea of a display of the objective complete working environment quality in the spatial coordinates that define the different views, approaches and needs of the specification of the working environment parameters. In the designing of an experimental methodology of a comprehensive assessment of the quality of working environment we will build on the condition that the worker is affected during his work at different job positions by various risk factors. These factors vary by their intensity and duration on which depends their influence on human organism. To quantify these effects is difficult because: [7]

- Each parameter in the working environment **requires a different approach** in analysing its effect on humans,
- Each parameter has a **wide range of effects**,
- The impact of individual risk factors **varies with time and change of working activity**,
- The perception of the effects of the working environment is significantly an **individual** matter.

It is important to determine also whether the environment will be evaluated by one criterion or we have more criteria available. In our case we propose to deal with the evaluation of multiple criteria simultaneously. We propose the following evaluation procedure:

- **Selection of the methods of the working environment quality assessment,**
- **Selection and measurement of the risk factors,**
- **Determining the weights of criteria (Saaty method and calculation by the software SANNA),**
- **Normalisation of the measured values,**
- **Calculation of the total load,**
- **Risk assessment (determination of the risk acceptability).**

SELECTION OF THE METHODS OF THE WORKING ENVIRONMENT QUALITY ASSESSMENT

Methods of decision making in general, present the summary of rules and procedures, using which we can come to choosing the best solution. The current situation offers us a wide range of methods of decision making. If we use a distribution based on mutual relation of empiricism and theory contained in the individual methods, it is possible to divide them into three groups of empirical, heuristic and exact methods. [2]

In solving practical problems such as the comprehensive assessment of the working environment quality is appropriate to use one of the following methods of multi-criteria decision making. Specific methods, which can be used by a comprehensive assessment, can be as follows: **point method of assessment, proportion index method, Decision Matrix Method - DMM, Forced Decision Matrix Method - FDMM, Analytic Hierarchy Process - AHP, method of quantitative comparison - Fuller method, ranking method, etc.**

The specified methods of multi-criteria decision making vary mainly according to how they determine so called weight of individual criterion. **The comprehensive assessment of working environment quality to determine the weights of the criteria we use one of the exact methods and the analytical multilevel evaluation method AHP, which provides a framework for effective decisions in complex decision making situations, it helps simplify and accelerate the natural process of decision making process.** [1, 3]

SELECTION AND MEASUREMENT OF THE RISK FACTORS

By the comprehensive assessment of the working environment is evaluated the interaction of all risk factors. In this case enter the process the workplace factors: noise, vibration, lighting, air purity, or dust, electromagnetic fields, ergonomics, radiant heat, physical stress, hygienic factors and safety factors. The most important step is the selection and evaluation will be based on an evaluation of information of interviewed people and also from expert opinions. The next step of a comprehensive evaluation is the measurement of risk factors. The results should then be processed to evaluate and draw conclusions from them.

DETERMINING THE WEIGHTS OF CRITERIA (SAATY´S METHOD)

The AHP method provides a comprehensive and coherent approach to structuring the problem to quantify the elements that relate to the overall objectives and for evaluating the alternative solutions. Before the application of the method, the valuation entity must define any criteria on the basis of which the evaluation will be conducted. [5]

This method is based on pairwise comparisons of the degree of significance of individual criteria. The evaluation is based on so called expert estimation, by which the experts in the field can compare the mutual effect of two factors. These evaluate on the basis of the scale **[equal - weak - moderate - strong – very strong]**, and to this wording evaluation correspondents following values **[1 - 3 - 5 - 7 - 9]**. [6]

	9	**7**	**5**	**3**	**1**	**3**	**5**	**7**	**9**	
Factor A								**X**	**X**	Factor B
	Very strong	**Strong**	**Modera te**	**Weak**	**Equal**	**Weak**	**Modera te**	**Strong**	**Very strong**	

The pairwise comparison the two criteria are placed in the opposite ends of the line against each other and compared, which is more important. In the middle of the line is number 1, which means that the compared criteria are equally important. Along the line are the numbers 1 to 9, where the number 9 means that the criterion on the relevant end was more important than at the other end criterion. In this case, the form for the evaluation are indicated two options (strong and very strong predominance of factor B over factor A), and as the resulting assessment will appear in the line of the factor B and the column of the factor A the value „8“, and in the line of the factor A and the column of the factor B will be indicated the inverse value i.e. the value „1/8“. If **n** is the total number of elements, which are compared, then the number of comparisons is [5] (Saaty, 1985)

$$n(n-1)/2.$$

Further procedure for determining the weights of criteria is more complicated than other methods because it is necessary:

- For each pairwise comparison matrix to determine a **normalised self-vector** corresponding the maximum real **self-worth (number) matrix,** as considered in an absolute value,
- Its components which accordingly determine the weights of criteria and the resulting evaluation can be reached the same way as the **weighted sum** of the determined evaluations multiplied by the weights of criteria.

General procedure of solution

I. Realisation of the pairwise comparison of the criteria and comparison of the scenarios according to the individual criteria – gaining the matrices.

	f_1	f_2	...	f_k
f_1	1	s_{12}	...	s_{1k}
f_2	$1/s_{12}$	1	...	s_{2k}
...	...			
f_k	$1/s_{1k}$	$1/s_{2k}$	...	1

II. Determination of self-worth (self-number) of each matrix
A. Obtaining the characteristic polynomial

a) *Solve the matrix determinant form* $(\mathbf{A_i} - \lambda.\mathbf{J}) = 0$
b) *Use the Fadejev method*
c) *Use the available software (Matlab, Mathematica etc.)*

B. Determination of the roots of the characteristic polynomial and get their self-number, for which is valid $\max|\lambda_i| = SN$

a) *Procedures for dealing with such polynomials for example Bairstow method*
b) *To use the available software (Matlab, Mathematica etc.)*

III. Obtaining the values of the self-vector matrix
A. Determined self-number of matrix introduced into the system in the form $(\mathbf{A} - \lambda.\mathbf{J}).\mathbf{x} = 0$
B. We obtain a homogeneous system n – equations (with zero right sides). The solution of it we obtain values so called **self-vector.**

a) *Use the method of LAR system solution, for example Gauss elimination method, LU decomposition, Gauss - Jordan method etc.*
b) *Use the available software (Matlab, Mathematica etc.)*

IV. The transformation of self-vector matrix to the normalised self-vector, which components determine the weights of individual criteria and weights of variations according to how they fulfil the requirements of individual criteria.
V. The final evaluation and ranking by the weighted sums. [6]

In the Tab. 1 are shown the weights of criteria determined by Saaty´s method of evaluation.

Tab. 1 Saaty´s method of weight criteria estimation

s(i,j)	Criteria					R(i)	Weight
Criteria	K1	K2	K3	K4	Π a(i,j)	[Π a(i,j)]$^{1/4}$	v(i)
K1	1	3	4	5	60	1	0,5462
K2	1/3	1	2	3	2	0,4253	0,2323
K3	1/4	1/2	1	2	1/4	0,2521	0,1377
K4	1/5	1/3	1/2	1	1/30	0,1533	0,0837
Total						1,8307	1,0000

APPLICATION OF THE SOFTWARE SANNA

Calculation of the vector of weights from the paired comparison matrix is usually part of the special programs implemented by AHP method. The calculation is also possible to realise in Excel with the utilisation of so called Wielandt theorem. This mathematical theorem states that for a vector of weights reciprocal pairwise comparisons matrix is valid:

$$\lim_{r \to \infty} \frac{S^r.e}{e^T.S^r.e} = c.v$$

The relation states that the vector formed by sums of row elements **r-squared** matrix **S** divided by the sum of all elements of this matrix is close enough for sufficiently large **r** of the self-vector of the matrix **S** corresponding to the largest self-number. In individual interact will be calculated the relation **(Sr.e)/ (eT.Sr.e)** pre **r = 1, 2, 4, 8 ...** and it is followed how the calculated vectors differ in two consecutive interacts. We can achieve the sufficient accuracy at **r = 16**. [4, 8]

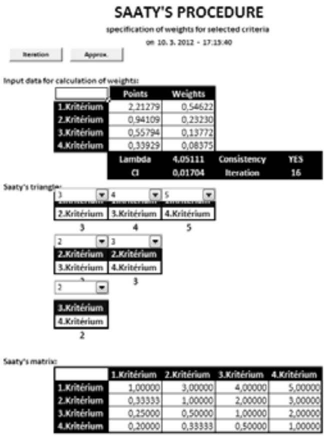

Fig. 1 SANNA: Saaty´s calculation o weight criteria

Such mathematical calculation is used also by the software **SANNA** (Fig. 1) – System for Analysis of Alternatives. The application utilises five methods of assessment (TOPSIS, WSA, ELECTRE I, PROMETHEE II and MAPPAC) and enables to determine the weights by three methods (Point method, Fuller´s method and Saaty´s procedure) and to solve multi-criteria problems by seven methods (TOPSIS, WSA, ELECTRE I, ELECTRE III, PROMETHEE II, ORESTE and MAPPAC). With SANNA it is possible to solve up to 100 variations and 50 criteria. [9]

NORMALISATION OF THE MEASURED VALUES WITHIN THE INTERVAL <0, 1>

The calculation of the measured values for indicators in the interval <0, 1> can be performed on the relation

$$F_{ij} = 1 - \frac{L_H - L_A}{L_H - L_D}$$

where: $\boldsymbol{F_{ij}}$ – normalised value of the basic indicator j from the class of the factor i, $\boldsymbol{L_H}$ – upper limit value of the factor, $\boldsymbol{L_D}$ – lower limit value of the factor, $\boldsymbol{L_A}$ – actual (measured) value of the factor. [7]

CALCULATION OF THE TOTAL LOAD

Interpretation of the final coefficient calculation evaluating the level of the working environment at a workplace or in a group of workplaces is based on Tab. 2 and Fig. 2. Manual calculation is appropriate to process according to the procedure set in Tab. 2.

Tab. 2 Procedure of calculation of the factor values of the working environment at n-workplace or valid for n-worker

Factors of the working environment	Normalised weight of a vector	Workplaces									Evaluation of each factor at all workplaces
		1		2		j		.....	n		
Factor 1	$\mathbf{v_1}$	F_{11}	ϑ_{11}	F_{12}	ϑ_{12}	F_{1j}	ϑ_{1j}		F_{1n}	ϑ_{1n}	
Factor 2	$\mathbf{v_2}$	F_{21}	ϑ_{21}	F_{22}	ϑ_{22}	F_{2j}	ϑ_{2j}		F_{2n}	ϑ_{2n}	
.....											
Factor i	$\mathbf{v_i}$	F_{i1}	ϑ_{i1}	F_{i2}	ϑ_{i2}	F_{ij}	ϑ_{ij}		F_{in}	ϑ_{in}	
.....											
Factor m	$\mathbf{v_m}$	F_{m1}	ϑ_{m1}	F_{m2}	ϑ_{m2}	F_{mj}	ϑ_{mj}		F_{mn}	ϑ_{mn}	
Evaluation of all parameters according to workplaces			$\boldsymbol{\vartheta_1}$		$\boldsymbol{\vartheta_2}$		$\boldsymbol{\vartheta_j}$			$\boldsymbol{\vartheta_n}$	$\vartheta_p = \frac{\sum_{j=1}^{n} \vartheta_j}{n}$

Real load of the working environment by the safety factors we can express in following relation $\vartheta_{ij} = \mathrm{v}_i . F_{ij}$

Where: $\boldsymbol{\vartheta}$ – real load by the safety factors, $\boldsymbol{v_i}$ – normalised value of the vector weight, $\boldsymbol{F_{ij}}$ – measured normalised value of the safety factors.

The average value of the load by individual indicators $\boldsymbol{\vartheta_p}$, which is the indicator of the average load of the whole working environment we can state as follows

$$\vartheta_p = \frac{\sum_{j=1}^{n} \vartheta_j}{n}$$

Where: $\boldsymbol{\vartheta_j}$ – are the elements of the column vector.

Overall load of the working environment is then given by $\vartheta = \sum_{j=1}^{n} \vartheta_j$.

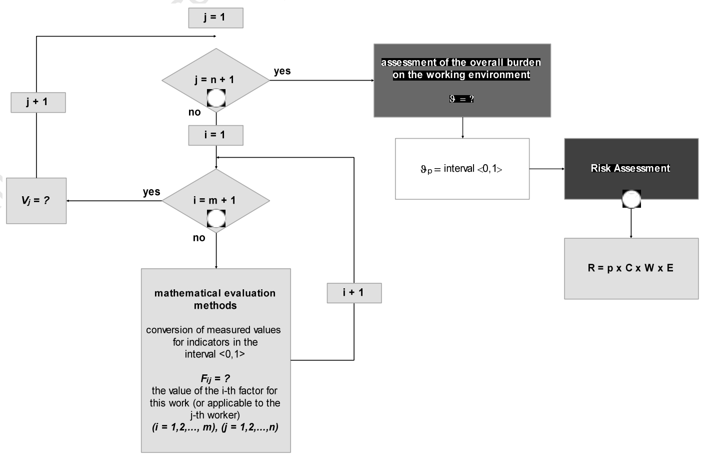

Fig. 2 Procedure of the calculation of the working environment factor values at the n-workplace

RISK ASSESSMENT

If the **risk (R)** is the probability of formation and at the same time the severity of consequences or adverse event, we state that the risk is the function of two basic parameters: **probability (p)** and **consequence (C)**. Mathematically expressed: **R = p x C.** And the symbol **x** expresses the type of function according to the type of evaluation (it can be a matrix or conjunction). In our opinion, a straightforward risk assessment process in five steps is suitable: **Step 1: Identifying hazards and persons at risk, Step 2: Risk assessment and prioritizing, Step 3: Deciding on preventive measurements, Step 4: Taking action, Step 5: Monitoring and control.**

Choice of approach to the assessment will depend on the **nature of the workplace** (e.g. stable or temporary operation), the **type of process** (e.g. repetitive activities, developing / changing processes, work on the contract), the **task being performed** (e.g. repetitive, occasional or high risk) and **technical complexity.** [10]

Criteria of system safety evaluation and risk assessment are not firm. As accepted risk is considered the risk which the persons in concern taking into account all operational and human conditions will be willing to bear. In our case, the risk assessment method was selected the point method. Compared to the classical definition of risk is by the assessment of the risk level utilized the expanded definition of the risk in the following form:

R (risk) = p (probability) x C (consequence) x W (effect of the safety and health at work) x E (period of exposition)

Where: **p** – probability we determine on the basis of the Gauss function of the density of the probability normal distribution and overall load of the working environment adapted for our case study.

and: $$p = 5 - \frac{1}{0{,}1\sqrt{2\pi}} e^{-\frac{(\vartheta - 0{,}5)^2}{2.0{,}1^2}}$$

then: $$\mathbf{R = 5 - \frac{1}{0{,}1\sqrt{2\pi}} e^{-\frac{(\vartheta - 0{,}5)^2}{2.0{,}1^2}}} \text{ x } \mathbf{D} \text{ x } \mathbf{V} \text{ x } \mathbf{E}$$

Risk – final indicator, which is the product of the four values of risk parameters. The lowest value can be 1 and the highest 625. The score range is classified into five risk categories according to the points: **Insignificant, Negligible risk; acceptable, Less significant risk; Adverse risk; Significant risk and Unacceptable risk**.

CONCLUSION

Comprehensive evaluation of the environmental quality is a new innovative approach for assessing the effects on humans. It should be noted that this issue is complicated and therefore there are many approaches to its solution. The methodology presented in this paper describes the authors' idea about how to resolve this issue. The presented results are based on past experience in the field of measurement and evaluation of environmental factors, the authors actually perform.

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REFERENCES

[1] Ramík, J. 1999: Vícekriteriální rozhodování - Analytický hierarchický proces (AHP), Karviná: Slezská univerzita, 1999. ISBN 80-7248-047-2

[2] Máca, J., Leitner, B. 2002: Operačná analýza I. Deterministické metódy operačnej analýzy. 2. vydanie. Žilinská univerzita. Žilina 2002. ISBN 80-88829-39-9

[3] Hnilica R. 2011: Development of framework for assessment of combined effects of risk factors. Acta Facultatis Technicae. No.2/2011. Zvolen 2011. ISSN 1336-4472

[4] Korviny P.: Teoretické základy vícekriteriálního rozhodování. Dostupné na: http://korviny.cz/teorie_mca.pdf

[5] Roháčová, I., Marková, Z. 2009: The Analysis of AHP method and its potential use in logistics. Acta Montanistica Slovaca. Ročník 14. 2009. Číslo 1. pp. 103-112. ISSN 1335-1788

[6] Viackriteriálne (multikriteriálne) rozhodovanie (rozhodovacia analýza). Dostupné na: http://fsi.uniza.sk/01_VR_1.pdf

[7] Lumnitzer, E., Badida, M., Romanová, M., 2007: Hodnotenie kvality prostredia. Elfa s.r.o., Košice 2007. ISBN 978-80-8073-836-5

[8] Ramík, J. 2010: Analytický hierarchický proces (AHP) a jeho možnosti uplatnění při hodnocení a podpoře rozhodování. Sborník příspěvků z konference Matematika v ekonomice. Vydaní: První. Jihlava 2010. ISBN 978-80-87035-34-4

[9] Mašátová, J. 2011: Výběr vhodného softwaru z pohledu vícekriteriálního rozhodování. Diplomová práce. Vysoká škola ekonomická v Praze. Fakulta informatiky a statistiky

[10] Ako vykonávať hodnotenie rizík. Dostupné na: http://osha.europa.eu/

EXPLOITATION OF SAND AND GRAVEL IN THE RIVERS OF KOSOVA-ENVIRONMENTAL CHALLENGE

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ABSTRACT

The purpose of this paper is analysis and assessment through theoretical and research method affected in drawing attention to deal more seriously with the problem and the damage caused for years by exploitation of sand and gravel in the rivers of Kosova.

During this activity by different companies a major damage and degradation on environment has been caused, as the landscape changes, deterioration of riverbeds, flood, and water increasingly polluted, endangering the flora and fauna, depletion of water in fish, soil erosion, impacts of noise and vibration, which affect the quality of life and human health.

Activities by illegal companies, mainly in exploration and separation of sand and gravel in alluvium, on the banks of almost all rivers in Kosova (Lumbardhë, Drini i Bardhë, Erenik, Lepenc, Krivarekë, Morava e Binçës, Ibër, Sitnicë, Llap, etj).

According to the analysis, indicates that the length of the riverbeds in the Republic of Kosova, threatened by flooding is around 491km.The most drastic case is to destruction of river bank of "Lumi i Bardhë" ,which has longest flow in the territory of Kosova with 122 km, specifically part from Kramoviku to the Gjonaj region.

Final proposals are to undertake all necessary measures to put this activity under control according to the criteria specified. Activities to take place at least 50m from the river bank, then according to the annual river flow to extract adequate quantities of sand and gravel. Beginning the correction of actual situation should start with development of a national program by the respective institutions for the rehabilitation and re-cultivation of damaged and degraded environment.

Key words: exploitation, sand and gravel, river, degradation, environment.

INTRODUCTION

Taking into consideration the trends, today among the world's current issues are environmental issues. Stable countries and powerful government`s worldwide did put environmental issues very high on their agendas. EU countries on this issue are doing especially efforts. They have set standards for environmental issues for their countries but as well for the countries that are candidates or potential candidates for EU membership, like we are. Just to remind that within the questionnaire prepared for the EU candidate countries, about 1/3 of the questions are only for the environmental and agricultural issues. Therefore one of the criteria for EU membership, which is very important and requires commitment, is environmental criteria.

Environmental problems at both local and global levels have impacts on economic, political, social, demographic, psychological and other issues. Irresponsible approach to environmental values on individual and institutional level consistently are observed in our country. If the problems will not be treated properly in the future we'll face inevitably with ecological disaster[5].

Kosova river basins mainly degraded by uncontrolled activities of operators, who perform the exploitation of sand and gravel in rivers and around their banks. Rivers affected by this phenomenon are in basin of Drini i Bardhë which is is mostly damaged, then Ereniku river and part of the river Lumbardhë in Peja. The most degraded areas and continues to deteriorate Drini i Bardhë river is in part that starts up in the village Kramovik Gjonaj. While the most damaging part of Ereniku river that starts from the village of Korenica to Tabaku Bridge (at the entrance to town Gjakova)[2].

In all above mentionted places sand and gravel exploitation has been done without any criteria, either in terms of maintaining water regime, either in terms of exploitation of mineral raw. Changing the water regime has also caused changes in the rivers banks and therefore the entire area of arable land is lost.

Last year Progress report, in paragraph 42 mentioned clear degradation of riverbeds and with specific emphasis degradation of Drini i Bardhë river.

MATERIALS AND METHODS

A possibility of inert exploitation is the topic which is treated with combined methodology. Taking into consideration the complexity of the topic being treated, we should apply appropriate approach and methodology to reach the compilation and provision of a paper with data on the extraction of sand and gravel and the situation in the rivers banks of Kosova.

Studies and observations conducted in locations mentioned and summarized by estimations, draft projects and given data for nowadays exploitation had to adapt to different demands of study for all cases, with theoretical methods of description, analysis and outcome evaluation, based on estimations and actual statistics described in Environmental impact Assessments, the impact on certain ecosystems.

Finally after an elaboration conducted in this paper, conclusions and recommendations for strategic planning and utilization in this sector will follow up.

Kosova needs an urgent economical development, but well balanced development, where exploitation of sand and gravel from the rivers will not be seen as the only chance to advance the economy. Inclusion of this sector will be facilitated by exploiting the limestone to create conditions for economic development but always taking care to don't abuse the most vital segments of society - of the environment[4].

RIVERS NETWORK IN KOSOVA

Kosova has limited water reserves which can be in the future an obstacle to economic and social development. All 22 rivers of Kosova are divided into four river basins which flow in different directions (Figure 1):

Drini i Bardhë, Ibri, Morava e Binçës and Lepenci.

Kosova has an estimated 1600 m^3/water per capita. Protection, conservation and development of water resources are of great importance and are one of the biggest environmental challenges[1].

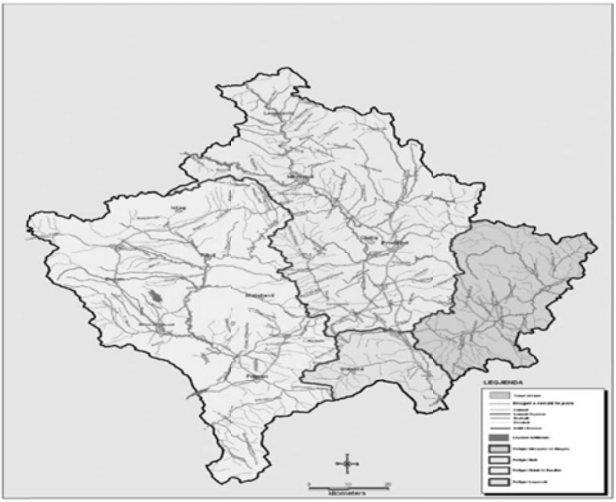

Figure1. Map of basins and rivers network in the territory of Republic of Kosova

The data for the length of the main rivers within the territory of Kosova are presented in the table below.

Table 1 Length in kilometers and the surface of the main river basins of Kosova

River	Length in km within territory of Kosova	Surface in km^2
Drini i Bardhë	122	4.622
Sitnica	90	2.873
Lumbardhi Pejë	62	424.9
Morava e Binçës	60	1.552
Lepenci	53	679.0
Ereniku	51	510.3
Ibri	42	1.155
Lumbardhi Prizren	31	262.6

ANALYSIS OF THE SITUATION IN ENVIRONMENT FROM THE ACTIVITIES OF SAND AND GRAVEL EXPLOITATION IN RIVERS BANKS OF KOSOVA

Mining exploitation, separation and processing of natural resources have contributed to environmental pollution[5]. Since this pollution to be controlled and managed with much lower impact on the environment, operators must be equipped and work regarding to legal licenses which are issued by the competent authorities under applicable law[6].

During analyses it was noticed that majority of operators who perform exploitation of sand and gravel have Working License and Environmental Accordance but they do not apply the criteria under which they should operate, they do not follow recommendations and conditions outlined in the report of Environment Impact Assessment being that based on project they are obliged after exploitation to perform rehabilitation and re-cultivation of degraded area[7].

There are cases when operators with working licenses their activities develop outside exploitation fields. If preventive and punitive measures against illegal operators wouldn't undertaken than all those legal operators that respect the state and its laws will be discouraged

Both legal and illegal operators are causing significant negative impacts on the environment such as: changing the important features of the environmental situation, major environmental degradation, the landscape changes, the effects of noise and vibrations, changes in microclimate, impacts on flora and fauna, natural heritage and geology that affect the quality of life and human health[3].

Based on data from the field, in 22 rivers 103 operators were identified which are doing exploitation of sand and gravel from the rivers, rivers banks and areas around rivers in the territory of Kosova[1]. The current situation on the field is worsening every year.

Erosion and streams in rivers of Kosova also leopardize nature and the public and private assets created and planned. These are manifested in the degradation of agricultural and forest land, road and rail network, as well as buildings and settlements. Productivity of allusions is more emphasized upstream of the river Ibri (situation should improve with the measures and anti erosive actions). Also Lepenci, Drin i Bardhë and Morava e Binçës basin surfaces are vulnerable to erosion, while lower risk to erosion is Sitnica River Basin.

Also big concern is that in rivers garbage is thrown by operators and conscienceless citizens and that makes even more difficult situation on the ground.

As a result of water pollution and degradation of riverbeds, biodiversity of river ecosystems is seriously diminished, especially in terms of fish species.

Distinctive phenomenon is that greater degradation in the field is caused from exploitation and separation of sand and gravel from illegal operators. The most drastic case is degradation of agricultural land , destruction of riverbeds and changes of water flow along various rivers in Kosova and especially along the Drini i Bardhë river from Kramoviku by up to Gjonaj (Figure 1).

Figure 1. View of river flow change along the Drini Bardhë river

As a result of indiscrimination during sand and gravel exploitation, agricultural land is degraded and the direction of water flow of the Drini i Bardhë river is changed. (Figure 2).

Figure 2. View of agricultural land degradation along the Drini Bardhë river

CONCLUSIONS AND RECOMANDATIONS

By anthropogenic activities riverbeds, riversides and areas around rivers in Kosova have been subject of uncontrolled exploitation of sand and gravel that has caused the degradation of these areas. Higher degree of degradation from sand and gravel exploitation has Drini i Bardhë and Ereniku rivers and partly Lumbardhi i Pejës.

Based on analyses in 22 rivers, 103 operators were identified, which are doing exploitation of sand and gravel around the rivers and agricultural lands. Most of these operators do not follow, even approximately, the conditions of Working Licenses and Environmental Impact Assessments. It is also concluded that number of illegal operators who did uncontrolled exploitation of the river sand and gravel threatening to flood about 491 km in length.

Uncontrolled sand and gravel exploitation damaged nature and riverbeds but also did the impoverishment of flora and fauna which has consequently impact on river's depletion. This also represents a threat to public safety, permanent risk from flowing and flooding.

Policy makers at the institutions that have an obligation and responsibility to the environment as soon as possible should undertake concrete steps and approaches to create and develop strategy of this kind of activities based on the principles of Environmental Protection and Sustainable Development Strategy.

Development of Environmental Policy should foresee interruption of operations of sand and gravel exploitation taking into consideration market demands for this kind of product and favoring the exploitation of limestone.

Sand and gravel's annual flow should be analyzed and each river characteristics when there is a lot of rainfall cleaning has to be every three years whereas leveling every each year.

One of the preconditions to begin in a general national plan for rehabilitation and re-cultivation the degraded spaces is to be estimated the degradation of river beds, rivers coasts, fields on river and gravel's exploitation fields.

For this program realization and to stabilize the situation it would be great that in a period of three years to discontinue the whole operator's activity from the spaces around the rivers.

To be issued as soon as possible a draft environmental protection fund after advanced practice s of legislation of EU to make it possible the sustainable development environmental protection progress.

Realization of the Understanding Memorandum with all the relevant Ministries that the decision has to be applied in precision and give a successful result.

Kosova police to forbid and legitimize all transport vehicles charged with sand and gravel from river space, whereas to those people to initiate against them a procedure according to applicable laws.

Being ready to enter into the UN requires time and besides fulfilling of these criteria (so that the progress report last year explicitly mentioned in paragraph 42 of river bed degradation and especially the river bed Drini i Bardhë requires long time, early identification of these areas should be priority.

REFERENCES

[1] Ministry of Environment and Spatial Planning/ Kosova Environmental Protection Agency, "Kosova State of the Environment Report 2008-2010". Prishtina-Kosova. pp 91-99. 2011.

[2]. Ministry of Environment and Spatial Planning/ Kosova Environmental Protection Agency, "Kosova State of the Environment Report 2006-2007". Prishtina-Kosova, pp 52-69. 2008.

[3] Report of Joint Commission ICMM and MESP on Environment Condition for the Government of Kosova.Prishtina-Kosova. pp 4-10. 2009.

[4] B. Baruti, A. Vitaku, I. Malollari, R. Zeqiri, M. Kelmendi, "Analysis of the possibilities of decrease the impact of crushing operations on environment". Journal of ENVIRONMENTAL PROTECTION AND ECOLOGY. Vol.12. No.4A, Thessaloniki-Greece. pp 2056-2061. 2011

[5] Carl Bro "Estimate the Impact in the Environment and Action Plan on Environment". Prishtina-Kosova. 2003.

[6] Assembly of Kosova, "The Environmental Protection Law". DL-007-2009. Nr.03/L-025, Prishtina-Kosova, 2009.

[7] Assembly of Kosova, "On Environmental Impact Assessment". DL-048-2010, Nr.03/L-214. Prishtina-Kosova, 2010.

FREQUENCY OF DIVIDING CELLS AND GROWTH RATES IN POPULATION OF FILAMENTOUS CYANOBACTERIA ISOLATED FROM SULPHUROUS MESOTHERMAL SPRING OBANUL MARE (MANGALIA)

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ABSTRACT

This report presents the use of frequency of dividing cells (FDC) method to calculate the growth rate in populations of filamentous (heterocystous and nonheterocystous) cyanobacteria isolated from sulphurous mesothermal spring from Obanul Mare (Mangalia).Septa were counted on heat - fixed preparations of cyanobacteria (300 cells per sample) stained with 0.02% crystal violet, using digital image analysis using two software CellC and ImageJ to clearly observe the shape of the dividing cells form filaments allowing us to obtain accurate data: for heterocyst forming strain (IS-H) the maximum growth rate on BG_0 in light is 0.039 h^{-1} and for non heterocyst forming strain (FG-11) the maximum growth rate on BG_{11} in light is 0.057 h^{-1}.

Keywords: frequency of dividing cells, growth rate, filamentous heterocystous cyanobacteria, digital image analysis.

INTRODUCTION

The frequency of dividing cell (FCD) is an indirect measure of growth rate in bacteria (Hagström et al., 1979, Campbell & Carpenter, 1986; Carpenter & Campbell, 1988; Nielsen, 2006) and this report extended and applied this technique on populations of filamentous heterocystous cyanobacteria isolated from sulphurous mesothermal spring Obanul Mare - Mangalia (Sarchizian and Ardelean, 2010). It has recently been proposed that the frequency of dividing bacterial cells (FDC) can be used to predict growth rates of natural aquatic bacterial assemblages. However, knowledge of rates of bacterial production is necessary for quantity of the flow of material and energy through the bacterial compartment of the ecosystem (Newell and Christian, 1981). Using the FDC method is based on theoretical and experimental methods which showed that FDC is directly proportional to the growth rates of bacteria in culture. The relationship between FDC and the growth rate has been studied extensively by researchers, especially by Hagström et al., (1979), who introduced the method of determining the FCD as a way to extend the scope of the method for estimating the bacterial complexes by adding capacity to estimate bacterial productivity, used-applied also for cyanobacteria (Yamamoto and Shiah, 2010; Tsujimura, 2003; Watanabe and Ichimura, 1977, Yamamoto, 2009; Yamamoto and Tsukada, 2009).

The aim of this paper is to the use the FDC method to calculate the growth rate in two populations of filamentous cyanobacteria isolated from Obanul Mare (Mangalia) in connection with automated image analysis of bright field microscopic images. Up to our best knowledge this is the first report on FDC applied on filamentous cyanobacteria, with or without heterocysts.

MATERIALS AND METHODS

Study area and sampling. Samples were collected from sulphurous mesothermal spring Obanul Mare (43˚49'53.6''N; 28˚34'05.3''E) and used to isolate in axenic culture filamentous heterocystous cyanobacteria by inoculation into conical flasks with nitrate-free medium BG_0, or in BG_{11} medium to isolate filamentous nonheterocystous cyanobacteria. Natural samples inoculated in either BG_{11} or BG_0 media, either solid or liquid, were incubated in culture room at 25 ± 1º C and illuminated with fluorescent tubes having the photon rate of 50 μmol $m^{-2}s^{-1}$ at surface of the culture vessels (Sarchizian and Ardelean, 2010).

We have introduced into two sterile tubes 50 mL suspension of cyanobacteria (30 mL suspension of cyanobacteria in the presence of 20 mL medium BG_0), one tube was cultivated in continuous light at 30°C, and second tube was grown in the dark at 30°C, For determination of FDC samples were collected at 12 hours (T0- initial time, T1 - after 12 hours of cultivation, T2 - after 24 hours of cultivation, T3 - after 36 hours cultivation, T4 - after 48 hours of cultivation, T5 - after 60 hours of cultivation). Fixing samples was performed with 100 µL 2% formaldehyde into 900 µL suspension of cyanobacteria. Visualization of dividing cyanobacterial cells was achieved by staining with crystal violet 0.02% for 3 minutes (Hagström et al., 1979; Agawin and Agustí, 1997) and also using digital image analysis software CellC and ImageJ.

The method of counting of dividing cells was as follows: 10 microscopic fields were chosen, each containing filaments of heterocystous cyanobacteria for at least 30 cells per filament. If there were filaments less than 30 cells were counted cells from other microscopic fields, until we finally obtained a total of approximately 300 cells per sample time (Nielsen, 2006). Dividing cells were counted on at least 10 microscopic fields per sample for analysis. If was counted less than 30 cells in division, we have examined more than 20 microscopic fields. The cells which showed the invagination, but without giving a clear area between cells was considered also located in division. Is noted that the colorless cells were not considered for the counting because were considered heterocysts.

Septa were counted on heat fixed cyanobacteria stained with crystal violet 0.02%. The frequency of dividing cells (FCD) was expressed as a fraction of the total number of cells counted, according to the following equation (after Agawin and Agustí, 1997):

$FCD = \frac{n}{N}$ **,** where **n** is the number of cells in division, and **N** is the total number of cells per sample for analysis (for our experiment the total number of cells per sample time was 300). Growth rate was calculated using the formula given by Agawin and Agustí (1997): $\mu = (\ln N_t - \ln N_0)/t_1 - t_0$, where **µ** is the growth rate, N_t is the number of cells in division at time t = 12 h, and N_0 is the number of dividing cells in early incubation time t = 0 h. As an improvement of the FDC method we combined automated image analysis using two software ImageJ and CellC to determine the exact shape and the size of the cyanobacterial cells in order to accurately identify the dividing cells. The taxonomic status of the two strain used in this paper is under research (Sarchizian, Litescu and Ardelean, 2012, manuscript in preparation).

RESULTS AND DISSCUTION

In figure 1 there are presented the images taken at different time during light incubation for our isolate named IS-H, the arrows indicating the cells in division within the cyanobacterial filaments stained with crystal violet [(initial time (T0), after 12 hours

(T1), after 24 hours (T2) and after 60 hours (T5)], and the digital image analysis obtained using ImageJ and CellC software for cell counting and determination of septa.

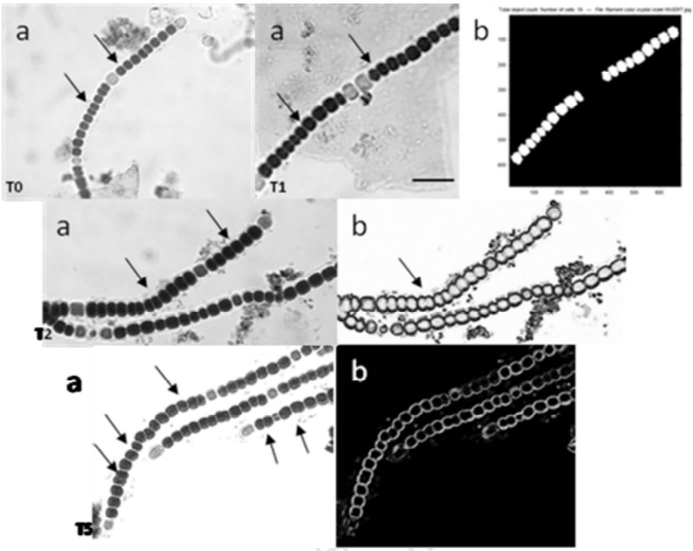

Fig.1. Cyanobacterial filaments during light incubation: at initial time (T0), after 12 hours (T1), after 24 hours (T2) and after 60 hours (T5); a) filaments of cyanobacteria stained with crystal violet b) digital image analysis using ImageJ and CellC software used for cell counting and determination of septa (arrows indicates the dividing cells).

Similar experiments were performed in darkness (pictures not shown) and in table 1 there are presented the number of dividing cell (from a total of 300 inspected cells), together with the calculated growth rate according to equation described by Agawin and Agustí (1997) for populations IS-H grown in light and in darkness.

Table 1. The number of dividing cells and the growth rate of IS-H cyanobacterium incubated in light and dark.

Time (hours)	**The number of dividing cells in light incubation (from a total of 300)**	**Growth rate in light incubation (µ) (hours^{-1})**	**The number of dividing cells in dark incubation (from a total of 300)**	**Growth rate in dark incubation (µ) (hours^{-1})**
T0 (initial time)	46	0	32	0
T1(12 hours)	74	0.039	45	0.028
T2 (24 hours)	113	0.035	68	0.034
T3 (36 hours)	148	0.022	75	0.008
T4 (48 hours)	161	0.007	72	-0.003
T5 (60 hours)	187	0.012	68	-0.004

In figure 2 one there are presented the results concerning the FDC in populations IS-H grown in light and in darkness

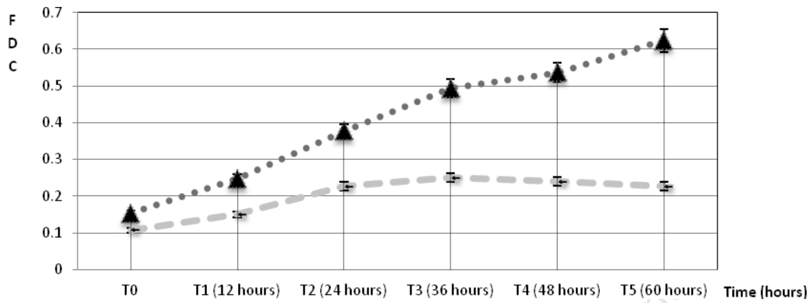

Fig.2. Frequency of dividing cells in IS-H incubated in light and in darkness.

The FDC calculated in light and darkness incubation clearly show important differences between light and dark incubations which are in strong correlation (in agreement with the above equation) with the differences in the growth rate (table 1). The main result concerns the differences between light and dark incubations, the growing rate being much higher in light as compared with dark conditions, especially after 24 hours. The occurrence of dividing cells in dark incubated samples and the corresponding growth rates almost similar during first 24 hours could be sustained by the use of endogenous reserves accumulated in previous (continuous) light period as a source of carbon and energy in agreement with the biological signification of these reserves. Furthermore, the absence of organic substances in the composition of BG_0 medium constrain the cells to have access only to intracellular organic reserves. The sharp decrease both in FDC and in the growth rate at longer incubation times in darkness could be correlated with the diminution of intracellular organic reserves and with a change in the strategy of the cells in order to survive during hostile conditions, the decrease in the frequency of cellular division being one of the most important responses of bacteria against shortage in carbon and energy (e.g. Roszak and Colwell, 1987) .

In figure 3 there are presented images of the filamentous nonheterocystous cyanobacterium, FG-11, after different periods of light incubation.

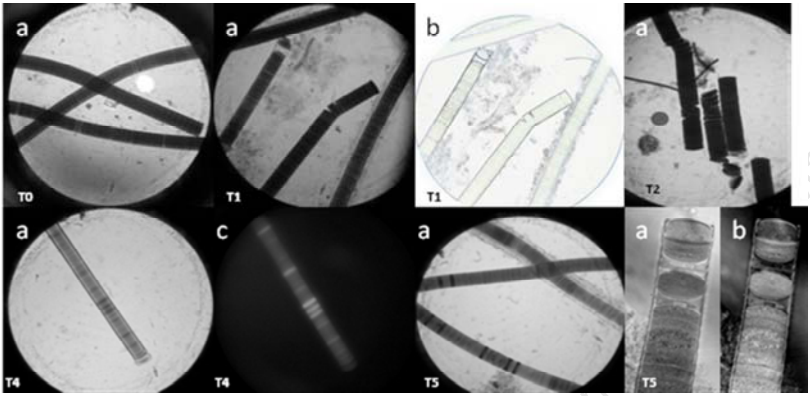

Fig.3. Cyanobacterial filaments of FG-11 during light incubation: at initial time (T0), after 12 hours (T1), after 24 hours (T2), after 48 hours (T4) and after 60 hours (T5); a) filaments of cyanobacteria stained with crystal violet; b) digital image analysis using ImageJ software; c) visualization of cyanobacterial filaments using epifluorescence microscopy.

In table 2 there are presented the number of dividing cell (from a total of 300 inspected cells), together with the calculated growth rate for populations of FG-11 grown in light and in darkness.

Tabel 2. The number of dividing cells and the growth rate of FG-11 culture in light and dark incubation.

Time (hours)	**The number of dividing cells in light incubation (from a total of 300)**	**Growth rate in light incubation (μ) (hours^{-1})**	**The number of dividing cells in dark incubation (from a total of 300)**	**Growth rate in dark incubation (μ) (hours^{-1})**
T0 (initial time)	32	0	31	0
T1(12 hours)	64	0.057	39	0.019
T2 (24 hours)	75	0.013	47	0.015
T3 (36 hours)	89	0.014	49	0.003
T4 (48 hours)	93	0.003	51	0.003
T5 (60 hours)	102	0.007	48	-0.005

In figure 4 one there are presented the results concerning the FDC in populations IS-H grown in light and in darkness.

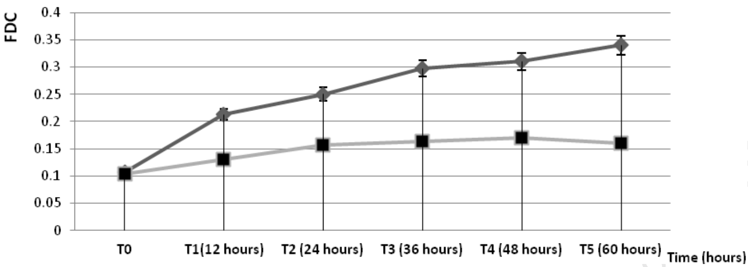

Fig.4. Frequency of dividing cells in FG-11 incubated in light and in darkness.

The FDC calculated for FG-11 cyanobacterium incubated in light and darkness clearly show important differences between light and dark incubations which are in strong correlation with the differences in the growth rate (table 2). The results obtained in this nonheterocystous strain are in agreement with those obtained in IS-H, the heterocystous strain used in this paper. The above argumentation based on the diminution of intracellular organic reserves and/or with a change in the strategy of the cells in order to survive during hostile conditions are probably valid also for FG-11 strain.

CONCLUSIONS

FDC method allowed us the calculation of the growth rate for two populations of filamentous cyanobacteria isolated from Obanul Mare (Mangalia) grown in laboratory in light : for heterocyst forming strain (IS-H) the maximum growth rate on BG_0 in light is 0.039 h^{-1} and for non heterocyst forming strain (FG-11) the maximum growth rate on BG_{11} in light is 0.057 h^{-1}. In both strains, in darkness, after 24 hours the growth rate approaches zero values.

Up to our best knowledge this is the first report on FDC applied on filamentous cyanobacteria (heterocystous or not), as well as the first report on the use of FCD method in connection with automated image analysis of bright field microscopic images.

Acknowledgments. We thank Dr. Tech. Jyrki Selinummi (Department of Signal Processing, Tampere University of Technology, Finland) for kind advice and helpful discussions concerning the use of software CellC (http://www.cs.tut.fi/sgn/csb/cellc/) for automated image analysis to count cyanobacterial cells, and also to identify the correct cell shape and size of studied cyanobacteria with ImageJ software.

REFERENCES

[1] Aderem A. & Shmulevich I. Bright field microscopy as an alternative to whole cell fluorescence in automated analysis of macrophage images. PLoS ONE 4 (10), pp.9, 2009.

[2] Affronti L.F. & Marshall H.G. Using frequency of dividing cells in estimating autotrophic picoplankton growth and productivity in the Chesapeake Bay. Hydrobiologia, 284, pp. 193-203, 1994.

[3] Agawin N.S.R. & Agusti S. Abundance, frequency of dividing cells and growth rates of *Synechococcus* sp. (cyanobacteria) in the stratified Northwest Mediterranean Sea, Journal of Plankton Research, Vol.19 no.11, pp.1599-1615, 1997.

[4] Campbell L. & Carpenter E.J. Diel patterns of cell division in marine *Synechococcus* spp. (Cyanobacteria): use of the frequency of dividing cells technique to measure growth rate. Mar. Ecol. Prog. Ser., 32, pp. 139-148, 1986.

[5] Carpenter E.J. & Campbell L. Diel patterns of cell division and growth rates of *Synechococcus* spp. in Long Island Sound. Mar. Ecol. Prog. Ser., *vol.*47, pp. 179—183, 1988.

[6] Gieskes W.W.C. & Kraay G.W. Estimating the carbon specific growth rate of the major algal species gTOups in eastern Indonesian waters by 14C labelling of taxon specific carotenoids. Deep-Sea Res., 36,pp. 1127-1139, 1989.

[7] Hagstrom A. U. & Horstedt P., Normark S. Frequency of dividing cells, a new approach to the determination of bacterial growth rates in aquatic environments. Appl. Environ. Microbiol., vol. 37, pp. 805-812, 1979.

[8] Ituriaga R. & Marra I. Temporal and spatial variability of chroococcoid cyanobacteria *Synechococcus* spp. Specific growth rates and their contribution to primary production in the Sargasso Sea. Mar. EcoL Prog. Ser, 44, pp. 175-181, 1988.

[9] Joung S.H. & Kim C.J., Ahn C.Y., Jang K.Y., Boo S.M., Oh H.M. Simple method for a cell count of the colonial cyanobacterium, *Microcystis sp.* Journal of Microbiology, 44(5), pp. 562-565, 2006.

[10] Lehmussola A. & Ruusuvuori P., Selinummi J., Huttunen H., Yli-Harja O. Computational framework for simulating fluorescence microscope images with cell populations. IEEE Transactions on Medical Imaging, pp. 1010–1016, 2007.

[11] Li W.K.W. & Dickie P.M. Relationship between the number of dividing and non dividing cells of cyanobacteria in North Atlantic picoplankton. Journal of Phycology, 27(5), pp.559–565, 1991.

[12] Li W.K.W. & Zohary T., Yacobi Y.Z., Wood A.M. Ultraphytoplankton in the eastern Mediterranean Sea: towards deriving phytoplankton biomass from flow cytometric measurements of abundance, fluorescence and light scatter.Mar. Ecol. Prog. Ser 102, pp. 79-87, 1993.

[13] McDuff R.E. & Chisholm S.W. The calculation of in situ growth rates of phytoplankton populations from fractions of cells undergoing mitosis: A clarification. Limnol. Oceanogr., vol. 27, pp. 783-788, 1982.

[14] Newell S.Y. & Christian R.R. Frequency of dividing cells as an estimator of bacterial productivity. Appl. Environ. Microbiol., vol.42, pp.23-31, 1981.

[15] Nielsen S.L. Size-dependent growth rates in eukaryotic and prokaryotic algae exemplified by green algae and cyanobacteria: comparisons between unicells and colonial growth forms, Journal of Plankton Research, vol. 28, no. 5 , pp. 489–498,

2006.

[16] Roszak D. B. & Colwell R. R., Survival Strategies of Bacteria in the Natural Environment. Microbiological Reviews, vol. 51, no. 3, pp. 365-379, 1987.

[17] Sarchizian I. & Ardelean I.I. Axenic culture of a diazotrophic filamentous cyanobacterium isolated from mesothermal sulphurous springs (Obanul Mare - Mangalia). Romanian Journal of Biology - Plant Biology, vol. 55(1), pp. 47–53, 2010.

[18] Selinummi J. & Seppälä J., Yli-Harja O., Puhakka J.A. Software for quantification of labeled bacteria from digital microscope images by automated image analysis. Biotechniques 39(6), pp.859–863, 2005.

[19] Stockner J.G. & Antia NJ. Algal picoplankton from marine and freshwater ecosystems: a multidisciplinary perspective. Can. J. Fish. Aquat. Sci., vol. 43, pp. 2472-2503, 1986.

[20] Tsujimura S. Application of the frequency of dividing cells technique to estimate the *in situ* growth of *Microcystis* (Cyanobacteria). Freshwater Biol.,vol. 48,pp. 2009–2024, 2003.

[21] Van Wambeke F. Enumeration and size of planktonic bacteria determined by image analysis coupled with epifluorescence. Annales de l'Institut Pasteur Microbiology, 139(2), pp.261–72, 1988.

[22] Vaulot D. Estimate of phytoplankton division rates by the mitotic index method: the *fmax* approach revisited. Limnol. Oceanogr, vol. 37, pp. 644-649, 1992.

[23] Watanabe M.M. & Ichimura T. Fresh and salt-water forms of *Spirulina platensis* in axenic cultures. Bull. Jpn. Soc. Phycol., vol. 25 (Suppl),pp. 371–377, 1977.

[24] Yamamoto Y. & Shiah F.K. Relationship between cell growth and frequency of dividing cells of *Microcystis aeruginosa*. Plankton Benthos Res 5(4), pp.131–135, 2010.

[25] Yamamoto Y. & Tsukada H. Measurement of in situ specific growth rates of *Microcystis* (cyanobacteria) from the frequency of dividing cells. J. Phycol., vol. 45, pp.1003–1009, 2009.

[26] Yamamoto Y. Effect of temperature on recruitment of cyanobacteria from the sediment and bloom formation in a shallow pond. Plankton Benthos Res., vol 4, pp. 95–103, 2009.

GENERAL VIEWS ON ENVIRONMENT PROTECTION

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ABSTRACT

The main method of research used in the elaboration of this study is **the content analysis – simple or comparative**, as the case may be – approached in a manner specific to the research in the field of social-human sciences, respectively in the field of legal sciences. Therefore, this analysis in mainly **qualitative** (broadly speaking) and less quantitative, a few statistic aspects being however emphasized there where they are naturally completing the analysis of some qualitative aspects.

The environment protection is performed for the environment factors under the suzerainty of state or for the environment factors situated outside the national jurisdiction, protection made in conformity to international treaties in force.

The focus on the need of cooperation is determined by the multiplication and diversification of the kinds of pollution, of the polluting sources and of dangerous degree of some pollutants.

In 1972, it is organised in Stockholm, the first O.N.U. Conference on human environment. The conference was constituted in a first warning signal for the national policy of states with respect to the environment and development

The latest event, the European Union, the Emissions Trading System was enforced starting with January 1st 2012. Since such date, each air line which uses an European airport has the obligation to participate to a chart of compensation of pollution with carbon dioxide emissions.

Up to present, the principles of liability and compensation did not encounter a proper regulation in the international conventions, although, in terms of Stockholm Declaration, the states undertook to develop the international law on liability and compensation for cross-border damages.

Keywords: environment, protection, principle of liability, principle of compensation, Emissions Trading System

The International Pact draft related to environment and development (International Union for Conservation of Nature) proposes a general definition in art.1 thereof stipulating that "by environment, it is understood the matter as a whole, the natural resources, including the cultural patrimony and human infrastructure indispensable for social-economic activities"[1].

[1] Dumitra Popescu, Adrian Năstase, *Public international law*, Şansa publishing house, 1997, pag. 366

Another legal definition of environment is offered in the Convention with respect to civil liability for the prejudices caused by activities dangerous for the environment, drafted by the Council of Europe and opened for signing in Lugarno on June 21st 1993 and which, in the definitions contained by art.2 on point 10 stipulates: “The environment includes:
- abiotic and biotic natural resources, such as air, water, soil, fauna and flora, as well as the interactions between such factors;
- goods that form the cultural inheritance; and
- characteristic issues of landscape”.

The environment protection is performed for the environment factors under the suzerainty of state or for the environment factors situated outside the national jurisdiction, protection made in conformity to international treaties in force.

The focus on the need of cooperation is determined by the multiplication and diversification of the kinds of pollution, of the polluting sources and of dangerous degree of some pollutants.

In 1972, it is organised in Stockholm, the first O.N.U. Conference on human environment. The conference was constituted in a first warning signal for the national policy of states with respect to the environment and development[2].

In 1992, it is organised in Rio de Janeiro, the O.N.U. conference concerning the environment and development (UNCED). The north/south traditional dialogue was replaced with three categories of countries:
- industrialised countries;
- developing countries;
- countries in the period of transition to a market economy.

Two important categories of documents were adopted:
a. juridical instruments: Convention on biological diversity and Convention on climatic changes;
b. programmatic documents: " Rio Declaration on environment and development", "Principles concerning the forestry real estate" and "Agenda 21".

In 2002, it is organised the third World Conference of ONU on environment in Johannesburg, South Africa. The most important document is the Johannesburg declaration, which includes the commitment of the signatory states to promote and consolidate the basic principles of durable development –economic, social development and environment protection, on local, national, regional and global level[3].

Certain concepts and principles appeared in the international jurisprudence and in the doctrine with more than three decades before the Declaration from 1972. These did not refer to a factor or another as part of environment, but as part of state territory[4].

The pollution was combated, within some treaties, since the second half of the XIX century, but one did not intend to combat pollution ***per se***, but only to the extent that the polluted water became noxious for pisciculture.

Generally, it is claimed the Latin principle ***sic utere to ut alienum non laedas*** (use what belongs to you so as not to damage the other)[5].

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2 Daniela Marinescu, *Environment law treaty*, All Beck publishing house, 2003
3 Daniela Marinescu, *Environment treaty*, All Beck publishing house, 2003, pag. 14
4 The first observations related to environment protection are identified in the year 242 before Christ, when the Indian king Asoka ordered the protection of fishes, of terrestrial animals and of forests. For the historical evolution of regulations related to environment protection, see Daniela Marinescu, *Environment treaty*, All Beck publishing house, 2003, pag. 31

In 1978, the Board of International Law began the codification works in the field. The works were concretised in the project "International liability for the damaging consequences generated by activities which are not forbidden by international law". The works on this project were completed in 1990 and included 36 articles[6].
Up to present, the international law did not include one principle of conventional or unwritten law (according to some authors) in the field. According to the plan of action for the period 1973-1977 concerning the environment issues, such principle should express the obligation of the state to make sure that the activities carried out on its territory or in areas legally under the jurisdiction or control of state, do not cause damages to the environment of other states or to some areas situated beyond the national jurisdiction.
In the institutional plan, it is created the Program of United Nations for Environment (PNUE), the International Union for Conservation of Nature (UICN), the Agency for Environment Protection of European Communities, which appears pursuant to the amendment from 1987 of the Rome Treaty.
One of the general obligations refers to the commitment of states to prevent and reduce the risk, the hazard which involves an increased degree of danger as well as the commitment to prevent and reduce the pollution. In this respect, the states concluded bilateral and multilateral treaties. The international law of environment continues to develop in a multilateral plan on a sectoral ground, and on bilateral plan general conventions were concluded. For instance[7]:

- Basel Convention concerning the control of cross-border transport of dangerous waste and the elimination of it, 1989;
- Convention concerning the study of impact on the environment in the cross-border context adopted in Espoo in 1991;
- Convention on cross-border effects of industrial accidents adopted in Helsinki 1992;
- Convention on nuclear security adopted in Vienna in 1994;
- Convention on protection of tropical forests;
- Convention for combating desertification in the countries seriously affected by drought and/or desertification, mainly in Africa adopted in Paris in 1994
- Convention for protection and use of cross-border streams and international lakes adopted in Helsinki in 1992 and the Protocol concerning water and health attached to this convention adopted in London 1999.

These conventions may also have as object[8]:

a) General and permanent obligations of collaboration related to the exchange of information, evaluation of the situation and previous consultation on the measures to be taken:

- European convention on cross-border atmospheric pollution on long distances, Geneva, 1979.

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[5] For a more detailed presentation of the application of principle *sic utere to ut alienum non laedas*, see Daniela Marinescu, quoted work, pag. 67
[6] A. Năstase, B. Aurescu, C. Jura, Public international law. Syntheses for exams, 5th edition, CH Beck publishing house, Bucharest, 2009, pag. 394
[7] For an evolution of the norms concerning environment protection see Ion Diaconu, *Treaty of international law*, vol. III, Lumina Lex publishing house, Bucharest, 2005, pag. 111
[8] See also [8] A. Năstase, B. Aurescu, C. Jura, *Public international law.* Syntheses for exams, 5th edition, CH Beck publishing house, Bucharest, 2009, pag. 395

b) Protection of streams:

- Agreement between Uruguay and Argentina concerning the regime of Uruguay river, 1975;
- Convention between Germany, France and Luxemburg concerning the sewerage of Moselle river, 1956.
- Convention for the cooperation concerning the protection and durable use of Danube river adopted in Sofia in 1994

c) Protection of some ecosystems:

- Convention on wet areas, of international importance, mainly as habitat of aquatic birds, Ramsar, 1971;

d) Protection of some natural resources of the environment:

- African convention concerning the conservation of nature and of its resources from Alger in 1968;

e) Protection of marine environment:

- Convention on sea law from Montego Bay 19982;
- Helsinki Convention on protection of Baltic Sea in 1974;
- Barcelona Convention on protection of Mediterranean Sea in 1976;
- Bucharest Convention on protection of Black Sea in 1992.

Specific obligations of states in the field of environment protection

In terms of the protocol of 1988 attached to the Convention concerning cross-border pollution, the parties undertake to reduce by 30% the sulphur dioxide emissions[9].

In terms of the protocol of 1989 attached to the Convention concerning cross-border pollution, the parties undertake to reduce the sodium monoxide emissions.

The Vienna Convention on the protection of ozone layer in 1985 and the Montreal Protocol in 1987 on the substances which reduce the ozone layer, determine the legal frame for the supervision, evaluation and cooperation between the parties, and the Protocol stipulates the reduction by 50% of chlorofluorocarbon.

The International Agency for Atomic Energy adopted on September 26th 1986 two conventions related to fast notification of a nuclear accident and respectively the support in case of nuclear accident.

The Basel Convention in 1989 stipulates objective obligations concerning the forbidden of the transport of dangerous waste outside the country without authorization, means of labelling such waste, it governs the special documents of transport, the conditions of authorisation, the specific obligations with respect to the transmission of information in case of accident, etc.

The Washington Convention on international trade with wide species of fauna and flora stipulates objective obligations with respect to the trade with wide species, measures to be taken by parties for the application of some disposals of the convention, measures concerning the possibility of public information on the annual and biannual reports concerning the legislative, regulatory and administrative measures taken for the application of the Convention.

The Kyoto Protocol attached to the frame Convention of ONU on climatic changes (UNFCCC - 1997) includes commitments of quantitative limitation and reduction of the emissions of greenhouse gases opposite to the level of the year 1989, during the

[9] 9 A. Năstase, B. Aurescu, C. Jura, *Public international law.* Syntheses for exams, 5th edition, CH Beck publishing house, Bucharest, 2009, pag. 397

obligatory period 2008 – 2012, therefore, it is an instrument to fight against global heating[10].

The agreement stipulates, for the industrialised countries a reduction of the polluting emissions by 5.2% during the period 2008-2012 opposite to those from 1990.

In order to be applicable, it must be ratified by at least 55 nations (condition already accomplished), producing 55% of the global emissions of carbon dioxide. This last condition was accomplished in October 2004 through the ratification by Russia of the protocol.

Pursuant to the Marrakech Conference (November 2001), the seventh conference of the signatory parties, 40 countries ratified the Kyoto Protocol.

In October 2004, Russia, responsible for 17.4% of the greenhouse gas emissions, ratified the agreement, which lead to the achievement of the quorum necessary for the enforcement of the protocol. In November 2004 there were 127 participating countries including Canada, India, Japan, New Zeeland, Russia, the 25 members of European Union.

In December 2008, the EU member states adopted a range of ambitious objectives, as part of a pack of real measures of fight against the climatic changes. These include a commitment to reduce, until 2020, the global emissions of greenhouse gases of EU by 20% opposite to the levels registered in 1990 and to increase the quota of renewable energy in the consumption of energy by 20% on the EU territory. Each member state has an individual objective which reflects its potential to produce renewable energy. The EU objective of emission reduction will increase by 30% if other developed countries agree to do the same by a global agreement.

In December 2009, the Copenhagen Summit focused on climate ended with a minimum agreement to be adopted. In the agreement, it is well formulated the objective to limit the heating of planet by maximum two Celsius degrees. However, there is no restricting commitment with respect to the reduction of greenhouse gas emissions. The objective of the meeting was to conclude an agreement for the reduction of greenhouse gases that may follow the Kyoto frotocol, after 2013.

The United Nation Conference on climatic changes (COP 17) was carried out in December 2011, in Durban (South Africa), the main results being the launching of a process meant to determine the adoption of a future agreement legally obligatory on global level, the decision on the extension of Kyoto Protocol.

The people with decisional powers on high level – presidents, prime-ministers, ministers – and experts from 196 countries negotiated for 14 days a wide range of documents and political, economic, financial and technological decisions meant to consolidate the climatic action on global level, in terms of the multilateral frame supplied by the frame Convention of the United Nations concerning the Climatic Changes (UNFCCC) and by Kyoto Protocol to this Convention.

Since the first period of commitment under the Kyoto Protocol, which stipulates obligations of reduction of greenhouse gas emissions, ends in 2012, one of the topics intensely debates was the continuation of Protocol with a second period of commitment that may include obligations for the developed states. According to the Decision adopted in Durban during the Conference, by the parties under Kyoto Protocol, the second period of commitment under Kyoto Protocol will last either 5, or 8 years, the decision following to be taken up to the end of the year 2012, by a legal amendment to

[10] [10] A. Năstase, B. Aurescu, C. Jura, *Public international law.* Syntheses for exams, 5th edition, CH Beck publishing house, Bucharest, 2009, pag. 397

the Protocol. The parties that will undertake further on obligatory targets of reduction of greenhouse gas emissions under Kyoto Protocol have conditioned this decision of determining a roadmap to a future global agreement with obligatory legal value.
This agreement will come into force immediately after the completion of the second period of commitment under Kyoto Protocol and to stipulate obligatory targets of reduction of emissions for all countries issuing important quantities of greenhouse gases, including the developing ones (among these, China, India, Brazil), as well as for the developed countries which currently are not part of Kyoto Protocol (for instance, the United States of America). The final documents of COP 17 from Durban stipulate the launching of a process meant to end with a legal instrument until at latest 2015, mentioning that this instrument will stipulate targets of reduction of emissions for all parties of the future agreement.
The form of the future agreement will be decided within a new subsidiary body, called "Ad-hoc working group concerning the Durban Platform for action focused on the field on climatic changes", which has to complete the mandate not later than 2015, so as the future agreement comes into force and is implemented starting with the year 2020. The European Union and its member states, as well as the representatives of small islander states or of the less developed countries in the world expressed their concern opposite to the refusal of the other major economies to undertake in Durban more ambitious targets of emission reduction. With a view to reduce the risk of aggravation of the impact on climatic changes on global level, it remains necessary an immediate decision of the great emitters of greenhouse gases concerning the acceptance of new commitments, which may limit the increase of global temperature to maximum 2°C opposite to pre-industrial period until the end of the year 2050. The European Union expressed the decision to continue the efforts in the field of combating the climatic changes, drawing however the attention that this process cannot evolve through the effort of a single entity (UE), which generates only 11% of the overall quantity of greenhouse gas emissions on global level.

COP 17 registered as well in Durban evolutions of the following parts:

- consolidation of the flexible mechanisms under Kyoto Protocol, which awards including financially the actions of reduction of greenhouse gas emissions;
- evolutions in the consolidation of the means of supervision-reporting-verification of the reduction of greenhouse gas emissions, mainly in the developed countries;
- development of the frame concerning financing on average and long term of the actions of prevention and combating the effects of climatic changes in the developing countries;
- operationalization of the Executive Technical Board and of the Station and Technological network in the field of climatic changes until 2012, with a view to promote and intensify the researches in the field of environment technologies, that will support the actions of reductions of greenhouse gas emissions and the actions of adjustment to the effects of climatic changes in the developing countries;
- possible reconfigurations of the action frame meant for combating the effects of climatic changes on sectoral levels, as well as those in agriculture.

The Canadian government announced in December 2011, after the Conference of the United Nations on climatic changes (COP 17) from December 2011 organised in Durban, that the country which it represented intended to withdraw from Kyoto Protocol. Canada becomes thus the first country in the world withdrawing from the international agreement on the limitation of CO_2 emissions.

In the European Union, the Emissions Trading System was enforced starting with January 1st 2012. Since such date, each air line which uses an European airport has the obligation to participate to a chart of compensation of pollution with carbon dioxide emissions.

Up to present, the principles of liability and compensation did not encounter a proper regulation in the international conventions, although, in terms of Stockholm Declaration, the states undertook to develop the international law on liability and compensation for cross-border damages[11].

Liability is considered a secondary solution opposite to the measures of prevention and reduction of negative effects on environment[12].

The issue is controversial if liability has to be assigned to the state and for licit deeds, namely for the prejudicing consequences of the facts which are not forbidden by international law.

In terms of the objective liability, the Board of International Law considers that liability is necessary for all serious deeds, but leaves the states the power to decide on amendment, under the equity and balance of interests.

Another issue is whether the established standards may form a ground for liability or may be claimed only as criterion of a diligent conduct that may be displayed by all states.

The European Community pays a special attention to the harmonization of legislations concerning environment protection. This issue was proclaimed as principle in the program of action concerning the environment during the period 1973-1977.

REFERENCES

[1] **Alston**, Philip, *The EU and Human Rights*, Oxford University Press, 1999

[2] **Buzan**, Barry, Ole Weaver and Jaap de Wilde, *Security: a new framework for analysis,* Lynne Rienner Publishers, London, 1998

[3] **Cassese**, Antonio, *International Law*, Oxford University Press, 2001

[4] **Diaconu** Ion, *Treaty of international law*, vol. III, Lumina Lex publishing house, Bucharest, 2005

[5] **Jura**, Cristian, *Role of non-governmental organisation on international plan*, All Beck publishing house, Bucharest, 2003

[6] **Marinescu** Daniela, *Environment law treaty*, All Beck publishing house, 2003

[7] **Năstase**, Adrian, Aurescu, Bogdan, Jura, Cristian, Public international law – *syntheses for exams*, ALL publishing house, Bucharest, 2000

[8] **Rehman**, Javaid, *The weakness in the international protection of human rights*, Kluwer Law Internat., 2000

[9] **Salmon**, Trevor, *Issues in International Relations*, Routledge, 2000

[11] [11] A. Năstase, B. Aurescu, C. Jura, *Public international law.* Syntheses for exams, 5th edition, CH Beck publishing house, Bucharest, 2009, pag. 397

[12] Daniela Marinescu, *Environment law treaty*, All Beck publishing house, 2003, pag. 435

GEOGENIC GAS EMISSIONS IN ROMANIA AND THEIR VALUE FOR TOURISM

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ABSTRACT

The emissions of geogenic gases have become a topic of growing scientific interest during the last decades. Natural gas seeping at the surface may indicate the presence of deep hydrocarbon accumulations. The suitability of gas geochemical investigations as convenient and effective tools for the exploration of oil and gas reservoirs has been widely demonstrated. The CO_2 and CH_4 released into the atmosphere from geologic sources are important components of the greenhouse gases atmospheric budget. Besides the scientific implications, geogenic gas emissions can also generate tourist attraction and economic added value for many regions.

Romania is a country rich in gas manifestations belonging to different genetic categories. The geothermal and ancient volcanic areas mainly release CO_2-dominant gases, as dry, free gas emissions, or dissolved in spring waters. A large area related to Neogene volcanism of Eastern Carpathians, extended well beyond the limits of the magmatic massifs, is the most representative from this point of view. Dissolved CO_2 characterises thousands of springs of sparkling mineral water, some of them used for hydrotherapy or as drinking water. High fluxes of dry CO_2 venting over small areas, known as moffetes, are also of medical use. An important mineral water bottling industry has gradually developed in the region. A less extended and less active area with CO_2 emissions is related to Neogene volcanism of the South Apuseni Mountains.

The second category of gas emissions is rich in CH_4, and it is mainly related to oil and natural gas accumulations. One of the most spectacular type of manifestations are mud volcanoes, which represent the result of the upward migration of fluids (gas and water) and solid phases (sediments and rocks) from deep sedimentary strata. The most impressive Romanian mud volcanoes, Paclele Mari and Paclele Mici, the biggest in Europe excepting the giant mud volcanoes of Azerbaijan, are located at Eastern Carpathians Foredeep. In other cases, dry gas seeps, without water discharge occur. When the methane flux is high enough, it might ignite spontaneously creating everlasting fires. Some spectacular everlasting fires may be visited northward of Paclele. Smaller mud volcanoes and everlasting fires occur in other areas of the Carpathian Foredeep and in the Transylvanian Basin. Previous studies have highlighted their main features and scientific significance. Some of these sites could be preserved and developed as natural attractions with tourist value. A better management and integration of such sites in the tourist circuits is desirable.

Keywords: geogenic gas emission, carbon dioxide, methane, Romania, mud volcanoes

INTRODUCTION

The different processes that occur deep in the Earth's crust and mantle generate geogenic gases that migrate towards the surface. The study of these gases is a growing research field with scientific and practical implications in several domains. Important information about the processes occurring at different depths is provided by the gas emission at the surface.

Emission of hydrocarbon gases may reveal the presence of oil and/or gas reservoirs at depth. Different techniques were developed for the geochemical survey of the hydrocarbon accumulations, and encouraging results were obtained [1 and references therein]. Methane (CH_4) and carbon dioxide (CO_2) released as geogenic gases are adding up to the global atmospheric budget of greenhouse gases [2, 3].

The release of geogenic gases in different forms may also be an important factor supporting the development of tourism in many regions. Thermal and mineral waters generally contain various amounts of dissolved gases, essential for their curative effect. In Europe, the use of thermal and mineral baths for therapeutic purposes has a long history. Beyond their practical use, the ancient Greeks, and especially the Romans, have developed an important element of their civilization and culture related to the healing properties of hot and mineral water. Across the territory of the Roman Empire, ruins of spas and other facilities dedicated to the use of waters for cleansing and therapeutic bathing can be found in almost every place with thermal springs. Later on, the bathing activity gradually developed, particularly starting with the 18th century. Many resorts have become famous throughout Europe. As a general outline, the main therapeutic factors that gave value to these watering places, present in various proportions and combinations in each of them, are the following: water with increased contents of dissolved mineral compounds, thermal water, dissolved and/or dry CO_2, H_2S, radon and other radioactive elements.

The methane manifestations related to oil and gas reservoirs may generate spectacular phenomena such as mud volcanoes and everlasting fires. The scientific interest and scenery of mud volcanoes and related manifestations in Romania are important premises for their inclusion in tourist circuits.

HEALTH EFFECTS OF THE GEOGENIC GASES

The most important geogenic gases that could induce positive effects on health are carbon dioxide (CO_2), hydrogen sulphide (H_2S), and radon (Rn). Although the three gases are dangerous at high concentration, the balneotherapeutic practice and some research support the idea of their beneficial health effects at low concentrations.

Hydrogen sulphide's distinctive smell of rotten eggs makes it easily detectable, even if present in very low amounts. H_2S is a potent neurotoxic compound, and consequently very low allowable concentrations were set for this gas in the ambient air. However, its ability to act as a gaseous transmitter involved in the blood vessels relaxation was proved. Recent research has been focused on the importance of H_2S for controlling the metabolism intensity, cardiovascular diseases, or even improving the erectile function [4, 5]. As dermal absorption of hydrogen sulphide is significant, further experiments would be useful in order to test the capacity of the balneotherapeutic procedures to induce comparable effects.

Carbon dioxide dissolved in water or as dry gas produces peripheral vasodilatation, and as a consequence, the increase of the cutaneous temperature. The individuals experience an intense sensation of warming the immerged body parts. Positive effects on the general blood circulation and on the heart rate were also observed [6].

Radon is currently considered as an important health hazard worldwide, being recognized as a primary contributor to the increase of lung cancer incidence in different cohorts such as workers in underground mines of uranium or some other minerals, or in the general population in areas with elevated natural radon background [7]. Based on the Linear-No-Threshold (LNT) theory, the radon-based treatment is considered as controversial, and many physicians claim that the use of radioactivity, even at very low doses, may not have beneficial effects. In spite of this, a long tradition in using radon for healing purposes perpetuates, and medical evidence supporting the positive effects of radon accumulates. Radon therapy seems to be especially effective in rheumatic diseases, and improves the general condition of the patient by its analgesic and anti-inflammatory properties [8].

CO_2-DOMINANT MANIFESTATIONS

In Romania, carbon dioxide rich emissions are mainly related to the Neogene volcanism of the Eastern Carpathians and southern part of the Apuseni Mountains. Additionally, CO_2 is released in some areas on the eastern border of the Pannonian Depression.

From East to West, the Eastern Carpathians consist of three lithologic and structural zones: Cretaceous and Paleogene flysch deposits (the external units), Mesozoic sedimentary formations and crystalline rocks in the median zone, and Neogene volcanites as an internal unit, bordering the Transylvanian Depression. The CO_2 manifestations typically consist of carbogaseous springs and related mineral deposits as travertines and silica sinters, dry emissions (mofettes) and increased CO_2 flux from the soil; these manifestations are widespread far beyond the area occupied by volcanites, generating the so called "mofettic aureole". The youngest volcanic products (less than 1 Ma) occur in the southern extremity of the volcanic chain (Harghita Mts.), where also the gas emissions are more vigorous, and the mofettic aureole is more extended. Carbogaseous springs are also found at distances exceeding 50 km from the volcanic area. An increased heat flow is also proved by the existence of meso-thermal waters in natural springs and drilled wells in Toplita and Tusnad areas.

In the region, there are plenty of vents where the CO_2-dominant gases have a high flux. Some of them were set up for use as dry gas baths, in a more or less sophisticated way. In certain places, special buildings where the gas baths are taken were raised over the vents. The interior has the shape of a small amphitheatre. Being denser than air, carbon dioxide fills the lower part of the room, where the patients may immerge into the gas to different levels, avoiding its inhalation. In other cases, the dry baths are more rudimentarily organized, just by digging a cavity over the vent and lining it with wood. Sometimes water is accumulating into the cavity, and the gases are bubbling through, being also of therapeutic use. The main component of the gas released by the mofettes is CO_2, very often exceeding 95% by volume. Additionally different proportions of N_2 and very low amounts of CH_4, Ar, He, H_2, and in some places H_2S may occur. Detectable amounts of H_2S were found in the mofettes from Pucioasa-Puturosu cave (fig. 1.1), Santimbru, Baile Harghita, Slanic, etc. Although the concentration of H_2S usually does not exceed 150 ppm by volume, it is considered to be an important component from a medical point of view. The ascending CO_2 enters the aquifers in the shallow zone, generating carbogaseous mineral waters with various characteristics. The presence of CO_2 increases the water-rock interaction. By lowering its pH, water becomes more aggressive against the rock, thus increasing its capacity to dissolve minerals.

The frequency of mineral water springs and gas seeps in the Eastern Carpathians represents an important premise for the development of tourism. The therapeutic properties of water and gases in this area had been noticed hundreds of years ago. Starting with the 18th century, a tourist activity initiated, mainly dedicated to "taking the water" (*i.e.* using or consuming the water onsite). Bottling the mineral water for drinking or for therapeutic purposes has started more than 200 years ago in a rather rudimentary way. Gradually, health resorts were developed and starting with the 20th century, a more scientific approach was established in the use of water and gas. Among the most famous resorts used to be: Borsec, Balvanyos, Tusnad, Covasna, Malnas, Sangeorz, Slanic Moldova,and Vatra Dornei. The mineral water bottling industry has remarkably grown during the last 20 years. On the contrary, the balneotherapeutic activity in a professionally supervised form has decreased in the area. With some exceptions, the existing facilities did not upgrade to the current exigencies of the customers. There is a need of investments in order to better take advantage of the important tourist potential of the area.

A less extended and less active area with CO_2 emissions is related to the Neogene volcanism of Southern Apuseni Mountains, covering also the eastern border of the Pannonian Basin. Both thermal and carbogaseous mineral waters are found in this region. The thermal waters are used for therapeutic purposes or recreation in small resorts. Some of the thermal waters may also contain different amounts of CO_2. Cold carbogaseous waters from Lipova and Buzias are currently bottled.

A very particular site, well known as a health resorts, not related to the geothermal areas presented before is Baile Herculane, in the south-western extremity of the South Carpathians. The thermo-mineral waters transport a mixture of gases dominated by methane and N_2, with relatively high amounts of He, Ar, and Rn [9].

Some of the waters and gases in the described areas show an increased radioactivity, mainly given by the radon content. The most important isotope of radon (^{222}Rn) originates from the decay series of uranium (^{238}U). The parent nucleus of radon is radium, which may occur in different minerals in rocks or soil. In normal conditions, the radon concentration in surface waters does not exceed a few Bq l^{-1}, but may significantly increase in groundwater. Natural anomalies related to high concentrations of radioactive elements in the bedrock or in the superficial deposits may increase the radon concentration in groundwater to hundreds or even thousands of Bq l^{-1}. A radon survey in Transylvania and neighbouring areas [10] has shown average concentrations of radon of 10 to 40 Bq l^{-1} in groundwater. Some of the mineral waters may contain much higher amounts. In Eastern Carpathians, the highest radon contents in mineral waters were measured in Sangeorz Bai – up to 400 Bq l^{-1}; Borsec, Pierre Curie Spring – 268 Bq l^{-1}; Tusnad – up to 450 Bq l^{-1}; Slanic Moldova – up to 142 Bq l^{-1} [11]. Many thermal waters have relatively high radon content, as Geoagiu – up to 130 Bq l^{-1}, or Herculane – up to 760 Bq l^{-1}, the highest value measured in natural waters in Romania. Other famous resorts in Europe show much higher radon contents in water used for balneotherapy. As an example, the radon concentration in the sources from Jachimov (Czech Republic) ranges between 5,000 and 20,000 Bq l^{-1}.

Relatively high concentrations of radon were found in some of the mofettes in the Eastern Carpathians. Szabo [11] reports the following values: Turia, Pucioasa Cave – 26,000 to 36,000 Bq m^{-3}; Baile Harghita – 10,000 to 13,000 Bq m^{-3}; Tusnad – 15,000 Bq m^{-3}; Malnas – 11,470 Bq m^{-3}; Borsec – 5180 Bq m^{-3}; Covasna – 11,470 Bq m^{-3}. More detailed measurements performed by Neda et al. [12] on five locations in the same region have shown activities up to 27,000 Bq m^{-3} in Santimbru mofettes, up to 14,000 Bq m^{-3} in Covasna, up to 33,000 Bq m^{-3} in the cave from Turia, up to 25,000 Bq m^{-3} in Lazaresti-Ciuc, and up to 3,500 Bq m^{-3} in Jigodin Bai. For comparison, the radon concentration in the famous "Heilstollen" in Bad Gastein (Austria) may exceed 40,000 Bq m^{-3} in air [13].

The descriptions above reveal the importance of geogenic gases (mainly CO_2 and Rn) in combination with water and other factors, for the existence of health resorts. However, a decline of many resorts can be noticed after 1990. The Romanian tourism as a whole did not make the expected progress in this period. The main reasons are briefly analysed in [14]. Some solutions can be seen for revitalising the tourist activity in such areas. Significant investments are needed for upgrading the existent infrastructure to an acceptable level relative to the requests of the present-day tourism. An integrated system for a particular resort or for a group of resorts will allow a better management of the available resources and better services for tourists. The current tendencies in the national/international tourism should be observed and the resorts should try to comply with them. As an example, the sports – wellness – relaxation tourism is rapidly developing. As well, the resorts could promote more the MICE concept (meetings, incentives, conventions and exhibitions/or events) attracting the segment of business tourism.

CH_4-DOMINANT MANIFESTATIONS

At global scale, mud volcanoes are mainly distributed in areas of active compressional tectonics. In Europe, onshore mud volcanoes are reported in Italy, Romania, and on the northern rim of the Black Sea, continuing eastward to Georgia and Azerbaijan. Some of the most impressive European mud volcanoes are located in the Eastern Carpathians Foredeep, north-west of Buzau town. The mud volcanoes position corresponds to the axial part of the hydrocarbon-bearing Berca-Arbanasi anticline. Four mud volcanoes are known in the area, namely Fierbatori, Paclele Mari, Paclele Mici, and Beciu (fig. 1.2-3). A more detailed description of these structures is given in [15, 16]. North of the mud volcanoes area, everlasting fires occur at Lopatari and Andreiasu (fig. 1.4).

In the Transylvanian Basin, relatively frequent, although less spectacular gas emitting features occur. An inventory of 73 mud volcanoes and gas seeps with their main characteristics is presented in [17]. Towards the eastern border of the Transylvanian Basin, the gas becomes richer in CO_2, due to the influence of the Eastern Carpathians volcanic units. Very unusual gas compositions may occur at the contact between the hydrocarbon bearing Neogene basin and the volcanic chain, as identified in the Homorod mud volcano [18]. This small gas manifestation has the highest N_2 and He concentrations in surface gas seeps and the highest deuterium concentration ever measured in methane in natural gas.

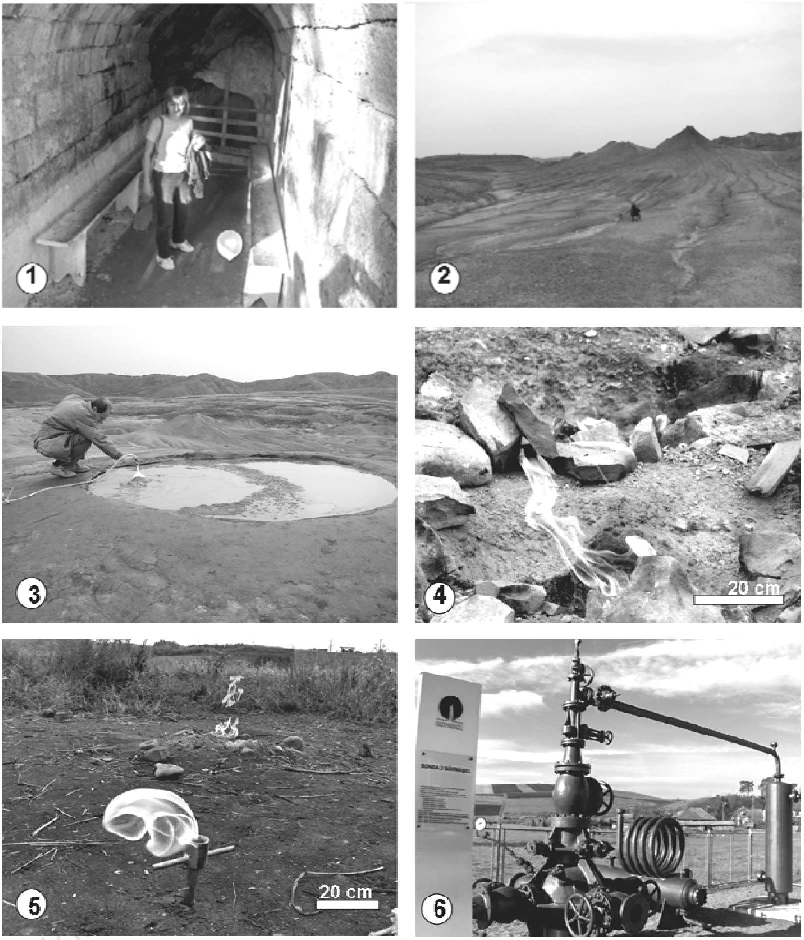

Fig. 1. 1 – *Mofette in Pucioasa-Puturosu cave; balloon floating at the limit between air and CO_2; 2 – Paclele Mari mud volcano, general landscape; 3 – Collecting gas samples from a bubbling pool at Paclele Mari; 4 – Everlasting fire at Andreiasu; 5 – Everlasting fire at Sarmasel; 6 – Well No. 2, Sarmasel.*

Among the sites with methane emissions in Transylvania, Sarmasel has a particular interest. On a field within the village of Sarmasel, burning flames, 20 to 30 cm high can be seen on an area of several tens of m^2 (fig. 1.5). Although this phenomenon has artificial origin, it is worth to be mentioned, as a historical evidence of the discovery of natural gas in Transylvania, more than 100 years ago. Based on the wide distribution of salt deposits on the borders of the Transylvanian basin, the existence of potassium salts (potash) at the inner part of the basin was inferred by the Austro-Hungarian geologists at the end of the 19th century. For checking this hypothesis, drilling of an exploration well was proposed. The first well was drilled in Sarmasu Mare in 1908, and it was stopped at 627 m, due to the strong bursts of brine mixed with a certain amount of gas, before reaching the proposed depth of 1000 m [19]. A second attempt was initiated in Sarmasel on November 1908, at about 3 km distance from the first borehole. Drilling the second well turned out to be even more difficult than the previous attempt. The first methane leaks occurred at very shallow levels (22 m depth). The gas outbursts became stronger and stronger as the drilling was progressing. The violent eruptions at different levels finally determined the decision to stop the drilling at the depth of 302 m, on 22 April 1909. This date marks the beginning of natural gas extraction in Transylvania, which subsequently proved to be one of the main gas-bearing basins of Europe. The original Well No.2 (fig. 1.6) can be seen onsite, as well as the flames burning the gas that is continuously seeping through soil.

Such manifestations have a distinct value for tourism and they are worth to be inserted into tourist circuits. This way, the segment of tourists that are interested to visit these sites will expand. The Paclele Mari – Paclele Mici mud volcanoes and the everlasting fires in the neighbouring area could be included into tours proposing a combination of cultural and religious objectives as the Moldavian monasteries and some sites of importance to nature conservation. Some Transylvanian gas seeps could be included into visiting tours of the medieval cities or of the Saxon villages listed as UNESCO world heritage sites.

CONCLUSIONS

The use of thermal/mineral waters and geogenic gases for healing purposes has a long tradition, especially in Europe. Although the medical scientists did not reach a consensus, a number of studies and the balneological practice suggest that using CO_2, H_2S, and Rn at low concentrations may have beneficial effects if applied to some specific maladies. An impressive number of gas occurrences, associated or not with mineral water are known in Romania. The geothermal area connected to the Neogene volcanism in the Eastern Carpathians and Southern Apuseni Mountans is rich in carbogaseous mineral waters, thermal waters in some locations, and dry releases of CO_2, eventually mixed with small amounts of other gases. Numerous health resorts have been established in the last two centuries in connection with these resources. The tourist activity has decreased in the last two decades, as a result of insufficient investments and the lack of adequacy to the requests and standards of the modern tourism. Detailed studies are certainly needed for choosing the most appropriate strategies for the sustainable development of the tourist areas. Taking into account the diversity of factors that characterize each area, tailor-made solutions are needed.

CH_4-dominant emissions are relatively frequent in hydrocarbon-prone regions. The strong gas releases may generate impressive mud volcanoes and everlasting fires. Such manifestations could be included into thematic tourist circuits dedicated to cultural, natural sites, or to other objectives.

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REFERENCES

[1] Etiope G.; Feyzullayev A.; Baciu CL. Terrestrial methane seeps and mud volcanoes: A global perspective of gas origin. Mar. Pet. Geol., 26, 3, 333-344, 2009.

[2] Etiope G., Lassey K.R., Klusman R.W., Boschi E. Reappraisal of the fossil methane budget and related emission from geologic sources. Geoph. Res. Lett., 35, 2008

[3] Morner N.A., Etiope G. (2002). Carbon degassing from the lithosphere. Global and Planet. Change., 33, 1-2, 185-203.

[4] Leslie M. Nothing Rotten About Hydrogen Sulfide's Medical Promise. Science, 320/5880, 1155-1157, 2008.

[5] Villa Bianca R. E., Sorrentino R, Mirone V., Cirino G. Hydrogen sulfide and erectile function: a novel therapeutic target. Nature Reviews Urology 8, 286-289, 2011.

[6] Pagourelias ED, Zorou PG, Tsaligopoulos M, Athyros VG, Karagiannis A, Efthimiadis GK. Carbon dioxide balneotherapy and cardiovascular disease. Int J Biometeorol. 55(5): 657-63, 2011.

[7] ATSDR Toxicological profile for radon (draft). US Department of Health and Human Services. 230 pp., Atlanta, 2008.

[8] Zdrojewicz Z. & Strzelczyk J. Radon Treatment Controversy, Dose Response, 4(2), 106-118, 2006.

[9] Cosma C. & Ristoiu D. Study of rare gases in geothermal waters from Herculane area, Romania. Nuovo Cimento, 22, 317–23, 1999.

[10] Baciu C., Cosma C., Ristoiu D. Radon contents in groundwaters in Transylvania and surrounding areas (Romania). Water-Rock Interaction, vol. 2, pp. 1477-1480, 2001.

[11] Szabo A. Radioactive waters and gases in Romania. Dacia Publ. House, 202 pp., Cluj-Napoca, 1978.

[12] Neda T., Szakacs A., Cosma C., Mocsy I. Radon concentration measurements in mofettes from Harghita and Covasna Counties, Romania, J. Env. Radioact. 99, 1819–1824, 2008.

[13] Becker K. Health effects of high radon environments in Central Europe: another test for the LNT hypothesis? Nonlinearity Biol Toxicol Med., 1(1), 3–35, 2003.

[14] Pop C., Cosma S., Negrusa A., Ionescu C., Marinescu N. Romania as a tourist destination and the Romanian hotel industry, Cambr. Scholars Publ. 283 pp., UK, 2007.

[15] Etiope G., Baciu C., Caracausi A., Italiano F., Cosma C. Gas flux to the atmosphere from mud volcanoes in eastern Romania. Terra Nova, 16, 4, 179-184, 2004.

[16] Baciu C., Caracausi A., Etiope G., Italiano F. Mud volcanoes and methane seeps in Romania: main features and gas flux. Annals of Geoph., 50, 4, 501-511, 2007.

[17] Spulber L., Etiope G., Baciu C., Malos C., Vlad S.N. Methane emission from natural gas seeps and mud volcanoes in Transylvania (Romania). Geofluids, 10, 4, 463-475, 2010.

[18] Etiope G., Baciu C., Schoell M. Extreme methane deuterium, nitrogen and helium enrichment in natural gas from the Homorod seep (Romania). Chem. Geol., 280, 1-2, 89-96, 2011.

[19] Chisalita D. & Piteiu M.A. Gas discovery as it happened, 1909 – Sarmasel. AGIR Publ. House, 124 pp., Bucharest, 2009.

GEOGRAPHICAL DISTRIBUTION OF RURAL DUMPSITES IN NORTH-EAST REGION FROM ROMANIA

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ABSTRACT

This paper proposes a spatial analysis of statistical data concerning the number and areas of rural dumpistes for local administrative units (LAU in Romanian's rural terrirory = communes) from 6 counties of North-East region using thematic cartography.Database created at local scale is correlated with demographic factors (eg population density) taking into account the various geographical conditions between these 6 counties (Neamt,Suceava,Botosani,Iasi,Bacau and Vaslui).Rural dumpsites have been identified by the county environmental authorities in 2008 and 2009,deadline for closure and rehabilitation being July 16, 2009 .The large number of these sites reflect the lack of organized waste management system in rural territory.Sanitation services are still poorly developed in rural areas and the waste generated and uncollected are often disposed in open dumps or river banks (mainly in mountain areas).Geographic location of human settlements influences the disposal of waste, most of these dumpsites were located in their proximity.These bad practices are still present being revealed by field observations.Thus,demographic background (rural population share of total county population, population density at LAU level) and local geographical conditions (mountain,hill/plateau,plains/valley corridor) reflect the territorial disparities between counties (regional scale) and communes (local scale) regarding the geographical distribution of rural dumpsites.

Keywords: dumpsite,rural areas,spatial analysis,geographical conditions,territorial disparities

INTRODUCTION

The current European regulations promoting the hierarchy of waste management inevitably involve a wealth of waste management practices tied to policies, institutional settings, financial mechanisms, technology selection, and stakeholder participation [1]. Also, analysis of policy effectiveness concerning waste management points out the existing gaps between EU countries [2].The European Landfill Directive led to major changes in national policies on waste management particularly in EU newcomers revealead in following studies [3],[4],[5],[6] or in EU candidate countries [7],[8] .

Implementation of EU acquis had a significant impact on waste disposal facilities from Romania. Primarily its made a schedule for closure of non-compliant urban landfills and secondly Romania has undertaken to close and rehabilitate the dumpsites from rural areas until July 16, 2009.This commitment is very difficult to follow under the conditions of partially access of rural population to sanitation services [3]. Uncontrolled waste disposal is still a current practice against environmental authorities efforts to limit this issue.This paper analyses the geographical distribution of rural dumpistes at regional scale (fig.1).The North-East Region consists of six counties (Bacău, Botoșani and Neamț, Suceava, Vaslui) there are 46 cities,506 communes and 2436 villages.Among the eight regions of the country,it is the region with the largest area of 36,850 km2, representing 15.5% of the Romanian area,the largest counties being Suceava and Bacău and the most populated is Iași [9].

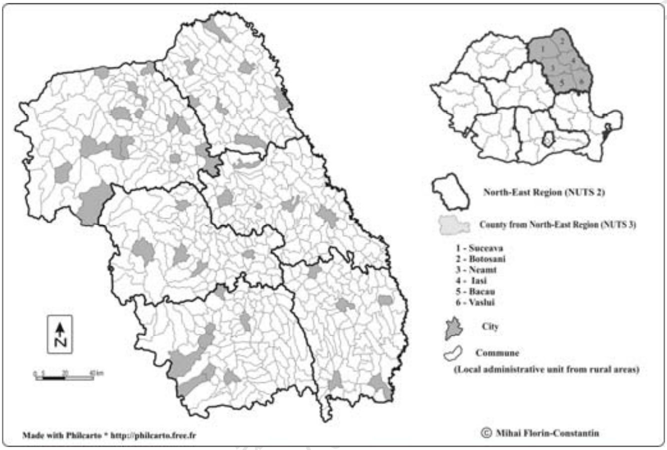

Fig.1. Nort-East Region- area of study

This region has a harmonious combination between all forms of relief: 30% mountainous area ,30% Subcarpathian hills (specific to Bacău,Neamț and Suceava counties) and 40% plains and plateaus (specific to Botoșani, Iași and Vaslui counties). Population is predominantly rural and most cities have less than 20 000 habitantsAlso the socio-economic context is less favorable compared to other regions of country.These features of the territory are also reflected in current waste management issues.

METHODS

It was conducted a database on the number and areas of rural dumpsites at commune level for the all 6 counties of North-East Region which include 506 communes.Commune is the local administrative unit in Romanian's rural territory usually consisting of several villages in which one plays the role of administrative seat (local authorities) or even one village.It was calculated the number and areas of these dumpsites for each commune.

Data were provided by local environmental protection agencies.Local authorities had responsibility to close and rehabilitate these sites until July 16, 2009.It should be noted that on the one hand not all communes have reported such dumpistes (although organized waste collection services were lacking) and on the other hand for 13 communes could not be calculated population density due to incomplete data Data on population of communes level were provided by the National Statistics Institute (INS) and refers to 2010.Areas of rural dumpsites (square meters) were correlated with population density from each commune.Thematic map (fig.3) was performed using on the one hand range colors method dividing population density of communes in 6 classes and on the other hand proportional circles method for absolute values (areas of dumpsites expressed in square meters).The proportional circles method was used for a comparative analysis of two absolute values such as number of dumpsites per commune and the number of villages that form a commune (fig.2).Those two maps are designed to highlight the geographical distribution of rural landfiills taking into account demographic factors (population density) and also local geographical conditions in the contex of a limited access of rural population to waste collection services.

RESULTS AND DISCUSSION

Poor development of waste management services in rural areas from North-East Region led to open dumping being the easiest method to dispose waste generated and uncollected.Until 2009,local authorities from rural areas were not concerned in providing facilities for collection, transport and landfill of household waste. Usually communes in proximity of cities are served by waste collection services provided by private operators from cities. Poorer socio-economic conditions from rural territory of this region is reflected in the existence of a rudimentary waste management infrastructure.The budget of communes particularly those away from major cities of the county are insufficient to invest in the improvement of this infrastructure.New regulations requires local authorities to provide waste collection following July 2009. Field observations from Neamt County between September 2009-April 2010 revealed several dysfunctions in this regard.[3] PHARE and ISPA programs developed in Nort-East Region stipulate the development of waste management systems which includes towns and villages from neighborhood but their implementation is still ongoing.
Regarding the ratio between the number of landfills at commune level and number of villages that form a communne it notice following trends (fig.2) :

- In the mountainous western half of the counties Suceava,Neamț and Bacău on the one hand the number of dumpsites is less than in the eastern half (dominant landscapes as Subcarpathian depressions and hills, plateau) and on the other hand number of sites from a commune in western half is much smaller than number of villages that form a commune, in other words are villages that did not report such dumpsites on their territory in the conditions of a limited access of local population to sanitation services.
- Botosani, Iași and Vaslui counties are overlapping the Moldavian Plateau, number of dumpsites is larger than the other three counties (especially to mountainous western half).Frequently,each village from a commune reported the presence of a waste disposal site and sometimes number of these sites exceeds the number of villages that form the commune.This explains the larger rural population especially in Iasi County.(tab.1)

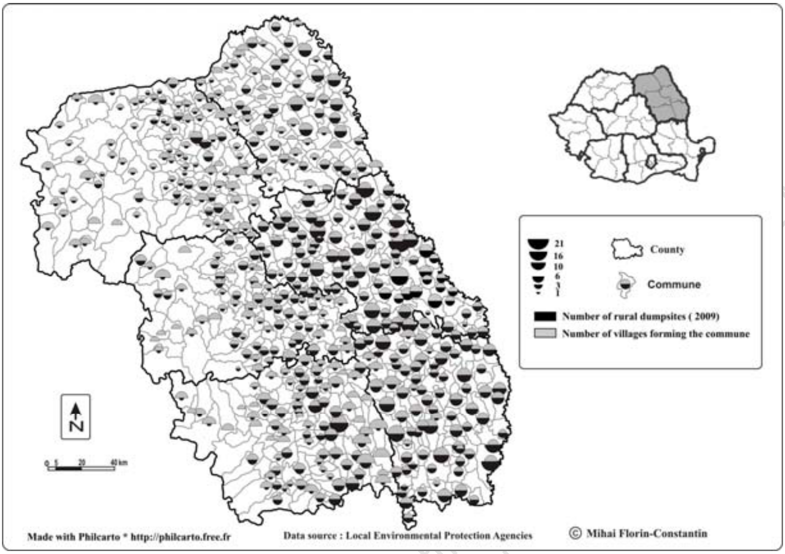

Fig.2 Geographical distribution of rural dumpistes (number per commune)

Tab.1. Rural dumpsites in the context of limited acces to sanitation services

County	Rural pop. 2008	Served (%) by waste collection	Rural pop. unserved(nr.)	Nr. of dumpsites 2009	Surfaces (ha)
Suceava	403559	43.5	227898	136	73.04
Neamț	350675	10.4	314205	124	23.632
Bacău	392052	18.1	218078	195	40.39
Botoșani	263365	3.5	254148	184	36.201
Iași	434898	3.2	420974	454	108.54
Vaslui	266273	0	266273	389	43.8
North-East Region	2110822	14.5	1701576	1482	325.603

Data source : Bacău- Regional Environmental Protection Agency

Rural population density at commune level reflects the geographical conditions. Regarding the surfaces occupied by these dumpsites, disparities between western counties (Suceava, Neamț and Bacău) and eastern (Botoșani,Iași and Vaslui) are obvious.In the mountainous western half of the counties Suceava,Neamț and Bacău population density is usually less than 50 inhab./sq.km and the surfaces of these dumpsites accumulated per commune are really low (< 1ha or 10,000 sq.m) and higher values are due to sawdust sites on the banks of rivers.Also,household waste generated and uncollected are uncontrollable disposed polluting mountain rivers and streams.Proximity of rivers to human settlements and lack of infrastructure for solid waste management favor this bad practice.Development of localities along the narrow valleys increase the vulnerability of rivers to illegal dumping.Summer floods carry the waste disposed downstream , these waste may accumulate behind the dams like those built on Bistrita river from Neamț County (Izvoru Muntelui,Vaduri,Pângărați,Bâtca Doamnei).Development of localities in mountain depressions may mitigate the pressure on rivers because the waste can be disposed in the form of open dumps located in larger floodplains (or on terraces or other sites) being multiannual operational (in Suceava and Bacău couties) but still are vulnerable to stronger floods**.**

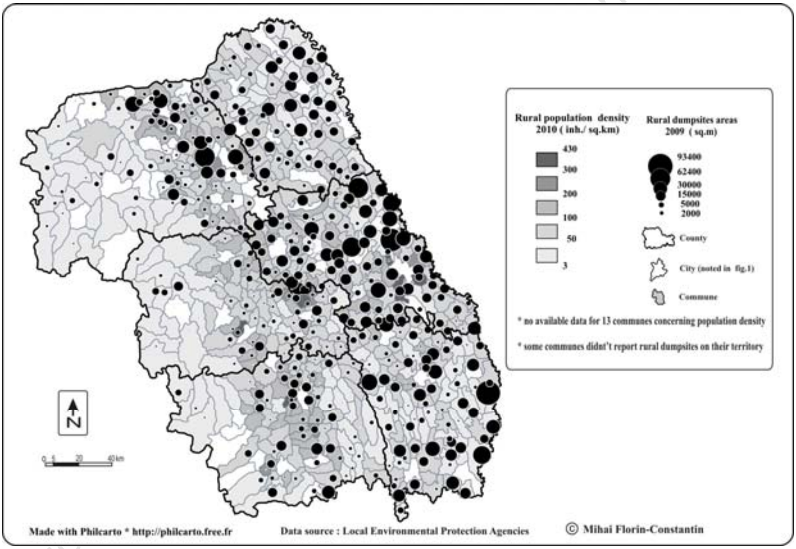

Fig.3 Geographical distribution of rural dumpsites areas at commune level from North-East Region

In counties that are overlapping Moldavian Plateau (Botoșani,Iași,Vaslui) due to landscape uniformity the disparities on number and surfaces of landfills are not so obvious in the territory of the same county(fig.3). However, in Vaslui County, there is a noticeable difference between north,south and east county where areas of these dumpsites are larger per commune compared to the center of county .

Communes frequently have densities over 50 inhab./sq.km and much higher in the proximity of large cities especially in Iași county (over 300 inhab./sq.km).

Geographical conditions,demographic context and lack of sanitation services have led to the disposal of household waste in open dumps.The large number of people but also villages that usually form a commune have led to a significant number of these dumpsites occupying large surfaces compared to western counties from North-East Region.Furthermore,sanitation services from rural areas in 2008 were almost absent.However is observed some disparities between these three counties.Iasi county has the largest number of rural dumpistes and consequently the largest occupied areas from the North -East region but also it is the most populated.Only 3.5% of the rural population of this county had access to waste collection services in 2008, open dumping was a current practice in every commune and even village.Vaslui county is less populated,poor economic and social conditions favored the lack of sanitation services in rural territory(2003-2008),open dumps was the only option for waste management.Neither in urban areas situation is not favorable compared to other counties of the country [10].The vulnerability of this county to illegal dumping in urban and rural ares is highest in North-East region.In Botoșani county,rural population access to sanitation services is insignificant thus encouraging uncontrolled waste disposal in open dumps like in the others two counties.

CONCLUSIONS

Physical-geographical transition of Suceava, Neamț and Bacău counties is reflected in disparities concerning the distribution of rural dumpsites within the same county, while in eastern counties (Botoșani,Iași and Vaslui) this distribution is more uniform due to a more homogeneous landscape (Moldavian Plateau).Higher share of rural population with access to sanitation services,lower densities and waste disposal on rivers banks in mountain areas of western counties explains the smaller number and lower surfaces of dumpsites reported as opposed to eastern counties.On the other hand,the most populated counties such as Suceava and Iași have the largest number and surfaces of dumpsites than the other four counties together.Yet significant differences between these two counties highlights on the one hand the role of sanitation services in rural areas and on the other and the role of various geographical conditions from Suceava county in spatial analysis of these sites.North-East region are still facing the uncontrolled waste disposal due to a partially acces of rural population to sanitation services damaging local environmental factors.Suceava and Bacău counties have some progress in the development of waste management facilities from rural areas while the Neamt county and eastern counties are still most vulnerable to illegal dumping.

Acknowledgements

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REFERENCES

[1] Pires A.& Martinho G.& ChangN.B. Solid waste management in European countries: A review of systems analysis techniques,Journal of Environmental Management ,USA,92,pp.1033-1050,2011

[2] Mazzanti M. Zoboli R.Waste generation, waste disposal and policy effectiveness Evidence on decoupling from the European Union, Resources, Conservation and Recycling, Netherlands,52 ,pp.1221–1234,2008

[3] Apostol L.& Mihai F.C.The process of closing down rural landfills Case study : Neamţ county, Present Environment and Sustainable Development,Romania,5/issue 2, pp.167- 174,2011

[4] Kulczycka J.& Zygmunt K.Principles of municipal waste management in Poland and selected regions of Europe. Polish Journal of Chemical Technology,Poland,10 /4, pp 28-33, 2008

[5] Orosz Z. Fazekas I. Challenges of municipal waste management in Hungary. AGD Landscape & Environment,Hungary, 2 /1,pp. 78-85,2008.

[6] Athanassiou M.& Zabaniotou A.Techno-economic assessment of recycling practices of municipal solid wastes in Cyprus,Journal of Cleaner Production,Netherlands, 16,pp.1474-1483,2007.

[7] Taseli B.K The impact of the European Landfill Directive on waste management strategy and current legislation in Turkey's Specially Protected Areas,Resources, Conservation and Recycling,Netherlands,52, pp.119–135,2007.

[8] Vucinic A.A & Hublin A. & Ružinski N. Greenhouse gases reduction through waste management in Croatia,Thermal Science,Serbia,10,14/3, pp. 681-691,2010

[9] Regional waste management plan for North-East Region, Romania,2006,

[10] Mihai F.C. & Ghiurca A.& Lamasanu A Estimation of urban waste generated and uncollected in Romania,Analele Universitati Oradea,Fascicula:Protectia Mediului,Romania,17,pp.719-724,2011

GREEN ROOFS AS A TREND OF KINDERGARTEN ARCHITECTURE – ECOLOGICAL BENEFITS AND IMPLEMENTATION

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ABSTRACT

Greening the roofs of buildings provide many ecological and economic benefits, including storm water drainage, energy saving, reduction of thermal effects, increasing the durability of roofing, as well as providing aesthetically pleasant environment. The paper treats aspects of implementation of extensive and intensive green roofs on different types of kindergartens. The analysis is based on researching building opportunities in Serbia. The research also provides the opportunities for the construction sector to make a real green choice that is consistent with the climate and environment. Having in mind that the existing building capacities in Serbia, spend huge amounts of energy, the research is focused on establishing the potential concepts for saving energy, without disturbing the comfort in kindergartens. Kindergarten building's design can have a direct effect on how children assimilate, learn and how a society integrate sustainability to their lives, to. A building has the potential to teach and convey new ways in which sustainable principles materialize.

Keywords: green roofs, energy efficiencies, thermal effects, kindergarten architecture

INTRODUCTION

The trend to cover relatively small areas of ground with as many buildings and roads as possible for economic reasons while not providing sufficient green spaces has many adverse effects. The urban landscape can be positively transformed by turning a town's roofs and walls into green spaces, replacing the land lost to buildings and roads. Interconnected with bridges and ramps, green roofs can recreate a continuous living landscape at roof level, linked via 'green walls' with planting on the ground. The resulting green cities could become more pleasant and healthier environments for people. In the wider context, if all urban habitats are greened in this way more carbon will be captured through photosynthesis, thus compensating for some of the emissions presently created by the urbanization of the landscape.

DEVELOPMENT

Green roofs are massively applied in many countries for centuries. The biggest reason for this is excellent thermal benefits achieved by combining different layers of vegetation and soil. In cold climates, such as in Scandinavia, green roofs have significantly contributed to the retention of heat in buildings, while in warmer regions prevented them from warming. Forerunner of green roofs in Canada, who first applied the Vikings and then the French colonists, can be found in New Faundlend and Nova Scotia.

Two contemporary proponents of the technology of green roofs are architects Le Corbusier and Frank Lloyd Wright. Although Le Corbusier used roofing as rare free surface for the greening of the overcrowded cities, and Wright greened the roofs of buildings in order to better assimilate in a natural environment, none of them was aware of the environmental and economic impact that this technology will have on urban areas. By the mid-20th century, green roofs are considered a traditional aspect of construction.

Modern green roofs have been developed in Germany 1960th year. It is estimated that approximately 10% of German roofs are green area. Green roofs are becoming increasingly popular in the United States, although not represented as such in Europe. European countries, including Germany, Switzerland, Holland, Italy, Austria, Hungary, Sweden, Great Britain and Greece, have done much to the promotion of green roofs. During the 1960's in Northern Europe is renewed interest in the use of green roofs as a result of increased concern about the decline of living conditions in urban areas and as a consequence of the rapid reduction of green areas in cities. The infrastructure of green roofs have a tendency to become an important option when building both private and public buildings.

In Austria, Switzerland and Germany planning policies regarding the greening of buildings in urban areas are issued by local authorities, while construction standards are imposed nationwide. Green roofs began to appear in some towns and cities in the 1970s and 1980s as an answer to problems with air pollution, storm water management and the urban heat island. High densities, sealed surfaces, emissions from industries and traffic, coupled with insufficient green spaces left on the ground drove planners to look for new solutions. Austria employ engineers to put green roofs since 1983. The first local authority to encourage green roofs by means of grants was the industrial city of Linz. In Switzerland the green roof installation is covered by federal law since the late 1990's. In the UK, its development is much slower, but a number of cities have developed political incentives whose role is to increase their use, particularly in London and Sheffield. [1]

In the 21 century solution to many problems that occur in urban areas as possible by placing green roofs. Living expenses suggest that green roofs cost the same or some more than conventional roofs, and that their use carries with it numerous social, environmental and economic benefits.

EXPERIENCES

The evidence of the benefits from green roofs is available from studies conducted in countries such as Germany, Australia and Canada. They all show that energy consumption for heating and cooling is reduced, that the urban heat island effect is diminished, that the air is cleaner, that rain water runoff is reduced and slowed down, in addition to enhancing biodiversity, and lifting people’s spirits. Policies have been shown to be effective in Austria, Germany and Switzerland where green roofs have been introduced on a large scale during the past 20 years.

The drivers for the introduction of policies in support of green roofs differ from place to place, depending on local needs. In Germany the main emphasis is on storm water attenuation. In Switzerland green roofs were introduced for their thermal quality with resulting reduced energy consumption, and for biodiversity. In Austria the main driver for the introduction and promotion of green roofs is air quality.

Since then incentives for green roofs have been introduced in many cities with good results. Where the provision of green roofs is mandatory, extensive green roofs prevail because they are less costly to construct, in less need of maintenance, and therefore more readily accepted. Intensive green roofs are mostly provided by choice, where they serve as accessible green spaces with special functions such as for recreation, education or cultivation.

Twenty years experience in countries like Germany, Austria and Switzerland and studies conducted in Canada prove that green roofs bring a number of private and public benefits (Table 1).

Private benefits	Public Benefits
Reduced energy use	Reduced temperature
Extended service life	Reduced storm-water
Noise reduction	Reduced air pollutants
Aesthetic value	Reduced greenhouse gases
Food production	Human health benefits

Table 1 Private and public benefits of green roofs

The Green Roof Technology Study conducted in Toronto concluded that, if 5 000 ha of available flat roofs - that is 8% of the total area of Toronto - would be covered with green roofs the ambient temperature would be reduced by 0.5 - 2.0^{o}C, depending on time of year. Thus the energy used for cooling due to the urban heat island effect would be reduced by an equivalent of 4.15 kWh/m2 of green roof per year. Other benefits that amount to substantial savings would come from the reduction in storm water flow and from air quality improvement. [1]

Portland and Seattle in the US and Stuttgart, Cologne and Münster in Germany are examples of cities that offer up to 80% reduced sewage tax rates to occupiers of buildings with green roofs. The volume of water retained by a green roof depends on its substrate depth and additional water retentive materials used in the superstructure such as reservoir boards and fleeces. According to the German Guidelines for Green Roofs from 2008 an intensive green roof with 250- 500mm substrate will retain an average of 70% water p.a. Substrates over 500mm retain more than 90%, while the figures for extensive green roofs with substrates of 20-200 mm are between 40-60% water retention.

TYPES AND IMPLEMENTATION

The green roof is a green space designed by depositing layers of soil and planting vegetation on the traditional roof structure. Green roofs are considered to be the fifth facade. The function of the roof space mainly determined by design - is to cover only the "ecological" or the space available to the people for recreation, gardening, etc. Limiting factors for the green roofs are capacity, load and slope of the roof. Depending on the depth of planting and plant maintenance, green roofs can be divided into extensive, semi-intensive and intensive green roofs.

Vegetation layer of extensive green roofs consists mainly of a mixture of sand, gravel, broken bricks, peat, organic matter and certain types of land. Because of the shallow layers of vegetation and extreme microclimate on most roofs (desert-like conditions), the plants must be low with the characteristics of wild plants and should not require special conditions of irrigation and maintenance. The plants are usually watered only when the trash is not prime, and after one year of maintenance involves removing the roof and checking the regularity of the membrane two times a year. Extensive green roofs can be applied to flat roofs and pitched roofs with a slight incline, provided they have taken appropriate measures to prevent soil shear strength.

Landscape features on intensive roofs are virtually limitless. They are intended for recreation, sports and gatherings, and often are in appearance indistinguishable from natural. A layer of drainage - water retention is usually deeper than extensive roofs. Filled with the extended aggregate to provide more space for storage of water, and to support deeper roots of plants, enabling the growth of trees and shrubs. The depth of the growing layer of intensive green roofs also brings additional requirements to maintain the structure of the roof and irrigation system. They are generally quite expensive and require additional structural reinforcement of the building. Traditional roof gardens, which require a reasonable depth of soil for the growth of large plants or conventional lawns, are the roofs as they require intensive irrigation, fertilization and other forms of maintenance. Intensive roofs are more like a park with easy access and can include everything from shrubs and small trees, plants, and fountains, ponds and threshing barn. They are demanding that the maintenance concerns. Intensive roofs provide an excellent recreational area and encourage interaction between people and nature.

Because of the greater thickness of the soil the choice of plants is much broader and includes the planting of trees and shrubs, which form a complex ecosystem. The need for maintenance (especially for irrigation) are much more demanding and more frequent and irrigation systems are usually unavoidable. It is recommended that advice from a horticulturist, and the installation of the roofs need more experience than is the case for extensive roofs (Table 2).

	Extensive Green Roof	Semi-Intensive Green Roof	Intensive Green Roof
Maintenance	Low	Periodically	High
Irrigation	No	Periodically	Regularly
Plant communities	Moss-Sedum-Herbs and Grasses	Grass-Herbs and Shrubs	Lawn or Perennials, Shrubs and Trees
System build-up height	60 - 200 mm	120 - 250 mm	150 - 400 mm underground garages > 1000 mm
Weight	60 - 150 kg/m^2	120 - 200 kg/m^2	180 - 500 kg/m^2
Costs	Low	Middle	High
Use	Ecological protection layer	Designed G.R.	Park like garden

Table 2 The following criteria characterize three different forms of Green Roofs

It should be noted that due to specific features of the site, building design, budget, customer wishes and offers of materials and plants, each green roof is different and in most cases a combination of intensive and extensive systems as a semi-intensive green roofs.

KINDERGARTEN AND GREEN ROOF

One of the major challenges of kindergartens building is how to address the existing variations in the pattern of environmental quality across different facilities. The question of environment is of particular interest to professionals worldwide. The causal relations of architectonic design – ambience quality factors in the pre-school facilities, are an important starting point in defining the physical environment where the children stay, and which is significant for the development of children at all. [5] Environment stands among the highest priorities we are faced with.

Site design is a fundamentally important aspect of sustainable design. All aspects of environmental design, from energy and water efficiency, to acoustic comfort and environmental impacts, are affected. Building placement, orientation, massing, and layout decisions made early in the kindergarten design process can profoundly affect the energy impacts of the building (Fig. 1). These decisions also bear on the resulting indoor environment since they either capture or lose opportunities for day-lighting and natural ventilation. [3]

Fig. 1 Kindergarten “A Garden fo Children“ Vaduz, Liechtenstein, Christen A. and Ritter J., 2002

Fig. 2 Kindergarten Bevaix, Switzerland, GD Arch. FAS SIA, 2005

Other implications include acoustic comfort, safety, and visual quality. Sustainable kindergarten design incorporates the site’s natural advantages and features to achieve the kindergarten’s high performance goals (Fig. 2). In addition, the high performance kindergarten site and building can “teach” environmental protection concepts. Site design can take into consideration opportunities for outdoor classrooms and environmental learning projects.

A high performance kindergarten protects the natural ecosystem by not employing any products and technologies that could pollute or degrade kindergarten site [2, 3].


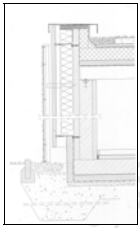

Fig. 3 Kindergarten Alsdorf, Germany, Arch. Hahn Helten, 2005   Fig. 4 Detail section

By embracing natural site conditions kindergarten design is environmentally responsive to the site as it enhances the building's performance. In this way children have opportunity to see directly how human activities impact ecological systems and can actively be immersed into learning about strategies to protect natural habitats (Fig 3 and Fig. 4).

KINDERGARTENS IN SERBIA – POSSIBILITY OF APPLYING

In Serbia, there have been some government supported initiatives both in commercial and residential sector which promoted higher energy efficiency standard. Kindergartens can consume up to 35% more energy than is necessary. [6] In addition, kindergartens and schools in Serbia account for 11% of the total energy used by the institutional/commercial sector and are the second highest consumers of energy in this sector. Throughout Serbia, there are over one half of kindergartens buildings are in urgent need of energy efficiency improvements. They are wasting expensive energy. [7] In Serbia today, 55 percent of kindergartens are more than 30 years old. Most of them need to be modernized and upgraded to bring them up to minimum basic standards. This is especially true of kindergartens built in the 1970's and 1980's (Fig.5).


Fig. 5 Kindergarten "Bambi", Nis, Serbia   Fig. 6 Possibility of greening

For many years in Serbia there are great difficulties with investing in the construction of new children's preschool facilities and therefore the scope of works is at very modest scale. However, even if the community was not at economic stagnation, and much more was built, the priority is reconstruction and adaptation existing buildings. [4] In this context the goal is mainly their revitalisation (Fig. 6). The reasons for that are: the preservation of existing buildings and improvement of accommodation conditions for children.[9] The task is a complete revitalisation of building and improvement of environmental quality, as a result of new quality of the interior space and improved characteristics of façade and roof layer (Fig. 7).

As a part of scientific project conducted at Faculty of Civil Engineering and Architecture in Nis, in last couple of years has been surveyed a great number of kindergartens in Serbia mainly in south-eastern part of Central Serbia. Although this is an on-going project, and some data are still collecting, there was sufficiently material to make an overview of field situation and make a draft framework for proposed reconstruction strategy, as a main goal of this study. In addition to the reconstruction principles of the buildings in general, one of further aspects is greening roofs discussed here as a contemporary trend in kindergartens design in accordance with changed educational principles and vision of modern upbringing of the children. [8] The paper goal is to explore the possibilities and suggest the best model for reconstruction and adaptation in terms of the full revitalization of children's preschool facilities regarding needs of children for acceptable environment and high-quality space in terms of both healthy and energy efficient environment (Fig.8).

Fig. 7 Kindergarten "Bambi", Nis, Serbia

Fig. 8 Possibility of greening

CONCLUSION

Green roofs remind us of how much the role of a natural biological systems in alleviating the extreme climatic conditions. Finding ways to build closer to nature, to the extent to which the urbanized nature will make the cities more liveable, not only for people but for plants and animals.

Governments everywhere recognize the benefits of green roofs and green roofs to realize a positive effect on the ecology of large polluted cities, and therefore more effort to provide benefits and assistance to owners of private buildings who want to put green roofs on their facilities. Green roof technology is spreading. Berlin has between 5-30% of roof space greened in different parts of the city at the time of writing. In London, about 100.000 m² green roofs were installed in 2008. Shanghai, also installed a similar amount in 2008. In France, approximately 1 million m² of roofs are greened per annum. Similarly, approximately the same area was covered in 2009 in North America. Germany adds about 11 million m² of green roofs each year. Quality and standards of design and installation vary in different countries.

The greening of roofs and walls with vegetation has taken hold in a number of kindergartens and countries. Because of their complex nature, green roofs incur higher initial capital costs, firstly for the additional load bearing down on the structure and secondly for the specialized green roof superstructure. The renovation process of kindergartens may have different ranges. This is implicated with condition of the buildings and financial support for the reconstruction. The scope of the reconstruction is conditioned with amount of available financial resources. Good financial basis may give possibilities to make a total makeover of the building including new green roof. Therefore the problem of reconstruction must be considered through priorities. First priority must always be the wellbeing of the children as occupants of kindergartens.

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REFERENCES

[1] Banting E. et al. Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto, Department of Architectural Science, Ryerson University, Toronto, Canada, pp 46-62, 2005.

[2] Chiles, P. Classrooms for the Future: An adventure in design and research, Architectural Research Quarterly, UK, Vol.14, No. 4, pp 297-299, 2003.

[3] Gough A. Sustainable Schools: Renovating Educational Processes**,** Applied Environmental Education and Communication, USA, Vol. 4, pp 339–351, 2005.

[4] Kostic A. & Stankovic D. The revitalization and sustainable development of kindergartens in Serbia – The case of the city of Nis, 2nd WTA International PhD Symposium, Building materials and Building Technology to Preserve the Built Heritage, Czech Republic, PART-I, Vol.2, pp 354-363, 2011.

[5] Stankovic D. The environmental revitalization of the space for children, Facta Universitatis, Series Architecture and Civil Engineering, Serbia, Vol.9 N^{o}3 – 2011, pp 481-489, 2011.

[6] Stankovic, D. Reconstruction in order to reduce energy consumption – Schools and kindergartens in Serbia, 10th International Multidisciplinary Scientific Geo-Conference SGEM 2010, Bulgaria, vol. II, 2010, pp 725-731;

[7] Stankovic D. Evaluating and improvement of environmental quality of kindergartens in Serbia, 11th International Multidisciplinary Scientific Geo-Conference SGEM 2011, Bulgaria, vol. I, 2011, pp 341-346

[8] Stankovic D. et al. Scientific Project "Revitalization of the Kindergartens in Serbia – Program and Methods for Improvements of Ambient, Functional and Energetic Quality" Annual Report, Faculty of Civil Engineering and Architecture, University of Nis, Serbia, 2011

[9] Straka, V., Aleksic, M. Post-Occupancy Evaluation: Three schools from Greater Toronto, PLEA2009 - 26th Conference on Passive and Low Energy Architecture, Quebec City, Canada, pp. 1-5, 2009.

HABITAT FRAGMENTATION DUE TO LINEAR TRANSPORT INFRASTRUCTURE. CAUSES. EFFECTS. MEASURES

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ABSTRACT

Concerns about biodiversity conservation awareness arose in response to the many changes caused by uncontrolled human interventions on the natural environment. In this sense, can be raised the discussion on the problem of the habitat fragmentation caused by transport infrastructure. Further increasing traffic results in a greater requirement for transport infrastructure, leading to inevitable conflicts between them and the environment. Fragmentation phenomenon became prominent in Central Europe in recent decades, and Romania will not avoid taking into account the expansion and modernization program for linear transport infrastructure.

Keywords: habitat fragmentation, biodiversity conservation, linear transport infrastructure

JEL Classification: R - Urban, Rural, and Regional Economics, R4 - Transportation Systems

INTRODUCTION

"Life and how it is done in nature is observed predominantly at any point of globe. The organic world determines the feature of the respective geographical complex, but this in its turn determines its existence" [1]

Concerns about biodiversity preservation arose in response to people becoming aware of the many changes caused by uncontrolled human interventions on the natural environment. It can be stated that "biodiversity or biological and ecological diversity reflects both structural and functional variety of natural, social and cultural capital and ultimately the complex socio-ecological peculiarities, both in terms of their foundation and the socio-economic architecture" [4]

In this sense, it can be raised the discussion of the fragmentation of habitat due to transport infrastructure.

Studies performed in the European Community have clearly shown that the linear transport infrastructure (meaning roads, railways and waterways) leads to habitat fragmentation, this phenomenon can be described as a division of natural habitats and ecosystems in remote small areas, which implies a significant decrease of the corresponding conditions of fauna life in adjacent areas, including the creation of barriers to their natural movement, resulting in a total isolation or extinction of vulnerable species.

Further increase of traffic results in a greater demand for transport infrastructure, inevitably leading to conflicts between the latter and the environment.

Wildlife mortality directly impacts and traffic safety, so habitat fragmentation issues can be solved only by including them in the national and even regional strategy, through an interdisciplinary approach, including direct involvement of the population, a prerequisite for establishing the optimal solutions in designing and managing of land communication routes.

Impact of transport infrastructure on the environment often depends on physical and geographical characteristics of the area and at the same time the characteristics of socio-cultural settlements and in particular, the "sensitivity of the site". Crossing parks or nature reserves, forrests, wetlands, special habitats or blocking of wildlife crossing areas are among the factors that determine the sensitivity of the site and justify a comprehensive and detailed impact and environmental protection measures.

Fragmentation phenomenon became prominent in Central Europe in recent decades, and Romania will not be able to avoid it, taking into account the expansion and modernization program for linear transport infrastructure.

In Romania, solving such problems is regulated by the legal framework provided by the "Environmental Protection Law" (no. 137/1995) where there are adopted the principle of preventing environmental risks and damage occurrence and the principle of conservation of biodiversity and specific ecosystems natural biogeographical framework. However, it is important that these principles can be materialized through the adoption of measures for each case of uncontrolled environmental intervention. It is therefore necessary that the infrastructure be designed and managed at the landscape scale, based on common national and European legislation, aimed to maintaining the balance of life on Earth.

However, it should be noted that the problem of fragmentation and methods of prevention, avoidance or mitigation, is characterized by universality, and therefore research efforts need to be initiated internationally. The continuity of habitat should be a strategic target of all environmental policies in the transport sector and beyond. EU Directive provides the legal basis for analyzing habitat fragmentation from early stages of planning.

1. HABITAT DEFRAGMENTATION - MEASURES AND TECHNICAL SOLUTIONS

Fragmentation of habitat can be characterized as a "division of a continuous environment that includes large areas in a landscape with many areas, small and rougly not interconnected" [3]

Migration of wildlife functions by its own laws and understading them from the planning phase requires the construction of *wildlife bridges* (term introduced by the Netherlands, and meaning all bridges that are covered by vegetation), designed to ensure continuity of flora and fauna of an area, the wildlife passages being, currently the most effective measure to minimize the effects of habitat fragmentation. The first constructions of this type have been built in France in the 60s, followed by a strong expansion, particularly for highways, in places like Switzerland, Luxembourg, Germany, Sweden, Netherlands, etc.

I will further detail several aspects of this new challenge of the XXI century, namely habitat defragmentation. Given the fact that in our country addressing these problems is in its infancy, there will be presented measures and technical solutions applied in some European countries.

Artificial "obstacles". Reflectors are the most widely applied measures to prevent animals crossing the road (ie, application of metal bands on tree trunk to reflect light from vehicle headlights in traffic on that road). Spotlight use is common in Europe, although some research studies have questioned their effectiveness.

Recently, there have been developed chemical or natural odorization systems which are applied in layers along the road, considering and demonstrating also that these substances keep the away mammals away from the road. Eventhough these systems have not been thouroughly studied, such systems are used today in countries such as Germany, Switzerland and Norway.

Adaptation of the habitat. Vegetation on the sides of the road or central reservations, can attract or guide animals away from the infrastructure. Planting hedges or other vegetation type was used to guide the animals along the transport infrastructure, supplemented by the use of animal passages. On the other hand, deforested areas near roads reduce the animals' interest for them as feeding areas and improve the visibility conditions. These measures are used, for example, in Norway, where the main purpose is to reduce the number of potentially fatal collisions between vehicles (or trains for the railway) and moose. Thus, it appeared that deforestation was effective in reducing accidents.

Also, with the help of high vegetation, birds can be encouraged to cross roads at a height high enough to avoid vehicles. Planting trees was proposed in France to establish a flight corridor for bats. Birds are often attracted to roadsides, especially during migration, because of existing shrubs, so avoiding planting them near the road reduces the risk of accidents.

Adapting infrastructure. The number of countries that resort to adapting infrastructure in order to reduce mortality of the fauna is extremely low.

In the Netherlands, France and Belgium, the risk of animals drowning in artificial water courses was reduced by creating special exits for animals or by reducing the bank slope. In recent years noise barriers or walls along the highway are becoming more and more made of transparent panels. Number of collisions with birds can be reduced by marking (with stripes) these transparent walls and avoid planting shrubs and trees near these noise barriers. In Switzerland there are several examples of marking these barriers, but to date, in Europe, there has not been paid attention to this problem. Street lighting can function as a trap for insects, especially for invertebrates. In Switzerland and Spain sodium lamps and light directed lamps are being used and fatalities resulting from collisions with the boards have been reduced.

Reducing the impact of vehicles. Slowing down the speed of vehicles is effective in reducing the frequency and consequences of accidents, both for wildlife and humans. Unfortunately, reducing speed to a level low enough to be effective is difficult. For example, in the Netherlands reducin speed on secondary roads is often implemented to enhance traffic safety, with a beneficial effect in animals safety. Road signs that point to the wild animals are widely spread, but since drivers are familiar with them, they do not seem to cause drivers to change their behavior.

More complex systems have been developed in recent years: infrared sensors that detect the presence of large mammals that approach road and causes a flashing speed limit signs and warning of wildlife. Tests performed in Switzerland and Norway have shown that this system reduces the number of collisions with wild animals such as deer and moose. So far, these new systems were installed in certain areas, requiring the development of several studies on cost and efficiency. Temporary closure of roads is sometimes used when secondary roads are crossed by amphibians during mating. This method has been used in Switzerland, where, often, it is imposed only at night.

2. REDUCTION OF BARRIER EFFECT

Measures taken specifically for wildlife: wildlife passages

The information about the construction and specific design of crossing structures for wildlife is widely known in almost all European countries. Most countries make similar distinctions between different types of fauna passages. Some (France, Netherlands and Switzerland) have developed design principles and minimum requirements. Implementing measures however varies greatly between countries. Except the Netherlands and France, there are no statistics on the number of crossings constructed. Therefore, a comparison between countries would rather be possible at a qualitative rather than quantitative level.

Types of fauna passages. Fauna passages can be grouped into two main categories:

- passages under the road or railway line;
- passages over the infrastructure.

They are often grouped further according to their size, which is closely related to the species concerned. It also is used only difference between animal passages and the ones used both by animals and humans, the latter ones being provided with a lane for people. Planning a common use passage has implications for design, although the distinction is not always necessary, because people can always use the passageways built exclusively for animals.

The so-called wet passages are not usually made only for animals but are built in areas where streams must be crossed.

Underpasses for small animals (tunnels and tubes). Underpasses for small animals are made of concrete, rectangular metal tubes or tunnels, with a diameter between 0.4 and 2 m They can be constructed to allow passage of several species of small animals, or built for a given species such as, for example badgers.

Figure 1. Badger tunnel

Underpassages for medium and large mammals. Larger underpasses are usually built for bigger mammals of the size of foxes or hares, to larger species such as deer, moose, etc.. Recommendations for sizes range from 5-12 m width for smaller species and 25 m, or more, for large species. Height also varies between 3 and 5 meters, suitable for the species for which passage was built. Sometimes, minimum specifications, on the width, height and length are used to indicate the minimum requirements. However, it should be noted that the lower part of underpasses should be covered with earth. In larger underpasses, vegetation may occur, but usually there is not sufficient light and water.

The use of underpasses by animals is sometimess facilitated by placing of tree trunks in the passage (a system mostly used in din the Netherlands), or other items used to cover the construction.

Tunnels for amphibians. Crossing structures for amphibians have been built in many countries, leading frogs safely cross the road, during their move towards the matting areas.

Figure 2. Tunnels for amphibians

They usually consist of a clamping sistem, which leads the animal towards the crossing structure. Double tubes or one direction crossing which in Switzerland was considered more effective on a long-term basis, forced the animals to move in one direction, while simple tubes, or crossing in both directions, allowed animals to move freely in both directions. Although they are built especially for amphibians, the tunnels are used by other small terrestrial animals.

Overpass for wildlife. The passages above are often called "wildlife bridges", after the term introduced by the Netherlands and are, in fact, all types of bridges covered with natural vegetation. They are far more common for roads than railways, where overhead power lines which can disrupt their construction. Width of overpasses varies from 8-80 m. The funnel-shaped overpass was developed in France, with a width of 15 m in the narrowest point, and it is also used in other countries like the Netherlands, Luxembourg, Norway , Switzerland. In general, the structures frequently found in Germany and Switzerland have only this form.

Vegetation on the bridge is intended to guide the animals while crossing the road or railway line. The animals concerned are usually the large mammalian species and this is the reason why hedges are usually planted along the bridge to provide a guide line, coverage and protection against light and noise from the road. Lateral protection panels are also used. In areas where small vertebrates and invertebrates occur, vegetation is planted in a way similar to the adjacent landscape, in order to create a suitable habitat corridor.

Important to note is the fact that upward passage may or may not be combined with a road. Forestry and agriculture bands, with limited public access, are common features of many overpasses.

Large passages or landscape bridges. Passages with a width of 100 m up to several hundred meters are designed to restore, as much as possible, previous vegetation and landscape structure. Therefore they resemble to tunnels dug under a hill, with the difference that soil depth covering the passage, is smaller which limits growth of vegetation, especially trees. The difference between the overpasses and the landscape bridges refers only to their width.

Passages with trees on top. Passages with trees on top are a type of structure especially designed for climbing animals (eg squirrels). They were recently tested, only the Netherlands and Spain and are made of a narrow structure, built high above the road.

Structures adapted for fauna / Combined fauna passages. Combined fauna passages use structures designed for other purposes, for example, crossing rivers or valleys.

Viaducts. Viaducts are constructions made usually in countries with a hilly terrain. When a road or railway line crosses a valley, high above the ground, the vegetation underneath is preserved. Animal movement corridors usually follow water streams at the bottom of the valley. They can be kept without incurring changes, while the corridor is not obstructed. However viaducts are not a solution to deep valleys. Flooded land, in particular, are often at a lower level than they cross roads. In these cases the construction of a viaduct preserve habitat and exchange required between the two sides of the road.

These solutions are favorable for invertebrates and small vertebrates. Sometimes, even low-altitude viaducts are used by large mammals. Changes necessary in ensuring animal movements consist mainly in conservation and restoration of vegetation under the viaduct, in some cases using structures supporting guidance and measures to prevent obstruction by artificial structures, improper use by humans.

Underpasses and modified bridges. Underpases can be easily adapted to facilitate movement of animals, by adding a layer of earth and cleaning the area near the overpass, a radius of several meters in the adjacent area of the road. A row of "stub" or similar items, covering structure may increase their chances of acceptance by animals. Similarly road bridge is able to provide opportunity for animal crossing, if a narrow stretch of vegetation is added to one side or both sides of the bridge. Such structures are used especially in combination with forest or agricultural roads without traffic. They can facilitate the movement of invertebrates and small vertebrates. While some underpasses were adapted in this way, bridges covered withvegetation strips are less used. If the vegetation exdends, these underpasses become "multi-purpose passages."

Crossings over rivers. Where a bridge is built over water courses, the movement of terrestrial animals becomes difficult because of the river channel which results in the formation of steep banks. Conservation of natural bed of the river allows wildlife to move without obstruction. Widening of a bridge involves placing the pillars at a greater distance from the river. Banks covered with soil can be designed to provide opportunity for movement of terrestrial animals. The larger the distance between pillars, more light can penetrate underneath resulting in a denser vegetation providing natural movement corridors, especially for invertebrates, which do not cross the bare soil areas. Such measures have been adopted in countries such as Holland, France, England, Switzerland.

Damp underground passages/drainage. Underground channels built to manage small water courses or drainages underneath roads or railways may be designed or improved in order to serve as movement corridors for small animals (aquatic and terrestrial). Designing of underground channels which do not allow such changes should be avoided. Some animals need a dry area near the water, and existing underground channels, with improvements, provide a top layer of soil that remains dry even under conditions of increasing water level. These so-called "eco-modified channels" are common in the Netherlands. In other countries, like England and the Czech Republic, they were built especially for otters. In arid countries, drainage channels are dry in most of the time, especially where they have a large diameter to capture water from torrential rains (Spain, Cyprus). They may also be used as passages for small terrestrial animals, without substantial changes.

Other measures to reduce the barrier effect. Where road infrastructure is a physical barrier to the movement of animals and the mortality caused by traffic accidents is not the most important factor, other steps may be taken to facilitate the passage of animals. There are few such measures reported, but should they be applied to a larger scale, they would have a significant effect. The width of the area next to the road is an important factor influencing invertebrates' possibility to cross the road. In Switzerland, the agricultural roads have been built consisting of tow concrete lanes separated by a land strip. This system has proven effective in increasing the movement of invertebrates and has a beneficial effect on vegetation. Again, in Switzerland there has been implemented a system of adapting the kerbs in order to facilitate the movement of small vertebrates: insted of a vertical kerb, there have been built ramps, thus the animals can go up or down the kerb without obstacles.Changes to drainage systems and drainage ramps system led to restoration of the number of amphibians and small land animals avoiding their death by drowning. Channels described above, not only reduce mortality from drowning, but also the barrier effects for terrestrial animals.

CONCLUSIONS

Road transport as an infrastructure component for sustainable development, may have a less significant impact on the environment if the negative effects are mitigated by several measures, such as technical solutions, promoting appropriate regulations and allocation of financial resources to solve the environmental challenges.

All issues raised on the issue of habitat fragmentation due to linear transport infrastructure can only lead to one conclusion, namely that there are several stages to be followed so that ecologic methods are fully developed and implemented in planning and developing transport and land management.

However, it is clear that Romania, in its current position of European Union member state, will identify the best solutions to minimize an increasingly complex process, that of the fragmentation of habitats due to transport infrastructure.
Certainly, the information presented in this paper and attached images have confirmed the effectiveness and need for fauna passages in order to reduce the barrier effect and minimizing the degree of fragmentation of habitats. The pictures reffering to to the several types of wildlife passages, described above, were taken by H. Cormont, V. Keller, G. Veenbaas, H. Bekker and B. Iuell, in 2003, during an excursion organized the IENE conference (Infra Eco Network Europe).

REFERENCES

[1] Calinescu Raul, Bunescu Alexandra, Pătroescu Nardin Maria, *Biogeography*, Didactic and pedagogical, Bucharest, 1972, pp.14

[2] Nedea Petronela-Sonia, *Traficul rutier transfrontalier in sud-vestul Romaniei - impact asupra mediului si a asezarilor*, Editura Universitara, Bucuresti, 2011

[3] Stelea Laurentiu, *Habitat fragmentation - parameters and measuring instruments*In volume "Road and Environment", Ed Ionescu, Caransebes, 2002, pp. 63

[4] Vadineanu Angheluta, *Development management. An ecosystem* approach, Publishing ARD docendi, Bucharest, 2004, pp. 209-210

[5] *** *Guide for roads and the environment*, developed by the World Bank, Development Department, Transport Division in cooperation with the SETRA (Service Roads and Highways Technical Studies), France, 1994

[6] *** Review *Roads and Bridges*, Year VIII, no. 42 May-June, Bucharest, 1998

[7] *** *Ecobridge Guide - Habitat Fragmantation*, 2001

[8] *** *COST 341 - Wildlife and traffic*, European Handbook, European Co-operation in the Field of Science and Technical Research, 2003

HEALTH AND ENVIRONMENTAL RISKS OF CYTOSTATICS PLATINUM GROUP RESIDUES

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ABSTRACT

Interest in waste drugs in relation to their negative impact on the environment is increasing during last years. Reason for that situation is high production and consumption of drugs in the world and ineffective treatment of sewage containing drugs.

Broad range of pharmaceuticals can be detected in aquatic environment now. Hospitals use a great variety of substances for medical purposes, as diagnostics as well as for therapy, care and research. Various groups of pharmaceuticals like analgesics, antibiotics, lipid lowering agents, psychotropic drugs, cytostatic agents, contrast media, as well as disinfectants can be detected in wastewater from hospitals and to some extent even in surface and ground water.

The main route of human pharmaceuticals to the environment is through faeces to sewage. Drugs are not easily degraded during wastewater treatment. They may subsequently cause contamination of the environment including the food chain, when sewage sludge is used as fertilizer of agricultural land.

Due to growing consumption of cytostatics containing heavy metals the threat of heavy metals to environment is increasing. Removal of cytostatics from wastewaters is not efficient as well as natural attenuation processes in environmental matrices. The project “Research of technologies and methods of removing heavy metals from the Platinum group of biological waste and their recycling options” addresses this issue. The project proposes a solution for minimization of content of Platinum drugs and their metabolites in environmental components after application of these drugs. The project proposes further a detailed study of Platinum drugs in environment.

Obtained results show the contamination of working environment in hospitals. Contamination was found in 88% of samples. Analysis was performed by ICP - MS (plasma mass spectrometry), which allowed detection of 0.50 ng/l of Platinum (5 pg/survey sample).

It was also demonstrated for waste water, where Pt levels ranged from 0.5 to 1.0 µm/l. Sewage sludge contains 0.1 mg/kg.

Goals of the project are:

- Reduction of the content of Platinum drugs and their metabolites
- Development of analytical methods for determination of Platinum compounds in body fluids of treated patients
- Development of method for reduction of Platinum compounds content in body fluids of patients
- Health and environmental risks assessment of spread of chemotherapeutic agents in the environment

New standards or amendments will be drafted aimed to reduction of health and ecological risk with respect to potential mutagenicity and carcinogenicity of Platinum compounds in biological wastes.

Keywords: cytostatics, platinum, risk, biological waste, environment

INTRODUCTION

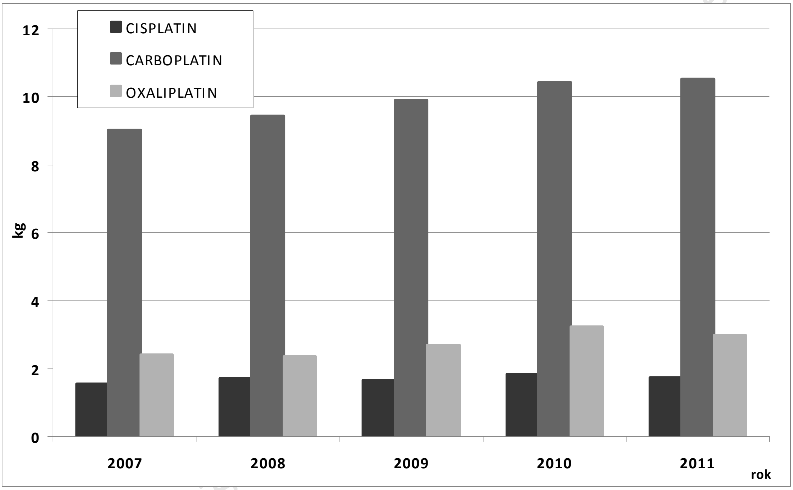
The issue of occurrence of Platinum metals (Pt, Pd, Rh) in the environment became important in the last 20 years, when catalytic convertors for treatment of automotive exhaust gases were introduced into use. Platinum metals are used as catalysts in organic technology, oil technology, petrochemistry, and they are used in electrical engineering, dentistry and medicine.

The group of Platinum metals includes Platinum (Pt), Palladium (Pd), Rhodium (Rh), Ruthenium (Ru), Osmium (Os) and Iridium (Ir) occuring in the earth's crust in µg/kg. These are chemically inert metals occuring only rarely in nature, mainly in Platinum including alloys [6]. Platinum is a toxic metal and its increasing content in the environment presents serious danger for human health. In general, it occurs only in low levels of 0. 001 – 0.005 mg/kg in the earth's crust. Higher levels are considered to be abnormal. The increase of Platinum content in various components of the environment during last years is alarming, and it deserves systematic monitoring. Significant resources of Platinum metals in the environment are exhausts of automotive catalysts. Healthcare facilities, were cytostatics containing Platinum are administered to patients, present a not negligible resource of contamination for the environment as well [7]. While preclinical, clinical and post-clinical phases of drug development study in detail mutagenicity and carcinogenicity of drugs on animals and humans, further fate of these drugs and their toxic metabolites in sewage after their administration is studied a little [3], [4]. Platinum is inert in the air, its reactivity comes into effect in contact with soil components, mainly with humic acid and in water with a high chloride content. Research shows that Platinum is biologically available for both animals and plants [5]. The question is what part of environmental contamination is due to Platinum metals originating from hospital facilities [7]. We partially try to answer this question in the submitted article.

Application of Platinum based cytostatics

The number of cytostatics applications increases with the increase of oncology diseases. One of the most important and most frequently used group of cytostatics in the Czech Republic is the group of Platinum (Pt) based cytostatics. It has been shown that the application of Pt cytostatics and their release from the human body causes contamination of the environment. During application of Platinum cytostatics in hospitals, 10 – 20 % of the applied Platinum binds to proteins in patients, and 50 – 75 % is excreted to waste water, where concentration of 10 – 601 ng Pt/l is reached. Fig. 1 shows the consumption of Pt cytostatics from 2007 to 2011.

Figure 1 Consumption of Pt cytostatics from 2007 to 2011



The risk presented by cytostatic preparations is important first of all for individuals who come into contact with them during and after their use. Preventive measures that are necessary during the use of cytostatic preparations are also necessary to be followed outside of facilities, since release of these products may have a harmful impact on the environment. Cytostatics are of low biodegradability and of long biological half-life, exert bactericide effects (synergy with antibiotics) and achieve high concentration in patient's urine. Since there is no way of removal of cytostatics metabolites from waste water, this is a serious problem due to the increasing number of patients undergoing chemotherapy (see the cytostatics consumption in Fig. 1). Most of Pt cytostatics are excreted through urine. About 10 – 40 % of Cisplatin excretes to urine within 24 hours. Carboplatin is excreted through urine unchanged (70 %) and as its metabolites, 60–70 % of which excretes through urine within 24 hours. Cytostatics application proceeds in most cases on out-patient basis, therefore patients warded during the complete application present only minor part of the overall number of patients treated by Pt cytostatics. This distribution of application sites is apparent in Table 1.

Table 1 Pt cytostatics consumption according to the mode of treatment

Year	Name	Overall consumption	Consumption by warded patients mg	Consumption by patients treated on out-patient basis mg	% patients treated on out-patient basis
2008	Carboplatin Eb.	25 700	10 800	14 900	58
	Cisplatin Eb.	37 140	9 470	27 670	75
	Eloxatin	86 350	150	86 200	99.8
2009	Carboplatin Eb.	69 400	6 250	63 150	91
	Cisplatin Eb.	74 535	8 675	65 860	88
	Eloxatin	269 200	117 320	151 880	56
2010	Carboplatin Eb.	90 550	20 250	70 300	78
	Cisplatin Eb.	70 170	11 750	58 420	83
	Eloxatin	137 450	15 350	122 100	89

METHODOLOGY

A project "Research of technology and methods of removal of Platinum group heavy metals from biological waste and their recycling FR-TI1/494" focused on the issue of contaminated liquid waste from healthcare facilities has been investigated since 2010. The investigators are Chemoprojekt, VUAB a.s. Projekt, Faculty of Environment of Czech University of Agriculture and National Institute of Health. The aim of this project is to study and create a separation system for Platinum metabolites directly from urine of treated patients after application of Pt cytostatics. This task presents a challenge as far the expertise, organization and logistics are concerned, and it requires an active cooperation of the investigating site with selected healthcare facilities and with universities. A potential advantage of this approach is processing of relatively small volumes of biological waste with high concentration of Platinum metabolites and direct elimination or significant reduction of waste water contamination by these metabolites from hospitals ("benign by design"). Due to the carcinogenicity, teratogenicity, mutagenicity and ecotoxicity of such compounds, another goal of the project is monitoring of individual components in living and working environment and modelling of migration of individual metabolites in living environment, including assessment of risks in individual critical points of migration of compounds. Results of these studies will be used for proposal of legal and methodical measures to optimize the system of management of this dangerous waste.

Methodology of sampling of individual matrices

Sampling of combined samples of soil in individual facilities was done with a groove sampling device from 20 partial soil samples and after mixing of individual samples a 1 kg sample was put to a sampler for chemical analysis. Sampling of the combined waste water sample was done with an automatic sampling device EPIC 1011 (24-hour sampling each two hours), the volume of a partial sample was 500 ml of waste water. Sludges were sampled with a groove sampling device. Collection of 10 partial samples - 10 samplings was put to the sampler after mixing. Weight of the combined sample was 1 kg.

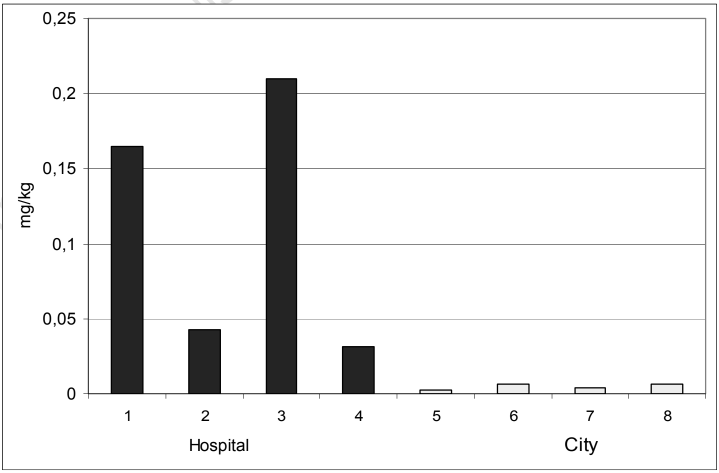
Methodology of the assay

To assay the total Pt content in samples, mass spectrometry with inductively coupled plasma (ICP-MS) was used. The analysis was performed in a quadrupole mass spectrometer Perkin Elmer ICP-MS Elan DRC-e. Two isotopes (^{194}Pt and ^{195}Pt) with highest natural presence and without isobaric interferences were used for the assay. Due to the low Pt concentration in the sample (extract of smear, urine of nurses, etc.), the sum of signals of both selected isotopes was used to increase the sensitivity of analysis. Re was added to all samples and standards as the internal standard. The interferences due to $^{178}Hf^{16}O^{+}$ and $^{179}Hf^{16}O^{+}$ ions were studied and signals were monitored.

RESULTS

Results of monitoring of selected components of living environment show contamination of the environment with Platinum, which is released from patients mostly by urine, and passes to waste water in the first phase. Pt levels in hospital waste water range from < 1µg/l to 1.5 µg/l . Fig. 2 shows an apparently higher presence of Platinum in the sludge from hospital waste water treatment plants compared to municipal waste water treatment plants. Pt concentration in the soil around hospitals was lower than Pt concentration around roads (Platinum from automotive catalysts), see Fig. 3.

Figure 2 Pt concentration in the sludge from waste water treatment plants



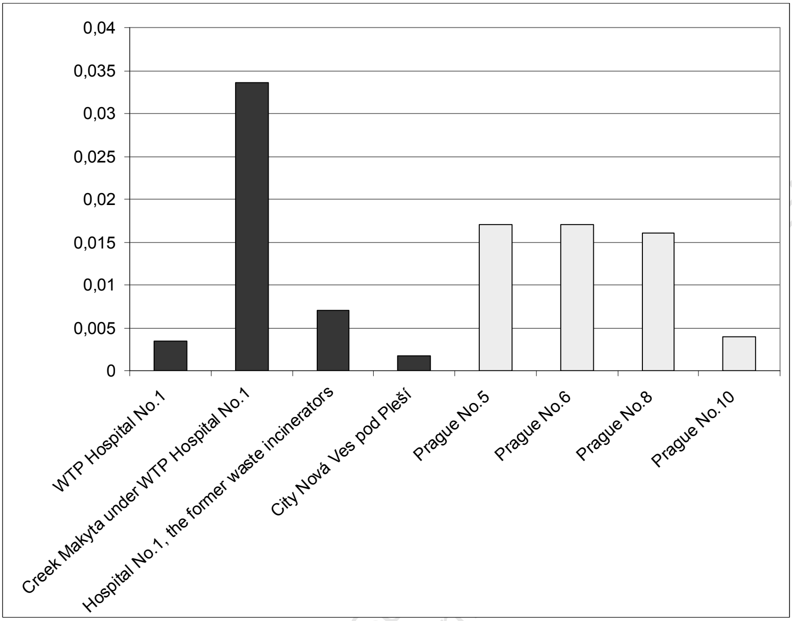


Figure 3 Pt concentration in the soil

DISCUSSION

Timorous diseases are becoming the most serious issue for healthcare worldwide. In the short-term perspective of the coming first quarter of this century, we expect another dramatic increase of new diseases. Global prevalence with the present count of 10 millions of new diseases is estimated to double [9]. Treatment facilities, where cytostatics containing Platinum are administered to patients, present a not negligible source of contamination for the environment [7]. Due to the high efficiency of cytostatics and their metabolites and due to the annual volume and dynamics of their consumption, serious health and environmental risks may develop or are already developing. The fate of drugs and their metabolites in the sewage and in individual components of the environment after their application has not been sufficiently researched [3], [4]. Concentrations we found in individual components of the environment were of lower values compared to published ones. Kümmerer [8] reports average daily concentrations in hospital water < 10-601 ng/1 Pt (20-3580 ng/1 in 2-hour combined samples). According to the data of consumption, the average daily concentrations should be in the range from < 10 to 710 ng/1 Pt. With regard to the day of publication of data for 1999, it is obvious that the application of Pt based cytostatics has shifted from the application to warded patients to the application in facilities where the patient leaves for home after several hours of the application, and does not stay in the healthcare facility for the entire cycle of elimination of residual cytostatics. The share of the out-patient application in the overall cytostatics application was in average between 78% and 89% in the Czech Republic in 2010.

Pt concentrations in the sludge unambiguously proved, in spite of the above mentioned ways of cytostatics use, higher Pt concentration in the sludge from hospital waste water treatment plants compared to municipal sludge. In spite of the preferred out-patient cytostatics administration, the higher Pt concentration in sludges is also due to the excretion of Platinum during the first hours of the application together with the higher number of treated patients.

For modelling and estimation of Pt spread in the environmemt, it is important to understand geochemical cycles and Platinum reactions in the environment. A lot of work has been devoted to Pt solubility in water or to its availability for plants. Another work addressed its adsorption in specific types of soil. The research has almost always been focused on the Pt exhaust from automotive catalysts, and there is not sufficient information on spread of Platinum from healthcare facilities or from patients due to its out-patient application. Becouse of this reason, it is necessary to obtain the most information possible on the actual concentrations in individual components of the environment. Concentrations found in the soil at hospital premises were not higher than concentrations found at different locations. Platinum found in the soil of control locations surely related to the exhaust of Platinum metal from automotive catalysts. It is the road transportation which is considered to be the main source of contamination of environment by the group of Platinum metals. Experimentally found values of Pt and Pd exhaust are in the range of 9 - 124 ng/km of travel. The exhaust of Platinum group metals due to the automotive transportation is approximately 0.5 – 1.4 tonnes worldwide (Pt and Pd combined) [2], [10], [11]. Most results of soil and road dust analysis in terms of PGM have been published in Germany. The average measured Pt value in soil was 10 μg Pt/kg and Pt content in road dust was in the range of 0.6 – 130 μg/kg, while the content is closely related to the frequency of the road traffic [1].

CONCLUSION

New treatment approaches have significantly increased the chance of prolonged survival of patients with a developed metastatic disease which was not possible in the past. On the other hand, cytostatics application increases the healthcare personnel exposure during preparation of cytostatics as well as the contamination of environment. Research projects focused on environmental and health risks of cytostatics residues in working and living environment are necessary for preventive protection of health and the environment.

REFERENCES

[1] ALT F., et al. 1997: Fresenius′ J. Anal. Chem. Vol. 357, 1013-1019 s.

[2] BARBANTE C., VEYSSEYRE C., FERRARI C., MOREL C CAPODAGLIO G., CESMÍN P., SCARPONI G., BOURTON C., 2001: Greenland Snow Evidence of Large Scale Atmospheric Contamination for Platinum, Palladium and Rhodium. Environmental Science & Technology, Vol. 35, no. 5, 835-839 pp.

[3] Council Directive 76/464/EWG: 2000.

[4] Council Directive 80/68/EWG: 1991.

[5] FARAGO M.E., et al. 1996: Fresenius′ J. Anal. Chem. Vol. 354, pp. 660-663

[6] GREENWOOD N. N., EARNSHAW A., 1993: Chemie prvků, svazek II. Informatorium. Praha, p. 299 (Chemistry of elements, volume II)

[7] Kümmerer K. et Helmers E., 1997: Hospital effluents as a source for platinum in the environment. Sci. Total Environ. 193: 179 – 184.

[8] Kümmerer K., Helmers E., Hubner P., Mascart G., Milandri M., Reinthaler F., Zwakenberg M., 1999: European hospitals as a source for platinum in the environment in comparison with other sources. Sci Total Environ 225: 155 – 165.

[9] Marek J. [ed.], 2005: Farmakoterapie vnitřních nemocí (Pharmacotherapy of internal diseases). Grada, Praha.

[10] WHO, 1991: Environmental Health Criteria 125 – Platinum. Geneva: World Health Organization.

[11] WHO. 2002: Environmental Health Criteria 226-Palladium. Geneva: World Health Organization, International programme on Chemical Safety.

HEAVY METALS BIOACCUMULATION IN ECONOMICALLY MPORTANT FISH (*Mugil cephalus* L.) OF KOYCEGIZ LAGOON SYSTEM (TURKEY)

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ABSTRACT

Concentrations of some heavy metals (Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn, Al, Hg, As, Se) were determined in water, sediment and muscle, gill and liver tissues of *Mugil cephalus,* collected from Köyceğiz Logoon system seasonally from September 2009 to July 2010. The concentrations of heavy metals were determined by using ICP-AES. Metal accumulation in *M. cephalus* tissues follows the order Fe> Zn> Cu> Al> Cr> Mn> Ni> Se> Co> As> Pb> Cd> Hg in liver, Fe > Zn > Al > Mn > Cr> Se> Cu> Ni> Pb> As> Co> Cd> Hg in muscle, and Fe > Mn > Zn > Al> Cr>Ni> Cu> Se> Pb> As> Co> Cd> Hg in *M. cephalus* in gill tissue. Statistical analysis of data was carried out using SPSS 15.0 statistical package program. One-way analysis of variance (ANOVA) was used to assess whether metal concentrations varied as significantly among tissues. Metal concentration differences among the tissues of *Mugil cephalus* were statistically significant ($p<0.001$) and highly significant positive correlation (0.70) were found between Co and Fe (n=202).

Keywords: Heavy metal, fish, Koycegiz Lagoon system

INTRODUCTION

Rapid development of industry, agriculture and tourism activities has an unavoidable affect on the increase of the levels of heavy metals in natural waters [1,2]. Heavy metals are present in the aquatic environment where they bio accumulate along the food chain. For this reason, heavy metal contamination of aquatic ecosystems is a serious pollution problem and it is important to determine the concentrations of heavy metals especially in commercial fish in order to evaluate the possible risk of fish consumption for human health [3]. Because of the importance of fish for human as food, numerous studies were published on heavy metal accumulation in the aquatic environment [4, 5, and 6].

Of the metals, iron, copper, zinc and manganese, are essential metals but mercury, lead and cadmium are non-essential metals, because they are toxic even in traces. However, all heavy metals are potentially harmful to most of the organisms at some level of exposure and adsorption [7]. Fish are often at the upper levels of the aquatic food chain and may concentrate large amounts of some metals from the water. In addition, fish are most indicative factors in fresh water systems, for the estimation of trace metal pollution and risk potential of human consumption. The essential metals like copper and zinc for the normal metabolism of fish must be taken up from water, food or sediment.

However, similar to the route of essential metals, non-essential ones are also taken up by fish and accumulate in their tissues [8, 9].

Köyceğiz Lagoon System, declared as a Special Protection Area in 1988, is located in south-western of Turkey [10]. The area is composed of terrestrial structures of various qualities around Köyceğiz Subsidence Lake. The lagoon is under pollution pressure of agricultural run-off, untreated urban waste and tourist-boat traffic. Fishing activities are carried on by Dalyan Fisheries Products Cooperative (DALKO) in Köyceğiz Lagoon system. Mullet is the main commercial fish on Köyceğiz Lagoon system. According to the data, obtained from DALKO, in 2006 160.386 tons of mullet was caught (Yorulmaz et al., 2008)[11].

THE STUDY SITE AND METHODS

Köyceğiz Lagoon System is located 36^{o} 45” and 37^{o} 15” North latitude and 28^{o} 22’ 30” and 28^{o} 52’ 30” East longitude in Southwest of Turkey in Muğla. Lagoon system covers an area of 5400 ha and connected to the sea with a 10 km long canal (Figure 1). The wide of the canal varies between 5-70 meters and the depth between 1-6 meters. This area designated as a national reservation area to be administrated by the Authority of Specially Protected Areas [12].

Figure 1. Study area

During the study period, four fishing expeditions were carried out in the Köyceğiz Lake between September–2009 and July–2010. Ten fish samples were transported to the laboratory in a thermos flask with ice on the same day in each study period. The main characteristics of the *Mugil cephalus* are given (Table 1). Approximately 5 g of muscle, two gill racers and entire liver from each sample were dissected, washed with deionized water, weighed, packed in polyethylene bags, and stored at -20 ^{0}C prior to analysis.

Table 1. Main characteristics of the fish species *M. cephalus* from Köyceğiz Lake

Fish Species	**Number of Species**	**Length (cm)**	**Weight (gr)**
Mugil cephalus	68	32,581±2,75	259,987±6,78

The tissue samples were digested with nitric acid. Dissected samples were transferred to a 100 mL Teflon beaker. Thereafter, 10 mL ultrapure conc. HNO_3 (Merck) was added, and the sample heated at 100, 150, 210, and 280 ^{0}C on a hot plate for 0.5, 0.5, 0.5 and 2 hours with a DK-20 Heating Digester respectively. Two mL of 1 N HNO_3 was added to the residue, and the solution continuously evaporated on the hot plate, until it was digested in every sample. After cooling, a further 10 mL of 1 N HNO_3 was added. The solution was transferred, diluted and filtered through 0.45 μm nitrocellulose membrane filter [13].

All samples were analyzed two times for metals by ICP/AES (Optima 2000- Perkin Elmer), which is a fast multi-element technique with a dynamic linear range and moderate-low detection limits [14]. Standard solutions were prepared from stock solutions (Merck, multi element standard). Standard reference materials, DORM-2 (for muscle) and DOLT-2 (for liver) – National Research Council Canada, were analyzed for analyzed metals. Statistical analysis of data was carried out using SPSS 15.0 statistical package program. One-way analysis of variance (ANOVA) was used to assess whether metal concentrations varied as significantly among tissues. To determine the correlation between the element pairs in tissues, the Pearson's correlation coefficient matrix ($p<0.001$) was accepted as statistically meaningful value.

RESULT and DISCUSSION

Mean concentrations and standard deviations of metals in muscle, gill and liver of *M. cephalus* from the Köyceğiz Lake lagoon system is shown in Table 2. Metal accumulation in *M. cephalus* tissues follows the order Fe> Zn> Cu> Al> Cr> Mn> Ni> Se> Co> As> Pb> Cd> Hg in liver, Fe > Zn > Al > Mn > Cr> Se> Cu> Ni> Pb> As> Co> Cd> Hg in muscle, and Fe > Mn > Zn > Al> Cr>Ni> Cu> Se> Pb> As> Co> Cd> Hg in *M. cephalus* in gill tissue. The results confirm the differences of heavy metal accumulation in the different tissues. The highest concentrations were found in liver, muscle and gill except for Cd and Hg.

The lowest levels were detected in the muscle, except for Fe. Liver is a target organ of accumulation for many metals, because of its strong irrigation and excretion function. Target organs, such as liver, gonads, kidney, and gills, are metabolically active tissues and accumulate heavy metals of higher levels, as was observed many experimental and field studies. The liver is often considered a good monitor of water pollution with metals since their concentrations are proportional to those present in the environment. The reason for high metal concentrations in the gills could be due to the metal complexions with the mucus that is impossible to remove completely from the lamellae before analysis [15].

Table 2. Mean concentrations of metals (μgg^{-1} metal) with standard deviations in muscle, gills and liver of *Mugil cephalus* in Köyceğiz Lake

Tissues / **Metals** (μgg^{-1})	**Liver**	**Muscle**	**Gill**
Cd	0,493±0,503	0,059±0,093	0,087±0,140
Co	1,618±1,383	0,153±0,579	0,174±0,240
Cr	2,857±4,045	2,256±4,441	2,571±4,060
Cu	32,762±45,047	1,021±1,051	2,397±5,671
Fe	275,656±254,481	51,575±125,633	79,298±117,759
Mn	2,853±6,212	7,659±20,796	60,890±67,452
Ni	1,964±2,653	0,834±1,245	2,423±5,891
Pb	0,747±0,963	0,479±0,776	0,872±0,974
Zn	85,825±64,664	22,077±30,149	31,244±32,553
Al	31,801±48,016	20,188±32,561	23,451±32,691
Hg	0,041±0,106	0,001±0,011	0,011±0,030
As	0,983±0,840	0,260±0,244	0,244±0,380
Se	1,704±1,820	1,311±1,039	1,039±1,231

The liver tissue is highly active in the uptake and storage of heavy metals. It is well known that large amount of metallothionein induction occurs in the liver tissue of fishes. The gills are uptake site of waterborne ions, where metal concentrations increase especially at the beginning of exposure, before the metal enters other parts of organism [15].

Analysis of heavy metal levels in tissues of *M. cephalus* showed that, highest values of Fe and Zn in liver and Mn in gills. Among the values mean iron (275,656 μgg^{-1}) and mean zinc (85,825 μgg^{-1}) concentrations appear considerably higher in the liver such as mean Mn (60,890 μgg^{-1}) in the gills. Our results showed that fish species contained different metal levels in their tissues.

Average heavy metal accumulation of *Mugil cephalus* was investigated periodically; the highest accumulated heavy metal in all seasons was Fe. The maximum accumulation of Fe (596,785 μg/gr) and Zn (121,105 μg/gr) were determined in liver on spring. Lowest Hg concentrations were detected in other tissues on every season. The highest As, Se and Cd (respectively, 1,373, 3,217 ve 1,427 μg/gr) toxic metal concentration were determined in liver at spring. Our results show that metal accumulation is highest in liver and in gills, whereas it is low in muscle at every season. On the other hand, high levels of metals in tissues of fish could be originated from different sources around the study area. These sources are; i) for Pb and Cd, boat traffic, motor oil and ballasts water, also Cd can be occurring from phosphorusfertilizer used in agriculture, ii) for Zn, composed fertilizer enriched with Zn, iii) for Mn, microelements fertilizer and iv) for Cu, conservative fungicides that contains Cu used for citrus fruits plantations and green-houses around Köyceğiz Lake[7].

Table 3. The correlation between metal concentrations in *M. cephalus* tissues

	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Al	Hg	As	Se
Cd	-												
Co	0.70**	-											
Cr	-0.01	0	-										
Cu	0.54**	0.41**	0.01	-									
Fe	0.58**	0.73**	0.02	0.32**	-								
Mn	-0.05	-0.14	0.22**	-0.15*	-0.04	-							
Ni	0.03	0.09	-0.05	0.06	0.09	0.03	-						
Pb	-0.05	-0.06	-0.04	-0.07	0.01	0.07	0.02	-					
Zn	0.52**	0.56**	0.06	0.32**	0.56**	-0.07	0.03	0.1	-				
Al	0.17*	0.15*	0.04	0.24**	0.13	0.11	0	0	0.17*	-			
Hg	0.12	0.09	0	0.06	0.12	-0.11	-0.01	0.17*	0.24**	-0.07	-		
As	0.49**	0.42**	-0.02	0.42**	0.29**	-0.14*	0.08	0.21**	0.34**	0.01	0.24**	-	
Se	0.34**	0.31**	0.06	0.08	0.29**	-0.03	0.08	-0.34**	0.05	-0.07	-0.09	-0.08	-

The correlation between elements in tissues of *M. cephalus* was statistically tested. Co, Fe and Cd were found to have relatively higher positive correlation coefficients (for Co and Fe = 0.73, for Cd=0.70) ($p<0.001$). Correlation coefficients were found between Cd, Cu, Fe, Zn, As and Se respectively 0.54, 0.58, 0.52, 0.49 and were calculated for Co, Cu, Zn, As, and Se respectively 0.41, 0.56, 0.42 and 0.31 ($p<0.001$). The value of correlation coefficients between Fe and Zn was 0.56. The correlation coefficient between Fe and Cu also for As and Se were found to be higher than 0.25 (Respectively 0.32, 0.29) ($p<0.001$). Only Pb and Se were found to have relatively higher negative correlation coefficients.

Table 4. The comparison of the Cd, Pb and Hg in *M. cephalus* muscle tissues between Turkish Food Codex (TFC) and European Commission Regulation (EU).

<table>
<tr><td rowspan="2">Sp</td><td rowspan="2">Session</td><td></td><td colspan="2">Cadmium (Cd)</td><td colspan="3">Lead (Pb)</td><td></td><td colspan="2">Mercury (Hg)</td></tr>
<tr><td>TFC (Max.limit) (µg/g)</td><td>EU (Max. limit) (µg/g)</td><td>Periodic Average (µg/g)</td><td>T.F.C (Max. limit) (µg/g)</td><td>EU (Max. limit) (µg/g)</td><td>Periodic Average (µg/g)</td><td>T.F.C. (Max. limit) (µg/g)</td><td>EU (Max. limit) (µg/g)</td><td>Periodic Average (µg/g)</td></tr>
<tr><td rowspan="4">M.cephalus</td><td>1</td><td rowspan="4">0,05</td><td rowspan="4">0,10</td><td>0,034</td><td rowspan="4">0,30</td><td rowspan="4">0,30</td><td>0,831</td><td rowspan="4">0,50</td><td rowspan="4">1,0</td><td>ND*</td></tr>
<tr><td>2</td><td>0.004</td><td>0,274</td><td>ND*</td></tr>
<tr><td>3</td><td>0,239</td><td>0,090</td><td>ND*</td></tr>
<tr><td>4</td><td>0,115</td><td>0,585</td><td>0,007</td></tr>
</table>

ND=Not Detected

This study was carried out to provide information on heavy metal concentrations in *M. cephalus* from SW Anatolia. Cd and Pb accumulation were well higher the limits for fish proposed by TFC and EU, 2008 [16, 17]. According to our results, the examined fish were associated with enhanced metal content in their muscle and were not safe within the limits for human consumption.

REFERENCES

[1] Gümgüm B, Ünlü E, Tez Z, Gülsün Z. Heavy metal pollution in water, sediment and fish from the Tigris River in Turkey. Chemosphere 29: 111-116, 1994.

[2] Freedman, B. 1989. Environmental Ecology. The impact of pollution and other stresses on ecosystem structure and function. London: Academic Press.

[3] Cid et al., B.P. Cid, C. Boia, L. Pombo and E. Rebelo, Determination of trace metals in fish species of the Ria de Aveiro (Portugal) by electro thermal atomic absorption spectrometry. *Analytical Letters*, **33** 15 pp. 3333–3341, 2001.

[4] Yilmaz, A. B. Levels of heavy metals (Fe, Cu, Ni, Cr, Pb and Zn)in tissues of *Mugil cephalus* and *Trachurus mediterraneus* from Iskenderun Bay, Turkey. *Environ. Res*, 92, 277–281, 2003.

[5] Marcovecchio, J.E. The use of *Micropogonias furnieri* and *Mugil liza* as bioindicators of heavy metals pollution in La Plata river estuary, Argentina*, Sci. Total Environ,* 323, 219-226, 2004.

[6] O. Ravera, Biological aspects of freshwater pollution, Pergamon press, New York, pp. 129–165, 1979.

[7] Fevzi Yilmaz The Comparison of Heavy Metal Concentrations (Cd, Cu, Mn, Pb, and Zn) in Tissues of Three Economically Important Fish (*Anguilla anguilla*, *Mugil cephalus* and *Oreochromis niloticus*) Inhabiting Köycegiz Lake-Mugla (Turkey), Turkish Journal of Science & Technology Volume 4, No 1,7-15, 2009.

[8] Yilmaz, F. Bioaccumulation of heavy metals in water, sediment, aquatic plants and tissues of *Cyprinus carpio* from Kızılırmak, *Fres.Env. Bull*, 15 (5), 360-369, 2006.

[9] Canli, M. Atli, G. The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Med. fish species*. Environ. Pollut*, 121 (1), 129–136, 2003.

[10] Kazancı N., Plasa R.H., Neubert E., Izbırak A. (1992) On the limnology of Lake Koycegiz (SW Anatolia). Zoology in the Middle East **6**, 109-126.

[11] Yorulmaz, B., Barlas, M., Yilmaz, F., Özdemir, N. (2008) Fishing Activities and Pollution Risk on Köyceğiz-Dalyan Lagoon System, EIFAC Symposium on Interactions Between Social, Economic And Ecological Objectives of Inland Commercial and Recreational Fisheries And Aquaculture (Antalya,Turkey, 21-24 May 2008)

[12] Bayari, C.S., Kazanci, N., Koyuncu, H., Caglar, S.S., Gokce, D. Determination of the origin of the waters of Köyceğiz Lake, Turkey, *J. Of Hydrology,* 166, 171–191, 1995.

[13] Alam, M., G.M., Tanaka, A., Allinson, G., Laurenson, L.J.B, Stagnitti, F., Snow, E. A comparison of trace element concentrations in cultured and wild carp (*Cyprinus carpio*) of Lake Kasumigaura, Japan. *Ecotoxicol. Environ. Saf*, 53, 348–354, 2002.

[14] Sturgeon, R. E. Current practice and recent developments in analytical methodology for trace metal analysis of soils, plants and water. *Commun. Soil. Sci. Plant,* 31, 1512–1530, 2000.

[15] Heath, A.G. Water Pollution and Fish Physiology. CRC Press, Florida, 1987.

[16] TFC. Turkish Food Codes, Official Gazette, Communique on Maximum Limits for Contaminants of Food Ingredients (Communique Number: 2008/26), 2008.

[17] European Commission Regulation (EC) No 1881/2006 of 19 December 2006.

HISTO-ANATOMICAL INVESTIGATION ON ENDEMIC CAMPANULA CARPATICA JACQ

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ABSTRACT

Campanula carpatica is endemic in Carpathian Mountains; this means that you can find it in Romania, but also in the north part of Carpatians (in Poland, Slovakia or Cehia). In Romania, in the Red List it is considered a rare plant. In this paper, the histo – anatomical features of these species have been investigated. Aerial vegetative organs (stem and leaves) were analysed in order to underline the structural peculiarities as response to their adaptation to the environmental conditions. Biometrical measurements of different anatomical parameters were performed. At the stem level, passing from the primary to secondary structure take place early, based only on cambium activity. The presence of the endodermis in the stem is not a commune features for the angiosperms; it serves to regulate the water fluxes between cortex and central cylinder. On the leaf, hydathodes could be observed on the marginal dentations; foliar hydathodes could be implicated in the absorption of surface water. The very narrow conducting vessels and the compact structure (with small aeriferous spaces) represent adaptations to an arid environment, with limited water resources.

Keywords: anatomy, endodermis, *Campanula carpatica*, leaf, stem

INTRODUCTION

The Campanula genus comprise approximately 200 to species and subspecies, in Europe, according to the still valid literature (Flora Europaea, MedCheck-list, Atlas Florae Europeae), for Europe [4]. In Romania, 27 species from Campanulaceae genus are identified (Flora R.S.R., volumul IX (1964).

Campanula carpatica is endemic in Carpathian Mountains, this means that you can find her in Romania, but also in the north part of Carpatians (in Poland,Slovakia or Cehia). In Romania, in the Red List it is considered a rare plant. This is of particular interest with respect to the palaeoendemic rapunculoid *C. carpatica*, a species that, according to Zlatko and collaborators (2008) [8] results, is closer to the ‘‘isophylloid’’ group (agg. *C. waldsteiniana*) than to sections Rapunculus Boiss. (subsection Rotula Fed.), where it traditionally belongs [2, 11].

There have been no anatomical and micromorphological studies on *Campanula carpatica* species. Erdelská (2001) [3] examined the stigmatic trichomes of *Campanula carpatica* using SEM. Other papers were focused on in vitro propagation of this species [5, 12].

In this study, we aimed to give detailed knowledge about *Campanula carpatica* by evaluating the results obtained from anatomical and histological investigations.

MATERIAL AND METHODS

The plant material was collected from the Cheile Bicazului – Hasmas natural reservation, located close to the city of Bicaz (Romania) (N 46º 50' 18", E 25º 50' 19" at an average altitude of 1267 m) in July 2010. A voucher specimen is stored in the Herbarium of Faculty of Biology, Al. I. Cuza Iasi University, Romania.

For histo-anatomical analysis the material was fixed in FEA and conserved in ethylic alcohol 70%. Free hand sections were performed using a razor blade. The sections were colored with ruthenium red and iodine green, fluoroglucine and HCl (for lignified cells), touluidine blu [10] for cellulosic and non-cellulosic walls, Sudan III to identify total lipid [6]. The photos were taken with an Olympus E-330 photo camera, using an Olympus BX51 research microscope. The measurements of the epidermis cells, stomata, vessels, fibers and assimilating parenchyma were made using the biometrical software from Nikon (NIR- Demonstration).

RESULTS AND DISCUSSIONS

Anatomical results

The stem (fig, 1, table 1)**.** Cross sections were performed at 3 levels: top, middle and base of the stem.

At the top, the stem has circular shape in cross section, with 5 prominent ribs. The epidermis is unilayered and shows no hairs. The collenchyma is 1-2 layered and present only in the ribs. The endodermis is distinguishable, but no chemical modifications (suberin and lignin) are visible in the walls at this level (negative at the histochemical test).

The vascular tissue consists in 10-12 irregular bundles linked by segments of the cambium producing the phloem island. In the phloem, laticifers, with thicker walls could be observed. The pith consists of thin-walled parenchyma cells, with small intercellular spaces.

At the middle level the stem show a well defined endodermis. The cell walls are uniform impregnate with a fat substance (suberine – positive histochemical test with Sudan II) and with lignine at the Caspaian band level (positive histochemical test with fluoroglucine and HCl). Lersten (1997) [7] revised the occurrence of the endodermis with a Casparian strip in the stem and leaf of vascular plants and considered that this strip in aerial organs has no known functional role. Although the presence of endoderm in the stem is not a specific feature of angiosperms, it is this present in many species of Campanulaceae [1, 9].

The vascular tissues have already secondary structure and consist in 2 concentric rings of xylem and phloem. Both primary and secondary xylem vessels are quite narrow

(12.53±2.58 and 7.77±1.77). In general, the tendencies are for vessel members to become shorter and narrower as the aridity increases to prevent collapse of vessels under high negative pressures and vessels towards grouping in arid environments.

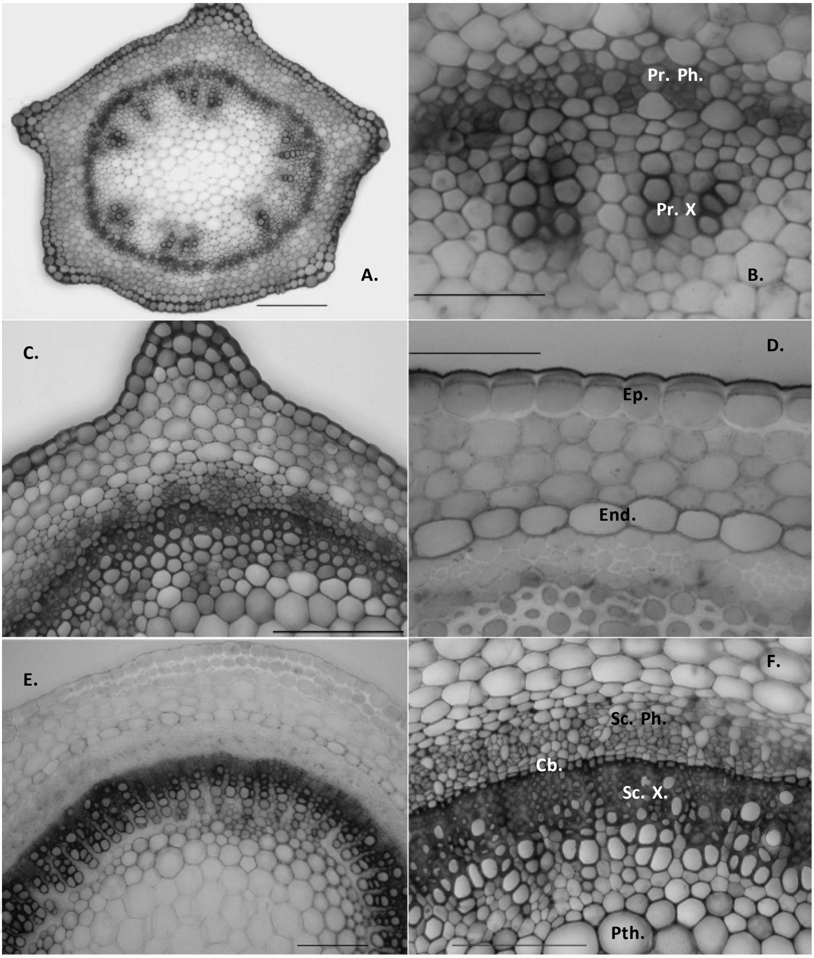

Figure 1 – Cross section through stem: A, B – top, C, D – middle, E, F – basis (Cb. – cambium, End. – endodermis, Ep. - Epidermis, Pr. Ph. – primary phloem, Pr. X. – primary xylem, Pth. – pith, Sc. Ph – secondary phloem, Sc. X. – secondary xylem (scale bar = 100 µm in A, C, E and 50 in µm B, D, E)

At this level the pith is partially disorganized and a central lacuna is visible. At the stem basis the collenchyma is discontinuous under the epidermis. The endodermis shows Casparian bands. The pith cells are sclerified in the primary xylem vicinity.

	MX v d (μm)	SX d (μm)	Px d (μm)	Lf d (μm)	Ep h (μm)	Ep w (μm)
Top stem	7.44±1.03	-	4.34±0.59	-	10.9±1.71	7.98±1.77
Middle stem	9.32±1.59		-	5.69±0.98	10.87±2.27	11.77±2.01
Base stem	12.53±2.58	7.77±1.77	-	8.21±1.8	18.53±2.86	20.95±5.83

Table 1 – Measurements of different anatomical parameters of the *Campanula carpatica* stem: MXv d – meta xylem vessel diameter, SX d – secondary xylem vessel diameter, Lf d – libriform fibers diameter, Ep h – height of the epidermis cells, Ep w – width of the epidermis cells

The leaf (fig, 2, tables 2, 3)**.** Young leaves (1 cm length) and mature leaves (2.5 cm length) were investigated. The midrib is prominent both on the lower and in upper epidermis (especially in mature leaf). A unilayered collenchyma is visible in subepidermic position. The vascular bundle is collateral, with an aria of internal phloem. Leaf is bifacial. Palisade parenchyma cells are unilayered; spongy parenchyma cells are 3-(4) layered. The hydathodes consist of epidermis, water pores, and the epithem.

	Sp d (μm)	Pp h (μm)	MXv d (μm)	PXv d (μm)	Ep l h (μm)	Ep u h (μm)
Young leaf	10.36±2.76	24.44±4.06	6.22±0.96	3.27±0.68	10.08±2.98	15.9±2.46
Mature leaf	11.96±2.08	35,83±4,09	8.29±1.32	3.31±0.42	12.35±3.18	22.56±3.22

Table 2 – Measurements of different anatomical parameters of the *Campanula carpatica* leaf :Sp d – spongy parenchyma cells diameter; Pp h – height of the palisade cells, MXv d – meta xylem vessel diameter, PXv d – protoxilem vessel diameter, Ep u h – height of the lower epidermis cells

		St h (μm)	St w (μm)	SI	HSt h (μm)	HSt w (μm)
Young leaf	Upper epidermis	17.77±1.61	17.27±1.63	8.82	22.83±1.68	24.42±2.69
	Lower epidermis	19.51±1.97	15.29±1.56	23.85		
Mature leaf	Upper epidermis	28.73±2.25	18.77±1.62	4.07	21.41±2.81	27.87±1.04
	Lower epidermis	29.2±2.51	21.81±3.09	18.06		

Table 3 – Measurements of different anatomical parameters of the *Campanula carpatica* leaf epidermis: St h – height of the stomatal cells, St w – width of the stomatal cells , SI – stomatal index, HSt h – height of the stomatal cells (from hydatode), HSt w – width of the stomatal cells (from hydatode)

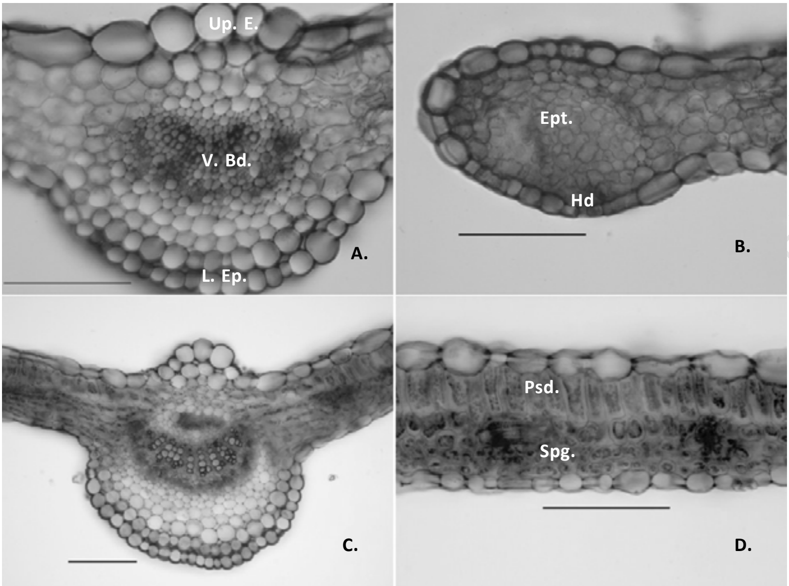

Figure 2 – Cross section through the leaf: A, B – young leaf, C, D – mature leaf (Ept. – epithem, Hd. – hydathode, L. Ep – lower epidermis, Psd. – palisade parenchyma, Spg. – spongy parenchyma, Up. E – upper epidermis, V. Bd. – vascular bundle) (scale bar = 50 µm)

The anatomical features of *Campanula carpatica* show relevant adaptation of this plant to particular ecological conditions. The foliar hydathodes from the leaf margins could be implicated in the absorption of surface water. The endodermis from the stem could play an important role in regulation of the water flux. The very narrow conducting vessels and the compact structure (with small aeriferous spaces) represent adaptations to an arid environment, with limited water resources.

Acknowledgements

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REFERENCES

[1] Alcitepe E. & Yildiz K. Taxonomy of Campanula tomentosa Lam. and C. vardariana bocquet from Turkey, Turkish Journal of Botany, vol. 34, pp 231-240, 2010;

[2] Eddie W.M.M., Shulkina T., Gaskin J., Haberle R.C. & Jansen R.K. Phylogeny of Campanulaceae S. str. inferred from its sequences of nuclear ribosomal DNA, Annals of the Missouri Botanical Garden, vol. 90/No. 4, pp. 554–575, 2003;

[3] Erdelská O. Stigmatic trichomes of Campanula carpatica, Biologia, vol. 56/Issue 4, pp 429-430, 2001;

[4] Fedorov A. & Kovanda M. Campanulaceae, In Flora Europaea (T.G. Tutin, V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters, & D.A. Webb, Eds.), Cambridge: Cambridge University Press, pp 74-93, 1976;

[5] Frello S., Stummann B.M. & Serek M. Shoot regeneration of Campanula carpatica Jacq. (Campanulaceae) via callus phase, Scientia Horticulturae, vol. 93, pp 85–90, 2002;

[6] Johansen D.A. Plant microtechnique, New York: McGraw Hill Book, 1940;

[7] Lersten N.R. Occurrence of endodermis with a Casparian strip en stem and leaf, The Botanical Review, vol. 63, pp 265-272, 1997;

[8] Liber Z., Kovacić S., Nikolić T., Likić S. & Rusak G. Relations between western Balkan endemic Campanula L. (Campanulaceae) lineages: Evidence from chloroplast DNA', Plant Biosystems, vol.142/No. 1, pp 40-50, 2008;

[9] Metcalfe C.R. & Chalk, L. Anatomy of the dicotyledons, 2nd ed., vol. 2. Clarendon Press, Oxford, 1983;

[10] O'Brien T.P., Feder, N. & McCully M.E. Polychromatic staining of plant cell walls by toluidine blue–O, Protoplasma, vol. 59, pp 368–373, 1964;

[11] Shulkina T., Gaskin J., Haberle R. C. & Jansen R. K. Phylogeny of Campanulaceae s. str. inferred from ITS sequences of nuclear ribosomal DNA, Annals of the Missouri Botanical Garden, vol. 904, pp 554–575, 2003;

[12] Sriskandarajah S., Frello S. & Serek M. Induction of adventitious shoots in vitro in Campanula carpatica, Plant Cell, Tissue and Organ Culture, vol. 67, pp 295-298, 2001.

IDENTIFICATION AND ASSESSMENT OF IMPACT OF THE CUPRUMIN COMPANY ABRUD ACTIVITIES ON THE ADJACENT AREAS

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ABSTRACT

Copper ore deposit is located in Rosia Poieni placed in north-western part of Metaliferi Mountains, about 8 km from Aries River, on the territory of Lupşa village, Alba county. Mining area Roşia Poieni includes the main entities ore bodies career with related dumps, ore processing plant, tailings ponds and yards necessary for this activities, plus auxiliaries transport, handling and storage. Present paper present the identification and the assessment of impact of the Cuprumin Company Abrud activities on the adjacent areas.

Keywords: Rosia Poieni, cooper, acid drainage

1. INTRODUCTION

Cuprifer ore deposit is located in Rosia Poieni placed in the north-western part of Ore Mountains, about 8 km from Aries River, on the territory of Lupşa village, Alba county. Mining area Roşia Poieni includes as main components the career with related dumps, ore processing plant, tailings ponds and facilities necessary to carry the work, plus auxiliaries transport, handling and storage facilities.

The analysed objective is made up of several components spread unevenly within a radius of approx. 5 km (preparation plant, quarry, waste dumps and tailings dams). The purpose of this study is to identify and quantify the impact caused by mining activities described above on adjacent areas and communities. For this pupose, it was done first to identify areas or groups of isolated houses within range of influence of different types of activities, which were chosen as sampling points for water, air and soil, taking into account a number of factors, including the: distance from mining objectives, micro elements and macrorelief, the prevailing winds in the area and surface water watershed position. Career and process plant premises are relatively isolated villages in the area, is located on the tops of hills in the area (Piciorului hills, Ghergheleului hills, Tofului hills). Ponds from Ştefancei Valley are located about 2.5 km upstream from a local farm. Sesei Valley setling ponds occupies an isolated position and is located at a distance of about 5 km upstream of Valea Lupşei village and Lupşa. In the location of the target area there is also Musca village, located about 5 km from the quarry.

The objective is positioned related to the urban areas, as follows: about 10 km SW of Abrud, about 5.2 km of Rosia Montana and about 10.8 kilometers northwest of the city Câmpeni respectively 10.8 km NE of Baia de Aries. Settlements are usually limited to the areas of the meadow, but some farms and dwellings used occasionally are built on top of the slopes.

2. IMPACT IDENTIFICATION

Any mining activity carried out affects considerable areas of land depending on the extent and type of work, nature of the useful ores and theirs spatial position.

Environmental factor that has most affected by the mine is soil with the entire ecosystem of the area. The most important destructive effects on soil are produced by the surface mining, by the actual career and the related waste deposits, but also by underground mining that affect the land, soil and subsoil, due to the location of yards and subsidence phenomena. Mining, through its specificity, may generate impacts on air and water, and also on the human factor, both at individual and community level [1].

Following comments made by field research team, which took into account the mining activities and status of environmental factors, and the results of laboratory analysis identified the main impacts on land, soil, subsoil, water, air, ecosystems and human factor, manifested in adjacent perimeters were analyzed and mitigation measures established.

2.1. Land, soil and underground

- Morphology changing due to quary development on depth and the emergence of sterile deposits (dumps and tailings)
- Risk of sterile deposit slip, with damage to objectives in the area of influence
- Change of land use of the affected areas
- Damage adjacent land use, due to changes in surface and ground water regime
- Soil contamination of surrounding areas in case of acid drainage.

2.2. Air

- dust production due to excavation and mining masses transport
- exhaust gas emissions and oil pollution
- Emissions of $NH3$, $NO2$ and $SO2$ because of their industrial processes
- Noise and vibration generated by transport and operation of heavy machinery.

2.3. Surface and underground

- risk of acid drainage and pollution of surface and groundwater with heavy metals
- Increased particulate mater loading of surface water
- change the biological parameters of surface waters.

3. ASSESSING THE IMPACT OF MINING ACTIVITIES ON LOCAL COMMUNITIES

The research has paid special attention to localities Garde, Musca, Lupşa, Bucium Sat, Lupsa Valley Abrud and an isolated group of households, which are located near the quarry, waste dumps or tailings. Therefore, 30 samples were collected, 14 samples of water, 6 soil samples, 5 samples of air and 5 samples of noise, as are shown in Fig. no. 1.

To assess the overall impact on adjacent localities of Rosia Poieni were considered sampling points shown in table no. 1.

Table 1 Representative samples from analyzed localities

Locality	Water	Soil	Air
Gârde	P_1, P_2	P_1	P_{1air} , P_{1noise}
Muşca	P_3, P_4	P_2	P_{4air}, P_{4noise}
Lupşei Valley; Şesei Valley	P_5, P_6, P_7	P_5	P_{3air}, P_{3noise}
Bucium Village	P_{10}, P_{11}, P_{12}	P_4	P_{4air}, P_{4noise}
Vinţei Valley	P_8, P_9	P_3	P_{2air}, P_{2noise}

Field samples were analyzed in the laboratories of the University of Petrosani and based on the obtained results (Tables 2, 3 and 4) were characterized main environmental factors and impact assessment has been conducted.

Surface waters have a low content of heavy metals, but, in most cases is obvious that the concentration of iron is great, fact that is explained by the area containing of iron ores. Biochemical oxygen demand (BOD5), which shows the organic load of water and a certain degree of pollution by the intense activity of microorganisms that consume from water, changing its qualities, placed all samples taken within the Aries River in quality class III and samples from Ştefancei Valley, Lupsa Valley, Sesei Valley and Musca Valley the lower limit of quality class II. This fact is determined by the probability of discharge into water courses of effluents with high organic matter content.

Regarding the soil were found, generally, exceeded concentration of cadmium, lead, copper, zinc, chromium and manganese, without exceeding the intervention and alert limits for that sensitive soils as well as less sensitive soils.

Based on the analyzed samples, it was found that air is not significantly affected by mining activity in the objectives. Also, the boundaries are not exceeded in terms of noise allowed. There can occur sporadically exceeded admissible values during the blasting works or enhancing of extraction, sorting, and transportation activities in the quarry, during dry periods or periods with winds intensification.

Regarding the population in the affected area, most affected by socially and economically point of view Geamăna village with a high agricultural potential, where most farms that were expropriated . The most affected part of the village Geamana, especially around the tailings Sesei Valley, is one that was not included in programs of expropriation, remaining isolated a total of about 60 households [2], [3].

Social problems facing the population remaining in the area are high because the local community is affected morally, people lost agricultural land, forest resources have been reduced due to deforestation, the owners that remain in the area are affected in terms of health [4].

For assessment of the impact generated by objective Rosia Poieni on localities close to the perimeter was used global impact index method, which enables the expression state of the environment based on a report of the ideal state and value at a time of specific quality indicators for environment analyzed, thus achieving global impact index.

To assess the environmental status in the ideal situation and real situation when environment is affected by human activities, using goodness scale for environmental factors and environmental components that include grades from 1-10, where 1 corresponds to a situation of serious damaged environmental factors analyzed, and 10 corresponds to the natural state, unaffected by human activities.

Goodness notes were given as follows:

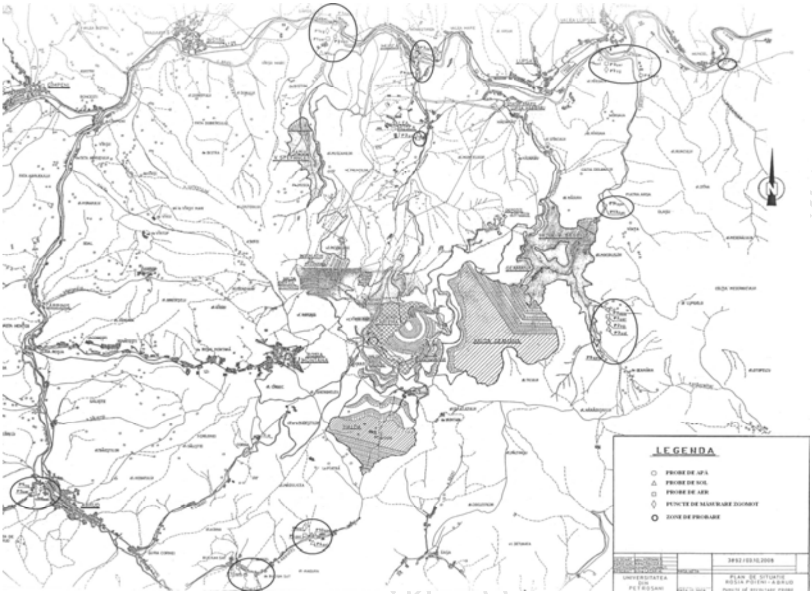

Fig. nr. 1 Sampling places from CUPRUMIN Abrud area

Table 2 Water sample analysis results

Quality parameter	C_a	P_1 water Aries		P_2 water V. Stefancei		P_3 water Aries		P_4 water Musca		P_5 water Aries		P_6 water Valea Sesei	
		C_m	NB	C_m	NB	C_m	NB	C_m	NB	C_m	NB	C_m	NB
pH	6.5-8.5	6.85	10	6.96	10	6.91	10	7.3	10	6.96	10	7.29	10
NH_4^+, mg/dm^3	0.2	0.17	9	0.17	9	0.15	9	0.15	9	0.15	9	0.15	9
Pb mg/dm^3	0.005	0	10	0	10	0	9	0	10	0	10	0	10
Cd, mg/dm^3	0.001	0	10	0	10	0	9	0	10	0	10	0	10
Cr total, mg/dm^3	0.05	0.002	9	0.002	9	0.002	9	0.002	9	0.002	9	0.002	9
Cu, mg/dm^3	0.02	0.004	9	0.004	9	0.004	9	0.005	9	0.005	9	0.005	9
Ni, mg/dm^{3}l	0.05	0.002	9	0.002	9	0.002	9	0.002	9	0.002	9	0.002	9
Zn, mg/dm^{3}c	0.1	0.013	9	0.013	9	0.013	9	0.012	9	0.014	9	0.013	9
Mn, mg/dm^3	0.05	0.029	9	0.025	9	0.025	9	0.025	9	0.029	9	0.024	9
Fe, mg/dm^3	0.1	0.21	4	0.17	5	0.22	4.1	0.1	9	0.22	4.1	0.17	5.3
P, mg/dm^3	0.2	0.002	9	0.002	9	0.002	9	0	10	0.002	9	0.002	9
Phenols, mg/dm^3	1	0	10	0	10	0	10	0	10	0	10	0	10
Detergents, mg/dm^3	0.5	0.003	10	0.003	9	0.004	9	0.004	9	0.003	10	0.003	9
CBO_5, mg/dm^3	5	6.42	7	5.9	8	6.6	6.8	5.48	8	7.42	6.1	5.23	8.6
CCO-Cr, mg/dm^3	25	24.55	9	15.27	9	25.26	8.9	16.16	9	22.84	10	16.83	9
Goodness note		**8,9**		**8,9**		**8,7**		**9,3**		**8,9**		**9**	

Table 2 Water sample analysis results - continuation

Quality parameter	C_a	P_7 water Aries		P_8 water Valea Vintei		P_9 water izvor		P_{10} water Abruzel		P_{11} water V. Bucium		P_{12} water Abruzel	
		C_m	NB	C_m	NB	C_m	NB	C_m	NB	C_m	NB	C_m	NB
pH	6.5-8.5	7.05	10	6,94	10	7,13	10	6.82	10	6.32	10	6.44	10
NH_4^+, mg/dm^3	0.2	0.16	9	0,06	9	0,17	9	0.15	9	0.15	9	0.16	9
Pb mg/dm^3	0.005	0	10	0	10	0	10	0	10	0	10	0	10
Cd, mg/dm^3	0.001	0	10	0	10	0	10	0	10	0	10	0	10
Cr total, mg/dm^3	0.05	0.002	9	0,002	9	0,002	9	0.002	9	0.002	9	0.002	9
Cu, mg/dm^3	0.02	0.004	9	0,005	9	0,005	9	0.005	9	0.004	9	0.005	9
Ni, mg/dm^{3}l	0.05	0.002	9	0,002	9	0,002	9	0.002	9	0.002	9	0.002	9
Zn, mg/dm^{3}c	0.1	0.014	9	0,012	9	0,012	9	0.02	9	0.021	9	0.021	9
Mn, mg/dm^3	0.05	0.025	9	0,024	9	0,016	9	0.01	9	0.01	9	0.011	9
Fe, mg/dm^3	0.1	0.2	4.5	0,11	8,2	0,11	8,2	0.12	7.5	0.29	3.1	0.27	3.3
P, mg/dm^3	0.2	0.002	9	0,002	9	0,002	9	0.002	9	0.002	9	0.002	9
Phenols, mg/dm^3	1	0	10	0	10	0	10	0	10	0	0	0	10
Detergents, mg/dm^3	0.5	0.004	9	0,003	9	0,003	9	0.003	9	0.003	0.003	0.003	9
CBO_5, mg/dm^3	5	6.33	7.1	5,06	8,9	2,38	10	3.09	9.0	5.6	5.6	5.16	8.7
CCO-Cr, mg/dm^3	25	25.69	8.8	16,05	9	7,95	10	10.21	9	16.46	16.46	17.9	9.0
Goodness note		**8,8**		**9,2**		**9,3**		**9,1**		**8,8**		**8,9**	

Table 3 Soil sample analysis results

Quality parameter	C_a	P_1 soil V. Stefancei		P_2 soil V. Stefancei		P_3 soil Vintei Valley		P_4 soil Abruzel		P_5 soil Lupsa	
		C_m	NB	C_m	NB	C_m	NB	C_m	NB	C_m	NB
Cd total, mg/kg	1	1.23	7	1.01	8.9	1.1	8.2	1.47	6.1	1.46	6.2
Pb total, mg/kg	20	20.44	9	20.22	8.9	18.46	10	15.08	12	19.84	9
CN free, mg/kg	1	0	10	0	10	0	10	0	10	0	10
Cu, mg/kg	20	76.49	2	66.1	3	63.76	2.8	59.94	3.0	54.91	3.3
Ni, mg/kg	20	14.81	9	12.99	9	14.47	9	15.33	9	13.12	9
Zn, mg/kg	100	183	5	178	5.1	159	5.7	184	4.9	146	6.2
Mn, mg/kg	900	930	9	931	8.7	1067	7.6	906	8.9	1228	6.6
Cr, mg/kg	30	48.16	6	54.41	5.0	48.21	5.6	50.31	5.4	53.88	5.0
Phenols, mg/kg	0.02	0	10	0	10	0	10	0	10	0	10
PAH, mg/kg	0.1	0	10	0	10	0	10	0	10	0	10
THC, mg/kg	100	0	10	0	10	0	10	0	10	0	10
Goodness note		**8.0**		**8.0**		**8,1**		**8.1**		**7.9**	

Table 4 Air sample analysis results

Quality parameter	Niv. sig.	P_1 air V. Stefancei		P_2 air Lupsei Valley		P_3 air Lupsei Valley		P_4 air Lupsei Valley	
		C_m	NB	C_m	NB	C_m	NB	C_m	NB
NH_3 [g/m^3]	100	29	9	22	9	24	9	33	9
NO_2 [g/m^3]	300	18	9	24	9	20	9	21	9
SO_2[g/m^3]	750	14	9	14	9	10	9	12	9
Noise [dB]	60	58	8	57	8	45	9	54	8
Goodness note			**8.75**		**8.8**		**9.0**		**8,8**

- Goodness note 10 is regarded as the ideal environment
- Goodness note 9, is given for imissions placed within the maximum limits
- For immissions greater than limits, the goodness note granted, is the product of number 9 and the ratio of the maximum allowed limits (Ca) and measured values (Cm) of immissions.

The method consists in the construction of two polygons (three, four or more sides, depending on the number of environmental components considered), one of which shows the ideal state and the other the real state of affected environment by the impacts generated by a project [1]. Impact overall index is calculated by comparing areas of the two polygons (fig. no. 2).

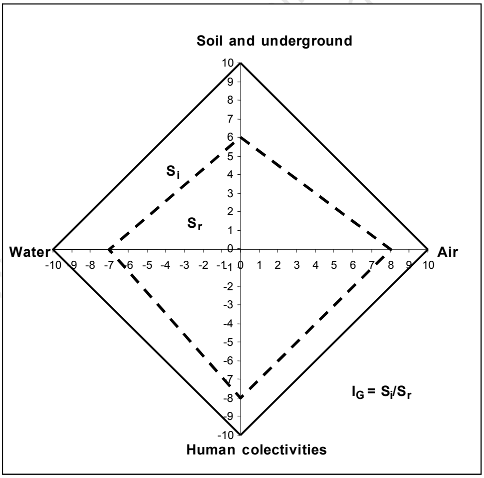

Fig. 2 Impact overall index determination

Depending on the value obtained for the impact global index GI, environment may be defined as follows:

I_G = 1 - natural environment unaffected by human activities,
I_G = 1 - 2 - environment under anthropogenic activity within reasonable limits,
I_G = 2 to 3 - medium under anthropogenic activity causing discomfort life forms,
I_G = 3 to 4 - environment under anthropogenic activity, causing damaging of life forms,

I_G = 4 to 6 - average severely affected by human activities, dangerous for life forms,
I_G> 6 - environmental degradation, inappropriate for life forms.

Using this method can analyze more environmental components such as water quality, air and soil health of the population, shortage of plant and animal species, etc..

Based on analysis results were calculated as the goodness notes for water, soil and air space of the studied localities and global impact index (table no. 5). Population health in the area was given the credit note 8, taking into account the results of special studies conducted in the area.

Table 5 Goodness note

Locality	Water	Soil	Air	Population	I_{IG}
Gârde	8,9	8	8,75	8	1,42
Muşca	9	8	9	8	1,34
Lupşei Valley; Şesei Valley	8,9	7,9	8,8	8	1,42
Bucium Village	8,9	8,1	9	8	1,38
Vinţei Valley	9,2	8,1	8,8	8	1,38

By planimetration were obtained ideal and real surface area for each corresponding locality polygons analyzed. Comparison of calculated values of the two surfaces to index global impact, which is between 1.34 and 1.42, which indicates that the adjacent territories belonging career objectives ore mining is subject to anthropogenic activity cuprifer environment within acceptable limits.

4. CONCLUSIONS

Mining in Rosia Poieni require extraction and ore processing and storage of sterile resulted in waste dumps and tailings ponds. Because in the mining areas there are a number of locations or isolated houses, subject of environmental impact assessment of these activities, particulary water, soil and air. For this purpose, representative samples were taken from areas where these places are located and their quality was analyzed in the laboratories of the University of Petrosani. Based on analysis, to assess the impact was used the global index method, which has the advantage of an overview on the state of the environment and the possibility to compare different areas, by analyzing them using the same indicators. Research has shown that the environment is subject to human activities within acceptable limits.

REFERENCES

[1] M. Lazăr, I. Dumitrescu – Impactul antropic asupra mediului. Ed. Universitas. Petroşani, 2006.
[2] L. Vasilache – Identificarea problemelor de impact asupra mediului generate de iazurile de decantare de la Roşia Poieni. Raport de cercetare nr. 1. Universitatea din Petroşani, 2008.
[3] SC IPROMIN SA – Bilanţ de mediu nivel 2 la obiectivul minier Roşia Poieni. 1999.
[4] SC OCON SRL – Bilanţuri de mediu în vederea privatizării pentru obiectivul Roşia Poieni. 2008.

IMMOBILISATION OF WASTE WITH METAL CONTENT IN THE VITREUOS MATRIX

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ABSTRACT

The paper presents studies concerning neutralization of hazardous waste with metals oxides contents in the glass which are materials chemically stable.

By incorporating of metal oxides from waste in the based vitreous matrix on SiO_2-Na_2O-CaO system, was studied the decrease of their pollutant potential and the influence of working temperature at melting process on structure and the physical-mechanical properties of the analysed oxide materials.

Important factors analysed were the chemical composition of obtained glass by re-melting packaging glass scraps and ability to include of metals oxides from hazardous waste as well the obtaining of final products with well-defined and constant properties.

Recoveries of glass waste for the achievement of vitreous matrix which can incorporate hazardous waste bring important economic and technical advantages.

Keywords: vitreous, matrix, oxides, metals, waste

INTRODUCTION

Through the incorporation of dangerous waste in the matrix of oxide glasses which are stable from the chemical point of view, the polluting potential of the waste decrease substantially, so that various uses may be found [1].

During the process of immobilisation in vitreous matrix, the following aspects need to be taken into consideration:

- the complexity and the non-homogeneity of the chemical composition;

- the high reactivity of the melts.

The recovery of glass waste in view of making the vitreous matrix for the immobilisation of dangerous waste was studied in the present paper due to the fact that it represents a research field which may bring about very important technical and economic advantages.

Through incorporating various components (heavy metal metal oxides, their salts, hydroxides) into the vitreous matrix, decorative glasses may be obtained, whose colour varies in keeping with the nature of the metallic ion, the quantity added and the work temperature [2].

Vitroceramic materials may combine properties specific to ceramic and with properties specific to glass.

To obtain the designed properties, the establishing of the appropriate chemical composition and the achievement of an adequate thermal treatment must be had in view.

The concept of controlled crystallisation involves the separation from the vitreous phase of a crystalline phase under the form of fine crystals, whose number, growth speed and final size are controlled through an appropriate thermal treatment [3].

Three techniques for obtaining vitroceramic materials are known:

- crystallisation of the vitreous solid through controlled heating (traditional method);
- crystallisation through the controlled cooling of the melt;
- sintering and crystallization of fine glass granules.

The immobilisation of wastes in the vitreous matrix mainly consists in their incorporation through melting in a glass with a particular composition, which allows the incorporation of certain chemical elements present in the waste.

The complexity of the correlation between the chemical composition and the properties of the base glass functioning as a vitreous matrix which incorporates the waste makes the choice of composition carry a large responsibility.

The production of vitroceramics with improved properties is highly dependent on the phases of the crystalline microstructure developed during the heat treatments of the base glass. Some glass compositions have their own crystallisation centres, but others need specific components to be added so as to ensure the internal formation of crystallisation centres. In glass factories, glass chips are used to a high extent (almost up to 100%) in the fabrication process as raw material, also known as adding material.

Nowadays, three large categories of vitroceramic materials used for their special properties may be highlighted [4]. The first is based on a base glass with a composition which is close to that of a eutectic from the MgO-Al_2O_3-SiO_2 system, the second is the ternary Li_2O-Al_2O_3-SiO_2 system, and the third refers to the vitroceramic materials which contain the keatite from a base Al_2O_3-SiO_2 system as main crystalline phase and which are characterised, like the other two, by special thermal properties.

The results for the $Na_2O{\cdot}2CaO{\cdot}3SiO_2$ and $2Na_2O{\cdot}CaO{\cdot}3SiO_2$ stoichiometric compositions based on the ternary SiO_2-CaO-Na_2O system have been discussed by Gonzales and James who have studied the nucleation speeds in stationary mode in the system mentioned, through measurements of viscosity and thermodynamic data [5,6].

EXPERIMENTAL RESULTS

More types of glasses go into the recycling flux, each having different chemical compositions and physical properties. The most frequently met is the glass based on silicon dioxide (SiO_2), sodium carbonate (Na_2CO_3), calcium carbonate or limestone ($CaCO_3$) and other minor additives. Most of the recycled glass is made up of packaging and plane surface glass (windows etc). The main stages in the treatment and elaboration of glass are shown in table 1.

Table 1. The main stages in the elaboration of glass

No.	Stage	Temperature interval
1	Formation of silicates in solid phase and of the first quantities of melt	Begins at 300^{o}C and ends at 800-1000^{o}C
2	Glass formation	Begins at 800-1000^{o}C and ends at1300-1500^{o}C
3	Refinement of glass melt	1350-1550^{o}C
4	Homogenisation of glass mass	Begins at the upper limit of the melting interval and ends at temperatures corresponding to the glass clarification
5	Cooling of glass mass	At temperatures 200-600^{o}C lower than those of the melting interval

The samples were made of chipped packaging glass, aluminium oxide, zinc oxide, arsenic trioxide, metal oxide wastes with a granulation of under 300µm. The refractory steel casts were filled with these chipped materials which were heated in an oven with silit bars, at a temperature of up to 1450^{o}C.

The quantity and the dimensions of the pieces of glass, as well as the metallic oxide resulting from industrial waste are of great importance for the melting time, but also for the end product. The granulation of the transparent glass chips which change colour following melting and in the presence of oxides plays an important role in the colour homogeneity and uniformity. As the glass grain sizes were small, was obtained a good colour uniformity. Homogenization of melt glass consists in uniformity of the physical and chemical characteristics of the whole mass of glass, a phenomenon which is usually based on reciprocal solubility.

The non-uniformity of colour may appear as a result of an insufficient mixing of the chips with the waste which contains a certain metallic oxide that influences the structure of the glass. The intensity of the colour and its nuance depend on the concentration of oxide, the valence of the colouring ion, the latter's modification due to the atmosphere of the oven and the chemical composition of the glass.

An extremely important role in finalising the homogenisation of the glass is played by high temperature diffusion, at the atom-molecular level. In glass melts, diffusion is the slowest stage and it depends especially on raising the temperature, which also leads to a reduction in viscosity. Glass without gas bubbles was obtained through refining the glass melt during its elaboration. Figure 1 presents a sample of dark green glass obtained with the aid of iron oxide resulting from the scale, which is a waste from the metallurgical industry, grinded at sizes of under 150 µm, in a reducing medium.

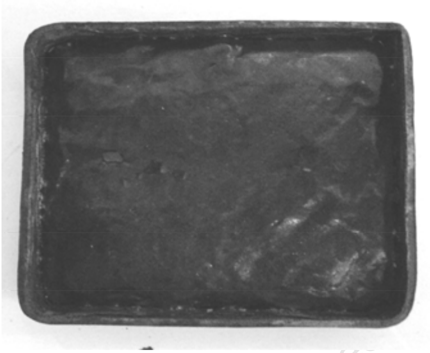

Figure 1. Green glass obtained through adding in the iron oxide elaboration batch

The raw materials used in obtaining glass when wastes containing chromium ions were added to the charge are presented in table 2.

Table 2. Raw materials for glasses which immobilise wastes containing chromium

Name of raw material	Percentage content (%)
Waste glass	49.80
Aluminium oxide	9.86
Zinc oxide	10.68
Arsenic trioxide	0,32
Waste with chromium content	29.34

Although the melting temperature should have increased to over 1450^oC through adding the concentration of chromium oxide, this did not happen because spinels were formed, thus reducing the Al_2O_3 activity in the system. After the temperature of 1450^oC was reached, it was maintained at this temperature for 120 minutes in view of homogenisation and degasification. The melt from the refractory crucible was poured into the preheated refractory metal form. What was noticed was that part of the melt was very fluid (it poured out very quickly), and that the other part had a greater viscosity.

From the data offered by the specialised literature, it results that there is an almost linear relation between the Cr_2O_3 addition and the formation of the spinels, at least up to a concentration of 17% of the chromium oxide. The system shows the phenomenon of immiscibility in the liquid phase. Two liquid phases, characterised by different compositions are separated in this domain. The samples obtained through casting were subject to a thermal treatment of afterglow at a temperature of 800ºC, according to the diagram in figure 2.

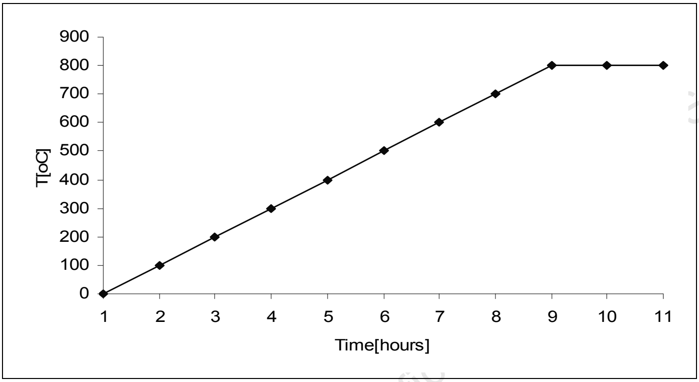

Figure 2. Diagram for the thermal treatment of the glass sample with chromium oxide

After maintaining the temperature at 800ºC for 2 hours, the oven was stopped and the samples were left inside until completely cooled. Following the afterglow thermal treatment, the sample is light brown in colour, figure 3.

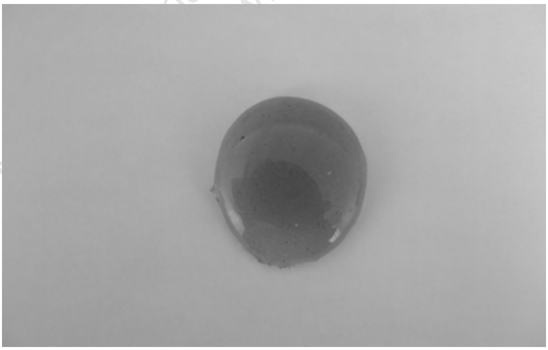

Figure 3. Glass with chromium oxide after thermal treatment

Part of the samples obtained was analysed at the SEM electronic microscope in view of emphasising their structure and the inclusions present in their mass.

Figure 4 presents the structure of the glass sample, for the obtaining of which green glass waste, other oxide additions and waste containing iron oxide were used.

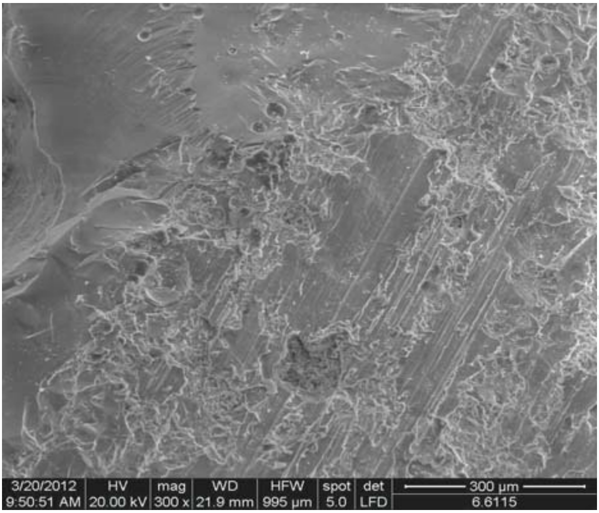

Figure 4. Microstructure of a green glass sample

The base structure is amorphous in cast oxide glass, being therefore specific to a vitreous mass. Figures 5 and 6 present the microstructures of the glass samples which were obtained through the re-melting of glass wastes mixed with slurry which contains chromium ions, following the casting and the afterglow thermal treatment.

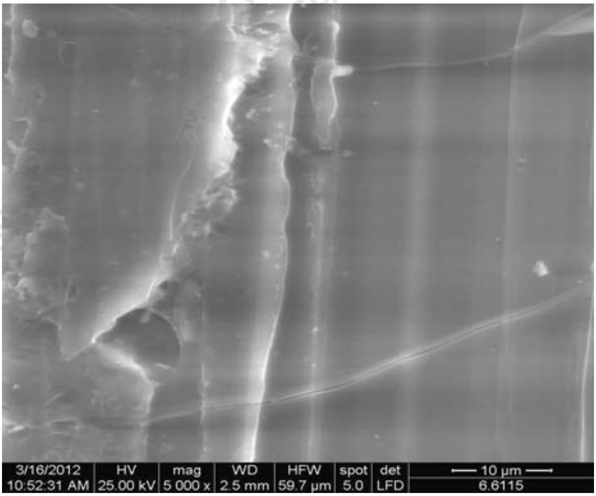

Figure 5. Microstructure of glass with chromium oxide, thermally untreated

Microstructures of the glasses achieved by re-melting of glass waste in the presence of iron oxides or chromium oxide and other components, has revealed the presence of crystals in the vitreous matrix that is specific of glass structure.

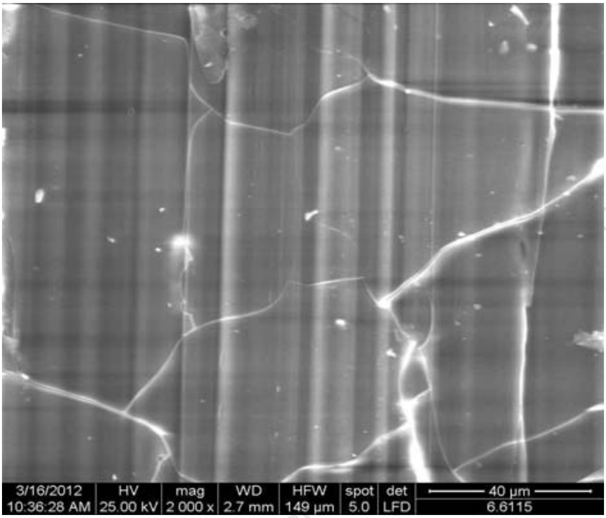

Figure 6. Microstructure of glass with chromium oxide, after thermal treatment

The new crystals formed as a result of the thermal treatment developed directly within and from the vitreous phase, determining at the same time a gradual change in the composition and structure of the base glass. Its colour may vary depending on the variable valence of the chromium present in the waste from the charge for obtaining glass.

CONCLUSIONS

As a result of the experimental research the following conclusions may be drawn:

1. The particles of waste glass with smaller granulation ensure uniformity in the colour of the glass mass. The growth of the chips size leads to a decrease of the melting time

2. To obtain the designed properties of the glasses, establishing the appropriate chemical composition and achieving an adequate thermal treatment must be had in view.

3. Incorporating different metals or metallic oxides from wastes in the vitreous matrix based on the SiO_2-Na_2O-CaO system determines the decrease of their polluting effect, favourably influences the temperature of elaborating or thermally treating vitreous or vitroceramic materials, and sometimes improves their physical-mechanical properties.

4. Crystals formed as a result of immobilisation of waste with heavy metal in the vitreuos matrix and of thermal treatment, have determined at the same time a gradual change of the glass composition and structure.

REFERENCES

[1] Moser H., Hot waste glass recycling in glassworks, Verre, vol.10, 2004, No.2, pp.42;

[2] Luminita-Daniela Ursu, Adriana Diaconu, B.A. Sava, Lucica Boroica, Ileana Mitiu, Elisabeta Rosu, D. Radu, M. Dinulescu, M. Eftimie, A Study of the industrial waste incorporating in glass, Advanced Materials Research Vols. 39-40, 2008, pp 675-678;

[3] Holland W., Beall G., Glass-Ceramic Technology, by The American Ceramic Society, Westerville, Ohio, 2002;

[4] James P.F., Nucleation in Glass-Forming Systems a Review, Advances in Ceramics, Vol. 4, Nucleation and Crystallization in Glasses, 1-48, by The American Ceramic Society, Columbus, Ohio, 1982;

[5] Gonzales C.J.R., James P.,F.,Crystall Nucleation and Growth in an $Na_2O{\cdot}2CaO{\cdot}3$ SiO_2 Glass, J. Non Crist. Solids, 38-39, 699-704, 1980;

[6] M. Garcia-Valles, G. Avila, S. Martinez, R. Terradas and J.M. Nogués, Heavy metal-rich wastes sequester in mineral phases through a glass–ceramic process, Chemosphere Volume 68, Issue 10, 2007, pp 1946-1953.

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PRODUCTION OF WASTE IN THE SLOVAK REPUBLIC IN THE PERIOD 2000 – 2010

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ABSTRACT

Waste is part of human life. It arises in all human activities, whether in manufacturing or consumer sector. Formation of wastes and their gradual accumulation have significant impact on the environment. At present, environmental protection is a priority, which often exceeds national boundaries. New developments in waste management point to the need to solve reducing the amount of municipal, industrial and hazardous waste. The first step in waste management is the prevention of producing waste. Directly in the design of the product, the manufacturers must bear in mind that product as its packaging become waste. That product as its the packaging should designed that the waste from them was little burdensome on the environment. This minimalization may not be at the expense of safety to human health or environment.

Keywords: waste, environment, protection

INTRODUCTION

Waste is a problem in human society, which is related to exploitation of natural resources and environmental degradation, and then quality of life.
Capture changes in quality of life can be based on the development of quality of life. [1] No single indicator but it does not show a full view of the achieved quality of life. To achieve adequate overall picture of the quality of life therefore expected to take into account the whole complex of indicators relating to the environment, development, population growth, waste generation and others.
According to data from Eurostat statistics [2] in 2009, the Slovak ranked in fourth place in the production of municipal waste per person. Better results were obtained only in Latvia, the Czech Republic and Poland. On the other hand, the largest producers of waste was Denmark, which reported production of 833 kg of waste per person, while the European average was 513 kg.

1 PURPOSE AND METHODOLOGY OF WORK

The aim of this article is to show on the development of selected economic indicators, population, waste generation and their interdependence.
From economic indicators we focus on gross domestic product in nominal and constant prices and inflation. Data on the development of these indicators was obtained from the available database of the Ministry of Finance of the Slovak Republic. [3]

To monitor the population we used data from the Statistical Office of the Slovak Republic. [4] Data on balance of waste in municipal solid waste division, other waste and hazardous waste and waste production we got together a database of the Slovak Environmental Agency. [5]
The results obtained for the gross domestic product, the amount of municipal waste per person and total waste production was converted per person in Slovakia. These indicators follow using basic index and compared to each other graphically.
Slovak republic since 1995 has been processing data and methods of waste disposal (except garbage) in nationwide information system used by the Regional Waste (RISO). Statistics in municipal waste since 2003, provides for the interdepartmental agreements in Slovak Republic. Since 2003, the reports on the status of the Environment The waste has referred into two tables' **The waste 'and' balance of waste placed on the market. "** The first reveal the total amount of waste generated by waste producers. From a conceptual point of view - regional infrastructure development, waste management has more explanatory table, which lists only the amount of waste that were placed on the market.
Waste Act provide recovery or disposal of the persons entitled to waste under the Waste Act. Balance of waste placed on the market was always starting the statistical basis for monitoring the development of Waste Management. From these data are based on our analysis.
Statistical processing of waste is perform according by the Waste Catalogue, which was established by decree of Ministry of the Environment. 284/2001 Z. of. establishing the Waste Catalogue, as amended, and which is in full compliance with European Waste Catalogue.

3 RESULTS OF RESEARCH

The basis for the interpretation of results is a table of selected economic indicators, and waste production in the Slovak Republic for 2000 - 2010.

Monitoring of economic results , we must recognize the fact that on 1 January 2009 was in Slovakia currency Euro as legal tender and Slovakia became the sixteenth member of the European Monetary Union. Slovakia joined the euro currency, however, lost its independent monetary policy that has already began to be implemented by the European Central Bank. In 2009, fully demonstrated the consequences of the global economic crisis on the economy of Slovakia. In that year was created **gross domestic product** (GDP) at current prices, EUR 63 331.62 million euros. The drop in foreign demand has caused the decline of Slovak exports and reduction of industrial production. For this reason, gross domestic product compared with the previous year declined in real terms by 4.7% (previous year was recorded growth of 6.2%).

Monitoring the development of waste in each year we see an un balanced state, which was mainly due to legislative changes. These changes may affect waste and disposed of by those entitled to such activities in accordance with the Act. 223/2001 Z. of. on waste and amending certain acts as amended. Differences in above total amount of waste is mainly due to waste, such as: dust and ferrous metal, sludge from effluent treatment in the place of production (different origin), water rinsing liquids containing dangerous substances (different origin), waste bark and wood, acidic pickling solutions, waste plant tissue and many other types of waste. Due to the resulting quantities of these wastes significantly affect the analysis of waste, therefore it is useful to point to distinguish the merits of waste generation for purposes of the overall record of waste and in particular for the purpose of planning activities focusing on new capacity for wastemanagement.

Table 1: Development of selected economic indicators, and waste production in the Slovak Republic for the years 2000 to 2010

year	2000	2001	2002	2003	2004
* GDP at nominal prices	22	23.5	26	29.5	34
* GDP at constant prices	22	22.4	23.8	25.7	28
Inflation **	12.2	7.2	3.5	8.4	7.5
Population ***	5402547	5378591	5379161	5380053	5384822
Municipal Waste	1800000	2100000	1524404	1599377	1475122
Other waste	12700000	12640000	12200000	14500000	8974972
Hazardous waste	1600000	1660000	1400000	1300000	432 257
Together	**16100000**	**16400000**	**15124404**	**17399377**	**10882351**
KO on a per person	333	390	283	297	274
Production per person waste	2980	3049	2812	3234	2021

year	2005	2006	2007	2008	2009	2010
* GDP at nominal prices	38.5	44.6	54.8	64.8	63.3	65.91
* GDP at constant prices	30.9	34.8	42.3	50.27	47.86	4 9,79
Inflation **	2.8	4.3	2.8	3.9	0.9	A
Population ***	5389180	5393637	5400998	5412254	5424925	5435273
Municipal Waste	1558263	1623306	1668648	1790691	1745494	1796160
Other waste	8809927	12349065	8740682	9177459	6293035	8480612
Hazardous waste	561 247	535 068	525 166	523 928	484 678	466 422
Together	**10929437**	**14507439**	**10934496**	**11492078**	**8523207**	**10743194**
KO on a per person	289	301	309	331	332	330
Production per person waste	2028	2689	2025	2123	1571	1976

Source: own processing on the data marked with *

* GDP in nominal and constant prices are listed in the bill. / € - [6]
The annual inflation rate ** is given in% - [7]
*** Population: Statistical Office – [8]
Balance of waste placed on the market - the CAP – [9]

All data related to the Slovak Republic, originally presented in Slovak crowns were conversion rate € 1 = SKK 30,126

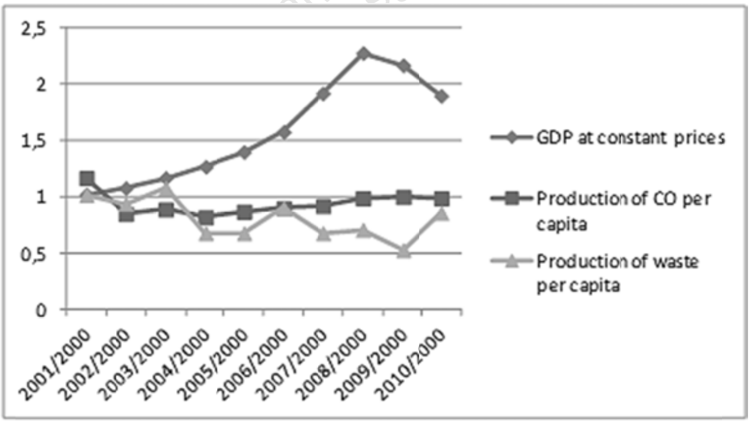
Table 2: Development of the basic indices of selected economic indicators, and waste production in the Slovak Republic for the years

2000 - 2010

Year	2001/2000	2002/2000	2003/2000	2004/2000	2005/2000
GDP at constant prices	1.02	1.08	1.17	1.27	1.40
Production of CO per capita	1.17	0.85	0.89	0.82	0.87
Production of waste per capita	1.02	0.94	1.08	0.68	0.68

Year	2006/2000	2007/2000	2008/2000	2009/2000	2010/2000
GDP at constant prices	1.58	1.92	2.28	2.17	1.90
Production of CO per capita	0.90	0.92	0.99	1.00	0.99
Production of waste per capita	0.9	0.68	0.71	0.53	0.86

Source: own processing



Source: own processing

Figure l:

Law no. 223/2001, which came into efficiency in 2002 created a new legislative conditions. In connection with the new list of waste were in 2002 and 2003 made the correction in the balance of waste. The year 2004 can be regarded as the first right, which applied the new method of monitoring waste production in Slovakia.
The total waste production in the area, according to RISO, had in the years 2005 - 2008 due to the increasing nature of the substantial increase in production of other wastes, which also had a total production of waste in the majority stake. Production of municipal waste showed a gradual increase.

CONCLUSION

Exceptional amounts of waste were reported in 2006. This increase resulted single recognition excavated soil resulting in the construction of highway and feeder Sitina tunnel in Bratislava (2,273,044 tonnes reported by HOMOLA TEAM spol s r. o.), as well as recognition in the wreckage of U.S. Steel Kosice. The decrease of waste generated in 2009 is due to the economic crisis, which resulted mainly industrial depression activity, which was subsequently reflected in a reduction of the quantities of waste generated.
In 2009 compared with 2008, an annual decrease of waste placed on the market about 26%. Producers to cast the recovery and destruction of the persons entitled to waste about the same amount of hazardous and municipal waste than in 2008. A significant decrease in waste placed on the market, however, occurred with other waste. Compared with 2008, an annual decrease of other wastes placed on the market about 32%. This significant reduction of waste was due to the economic crisis, which led to the decline in manufacturing output.
In 2010 compared to 2009 represents an annual increase of waste placed on the market about 21% compared to 2005 when it produced 10.9 million. tonnes of waste, representing a decrease of their 1.6%. Waste producers passed in 2010 for the recovery and destruction by persons entitled to waste slightly lower than the volume of hazardous waste in 2009. The significant increase in waste placed on the market, however, occurred with other waste, as compared to 2009 represents an annual increase of other wastes placed on the market about 26%.

REFERENCES

[1] LISÝ, J. et al .. the 1998th Economics. Bratislava: JURA EDITION, spol. s. r.o. ISBN 80-88715-43-1. 455 p.
[2] http:// www.europskaunia.sk / Eurostat
[3] http:// www.finance.gov.sk
[4] http:/www.statistics.sk
[5] http://www.sazp.sk
[6] http://www.finance.sk/hospodarstvo/hdp/bezne-a-stale-ceny/
[7] http://www.finance.sk/hospodarstvo/ceny-a-flacia/inflacia/
[8] http://portal.statistics.sk/showdoc.do?docid=4
[9] http://www1.enviroportal.sk/spravy-zp/zoznam-sprav.php?typ=1
[10] Law No. 119/2010 Z.z., the change of Law No. 223/2001 Z.z.
[11] Law No. 409/2006 Z. of. on waste.

[12] DECREET of Ministry SR No. 284/2001 Z.z.
[13] SAUER, P., MILDEOV Oh, S. Risk Reduction of Household Waste: Contingent Valuation Analysis. Prague Economic Papers, 1998, ro no. VII, no. 1, p. 67-7 7th ISSN 1210-0455.
[14] The 2010th *and the CFP and the environment in Slovakia in 2009.* Ministry of environment of the Slovak Republic and Slovakia Agency of Environment. PRESS GROUP, Banská Bystrica, 2010. 280 s. ISBN 978-80-88833-54-3.

IMPROVING WATER RESOURCES MANAGEMENT OF THE DANUBE RIVER BASIN USING MODERN MONITORING AND WARNING SYSTEMS

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ABSTRACT

Romania, as a European Union Member State from January 1st, 2007 finds itself in a deep transformation process of the water sector in order to align it to the new standards and requirements regarding the water resources management in the Danube river basin and the quality of the drinking water.

In Romania, around 65% of the drinking water is abstracted from surface water (lakes or rivers) and processed in water treatment plants. Upstream pollution threatens the quality of the drinking water and has effects at the treatment processes. The pollution of surface water is the result of human activities: communal and industrial discharges, mining activities and agricultural use of fertilizers and pesticides, apart from unexpected incidents / accidents.

This is the case for the regional drinking water company Apavital Iaşi in the North East Romania, which uses not only ground water, but also surface water from the rivers Prut and Moldova, tributaries of the Danube. The monitoring and warning system regarding pollution of the surface waters or the damaging of the drinking water's quality in the regional distribution system comprises several instruments, such as: identification system of high impact contamination of the rivers; online measurement system of the population's satisfaction with regard to the drinking water's quality; benchmarking water utilities' performance.

In order to improve the monitoring and warning systems, lot of efforts are being made by researchers for innovative developments of the existing instruments, in the framework of some research and development projects financed by different donors, such as:

1. In the framework of the project financed by the Partners for Water programme of the Netherlands Ministry of Infrastructure and Environment the goal is the development of the intake management system in the Prut and Moldova River, for the Iasi City in Romania, Chernivtsi City in Ukraine, Ungheni City in Republic of Moldova.

2. In the research project A-port (Water Portal), financed by the Romanian Ministry of Education and Research, the main goal was the development of an instrument for online measurement of the population's perception with regard to water quality and associated services level;
3. The project financed by European Bank for Reconstruction and Development, with the aim to improve the Benchmarking system, for raising the operational performance of the new regional water suppliers by taking into consideration the best practices in the field.

The Romanian Water Association (ARA) is an important stakeholder in the water sector and is playing different role in the three projects. The authors are trying now to develop an integrated approach for a better use of the three instruments in a much more efficient quality warning system. The full paper focuses on the stage results and further objectives of the research activities, taking into account the perspectives of different stakeholders.

Keywords: Iasi, Water sector, Warning system, A-port, Benchmarking

1. INTRODUCTION

Water is very important for human development. Access to reliable and safe drinking water supply and adequate sanitation is not only a basic human right, but also an unavoidable responsibility of a government. [1] Climate change is exacerbating the problem. Several documented cases of water contamination incidents have concluded that the monitoring of health-seeking actions pursued by the general public may have allowed for earlier detection of contaminated water. [2]

The Romanian water sector is facing major challenges today. Complying with national and European regulations, improving water services in a more efficient and sustainable way, call for better performance and smart innovations in the sector. The Romanian water resources are relatively poor and unequally distributed over the country, Romania being one of the countries with the poorest water resources in Europe. That is why an important objective of the water resources' management and of all water suppliers is to inform and to make aware the responsible stakeholders, including the population, in respect with the local, regional and national issues, such as:

- the risk of source pollution;
- the risk of pollution in the distribution network;
- the risk of pollution in the consumer's own networks.

Because all the water pollution hazards can become serious health threatening situations, national and local authorities together with all stakeholders involved in the sector have to design and implement monitoring and warning systems to cope with and reduce these risks. The warning system should have not only a theoretical base, but also an operational interface and should be accurate, direct and simple in order to provide valuable information for the decision markers. Currently, such a system can be implemented by applying latest computer technologies. [3]

Because the success in providing the safest drinking water to the public must be measured at the ultimate point of consumption — the consumer's tap, the entire flow stream must be thoroughly understood. This is becoming increasingly important in the light of the aging infrastructure, and even more so where expensive new treatment plants are being considered. The management of these risks is implemented with the help of several national tools, such as:

- The national system for monitoring the quality of the drinking water, implemented by the water suppliers together with the specialized department of the Ministry of Health;
- The national benchmarking system developed by the Romanian Water Association within a project financed by EBRD;
- The on-line system for the permanent measurement of the population's perception with regard to the quality of the drinking water and of the services associated to its supply.

Substantial efforts are also being made at regional level in order to enhance the management systems and tools necessary for diminishing the drinking water pollution risks. Such an example is the ***Iaşi county*** in NE of Romania (see the map), where continuous efforts have been made, in several directions, for improving the tools used in monitoring and warning systems.

Figure 1. Iaşi county's Regional Operating Company's supply area

The Regional operating company (ROC) in Iaşi county, S.C. Apavital Iaşi:

- Made a partnership with water suppliers from Netherlands, Ukraine and Republic of Moldova with the aim to implement a pilot project [4];
- Considering the capacity of online survey systems to monitor the characteristics of socio-economic processes with high importance with regard to the quality of life and health of the population, Apavital implemented a pilot within the framework of A-port project, for insuring a permanent tool for measurement of the population's satisfaction with regard to the quality of tap drinking water and the associated services;

- On the other hand, the benchmarking is a proven management instrument that can make a significant contribution to these challenges. It is increasingly applied in the European water sector and helps driving improvements and innovations as well as raising transparency. Apavital was involved in all three pilot benchmarking exercises realized by the Romanian Water Association between 2001 and 2010 and the outcomes reflected an increased performance in almost all performance indicators.

By consequence, Apavital insured, to several research teams from different projects, the necessary conditions for the implementation and modernization of powerful tools that will insure a performing water resources management, a good diligence of the hazards that determine diminution of the drinking water's quality in the distribution network and a more objective measurement of the drinking water at tap.

2. METHODOLOGY

With the support of several research and specialists teams, in which were part of, in different phases, also the authors of this article, an integrated continuous monitoring and warning on hazards with potential influence on the Apavital's water quality has been created, containing several components, such as:

- *A-port online tool for permanent measurement of the population's satisfaction with regard to the water's quality system;*
- *The water quality's monitoring system through lab analysis of samples taken from catchments and in another fixed points established by Apavital with the approval of the Direction of Public Health and the National Regulatory Authority for Public Services (ANRSC) – within a benchmarking system;*
- *The pilot development of an intake management system for the Prut and Moldova River in Iaşi.*

The integrated management system implemented by Apavital Iași will use the output data from the three systems above as input data. In this way, the new system will provide an integrated approach from source to tap in the whole area of operation. This means assessment of water quality trends, selection of target parameters for water quality monitoring, developing a reliable multi-sensor platform, including an integrated software platform, setting alarm thresholds based on the local circumstances, Reporting scheme on the benchmarking system and Action plans that are implemented in the management and quality systems of the Apavital water company.

3. WATER PORTAL FOR PERMANENT MEASUREMENT OF THE POPULATION'S PERCEPTION WITH REGARD TO THE WATER'S AND ASSOCIATED SERVICES' QUALITY

Because the way of providing safe drinking water to the population must be measured at the ultimate point of consumption — the consumer's tap, the entire flow stream must be fully under control. This is becoming increasingly important in light of the aging infrastructure and even more so where expensive new treatment scheme are being considered. In Romania, water quality monitoring relies heavily on spot sampling followed by instrumental analytical measurements to determine pollutant concentrations. The major problem, in terms of public health protection, is that monitoring the safety of drinking water is reactive, in the sense that any event or breakdown in the system can occur many hours before it is detected by monitoring for any of the routinely measured parameters. This is related to the monitoring strategy, which is traditionally focused on water as it enter and/or leaves the treatment plants and on the distribution system. While traditionally measured parameters have proved useful and still have an important role to play, the establishment and use of other tools as part of monitoring programs may complement by providing additional information with the aim to obtain a more representative picture of the quality of a water body. [5]

The project was aiming to develop and implement a Portal for customers' satisfaction related to the water supply services in a partnership built by the involvement of the academic area, Romanian Water Association and a private IT company. One main objective of the project was represented by the development of a virtual environment which will support the online interaction among the main actors involved in the evaluation of the water quality and in the decision making process concerning this service. The main information source is the customers' opinion and the water services providers' operational data. The analysis and the correlation of these two types of information will support the identification of short-, medium- and long-term trends and scenarios concerning the quality of the water supply services. This barometer will be an important tool in the water quality management.

The development of a Water Platform is an innovative solution for an integrated perspective of the local/regional administration. The new information and communication technologies have a significant contribution to the efficiency and the quality of the local authorities' activities. This approach integrates various dimensions of the water services framework to be applied in the design of the Water Portal, such as: the users' view, the processes perspective and the technical aspects. The specific objectives of the project are:

1. Stimulating the pro-active participation of the citizens in the process of controlling the water public services, in order to create a pressure on the service providers to improve and maintain the quality of the services;

2. Improvement of the citizens' online access to specialized information and possibility to have an immediate feed-back;

3. Improvement of the management systems dealing with the crisis situations, and increasing the security, hygiene and comfort of living.

The Water Portal (A-port) has as main goal to improve the communication flows from the services providers to the citizens and vice-versa, in order to increase the operational efficiency through a better decisional process and the transparency in this sector. A main concern is represented by the identification of the best ways to prevent and react in crisis situation.

4. PILOT WARNING SYSTEM

a) Existing situation

Upstream pollution (Ukraine, Moldova and North-Romania) by pesticides, chemicals and other pollutants can threaten the intake-system for a long period. That's why, during the last years, considerable efforts were undertaken to develop a monitoring system for both water flow and quality in Iasi city. Currently, Apavital carries out an investment program to upgrade drinking water supply in terms of improving serviceability and drinking water quality. Due to lack of adequate water quality monitoring systems of the raw water risks exist drinking water supply in Iaşi will be contaminated by high impact pollution events, such as pesticides, (untreated) waste water, industrial discharges, that possibly threaten public health. The incoming raw water at the intake is sampled and analyzed now once per 4 hours for a limited number of parameters (turbidity, pH, oxygen, hardness, chloride, ammonium, and nitrate). In case one of these parameters changes negatively, the water treatment process can be adjusted slightly, e.g. by changing the dosing of activated coal or the coagulation process. However, adjustments in the treatment process will be too late and there is a fair chance that insufficiently treated water is pumped into the distribution network. To further improve the drinking water supply and gain trust of customers in the drinking water supplied, Apavital wants to know the risks of pollution in its raw water sources and needs a framework for action to respond to pollution events. [6]

b) The development of an intake management system for the Prut and Moldova River in Iaşi pilot project's objectives

On this background, in the framework of the Partners for Water Program, Apavital Iasi and Dunea from the Netherlands are financed by Dutch Government to develop in partnership an early warning system for the intake of surface water from the Prut and Moldova Rivers. The expected result of the project is to avoid the inflow of polluted surface water into the inlet infrastructure and treatment plant, which might negatively impact public health and trust in drinking water, specifically:

a) assessment of actual water quality (developments) in the rivers Prut and Moldova, including threatening human activities;

b) engineered and implemented early warning water quality monitoring systems in the Prut and Moldova Rivers;

c) determined warning levels in case of pollution based on water treatment efficiency and desired water quality at the tap;

d) implemented integrated software platform, connecting all applied sensors, that generates alarms;

e) develop and implemented action plans and procedures in case of warnings;

f) more intensive co-operation between Romanian, Moldavian and Ukrainian water companies.

5. THE PERMANENT MEASUREMENT OF OPERATIONAL PERFORMANCE SYSTEM

The water's quality in the network is for sure heavily dependent on the performance of the water operators. The necessary information with regard to the suppliers' performance is provided through the benchmarking system. In the purpose of realizing a sustainable and efficient system, several water suppliers (among which, Apavital) together with the Romanian Water Association entered into a benchmarking project financed by EBRD. The project will assist the Regional Operating Companies, as well as the newly formed Intercommunity Development Agencies, through a benchmarking support assignment. Benchmarking will have multiple objectives. First, it will provide Regional Operating Companies with a tool to compare operational performance over time and to identify underperformance relative to industry standards both locally and internationally. Second, it will provide Intercommunity Development Agencies with an important tool to monitor the quality of service provision and performance under a Delegated Management Agreement relative to a peer group. Finally, it can provide the Romanian authorities including the National Regulatory Authority for Public Services, with additional information on performance levels in the sector. The overall objective of the assignment is to assist the newly formed Regional Operating Companies in their transition through improved benchmarking and performance support to ensure that the new water operations are fully integrated and result in the highest level of operating efficiency. This will increase transparency resulting in an effective management tool both for the Regional Operating Companies as well as for the Intercommunity Development Agencies, which monitor the Regional Operating Companies performance under the Delegated Management Agreement and subsequently assist the Romanian Water Association in monitoring and encouraging improved performance in the sector.

6. CONCLUSIONS

- Regional Operators in Romania depend for 65 percent on surface water for the production of the drinking water.
- By applying water quality monitoring systems, water companies can monitor the quality of intake water and have an instrument at their disposal that will help them to avoid the intake of heavily polluted surface water.
- The information collected through the monitoring systems are reported in the benchmarking system, which allows the identification of trends in the region and in neighboring regions;
- A supplementary support can be obtained through the online system of population's perception with regard to the water's quality using the A-port web-based platform.

REFERENCES

[1] Fuquan N. et al, ComGIS-Based Early Warning System of Rural Drinking Water Safety in Ya'an City of Sichuan, China, Journal of Water Resource and Protection, Vol. 02, Issue: 02, pp. 154-166, 2010.

[2] Haas A.J., Gibbons D., Dangel C., Allgeier A., Automated surveillance of 911 call data for detection of possible water contamination incidents, International Journal of Health Geographics, Vol: 10, Issue: 1 Pages/record No.: 22, 2011.

[3] Doong D.-J. et al., Development of an operational coastal flooding early warning system, Journal: Natural Hazards and Earth System Sciences, Vol: 12, Issue: 2, pp. 379-390, 2012.

[4] Ramaker A.B. and Biemond J.J., „Pilot 'development of an intake management system for the Prut and Moldova River in Iaşi, Romania", Dunea application document, 2010.

[5] Mureşan M., Turdean M., Ciomoş V. National Portal for the Permanent Assessment of Clients' Satisfaction in Water Supply and Purification-Sewerage Services Studies in informatics and control, Vol. 17, No. 1/2008, pp. 107-116, 2008.

[6] Dăscălescu I., Pilot 'development of an intake management system for the Prut and Moldova River in Iaşi, Romania, Romaqua, No. 5/2011, pp. 6-18, 2011.

IN SITU MEASUREMENT OF SOUND ABSORPTION COEFFICIENT

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ABSTRACT

Porous sound-absorbing materials are utilized in almost all areas of noise control engineering. Sound absorbers with desirable sound absorption coefficient are used for designing noise control measures. The designers of sound absorbers must know how to choose the proper sound absorbing materials, its geometry and the protective facing. The well-known Kundt's tube and reverberant room method are often used for measurement of acoustic absorption properties of samples under laboratory conditions [1]. In this paper the in situ measurement of sound absorption coefficient is investigated under free-field conditions. Particularly is investigated how the sample size is influencing the measurement results.

Keywords: measurement, sound absorber, sound absorption coefficient, sample.

INTRODUCTION

The Microflown in-situ technique to determine impedance, absorption and reflection makes use of a Microflown particle velocity sensor and a sound pressure microphone. Both sensors are mounted in the PU-mini probe that is positioned close to the material with a sound source positioned at a certain distance (fig. 1). The sound pressure and acoustic particle velocity are measured right at the surface of the material (fig. 2). The impedance can be derived from the ratio of sound pressure and particle velocity. From this, the material reflection and absorption can be calculated. The current usable bandwidth for the method is 300 Hz – 10 kHz. The method makes possible to measure under different angles, measuring with a high spatial resolution of just few millimetres, measure all type of materials and material sizes. There is also no need to take samples and measurement can be performed when the materials are installed. [3]

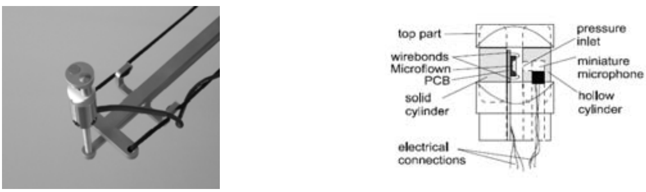


Figure 1 Microflown PU probes: PU-mini (left) placement of p and u (right) [3]

With a small, handheld impedance gun the acoustic absorption, reflection or impedance can be measured. This in situ absorption method is an alternative for the impedance tube methods or reverberant field method. With a sound source at 32 cm from the probe noise is generated towards the sample. The sound pressure and acoustic particle velocity are measured right at the surface of the material. High spatial resolution allows analysis of inhomogeneous, e.g. perforated, materials. [3]

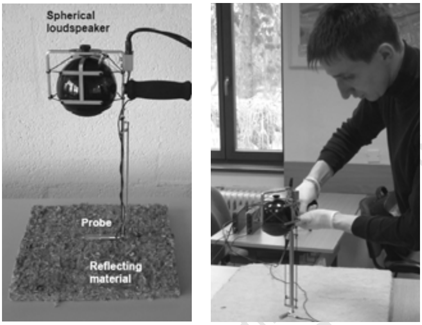
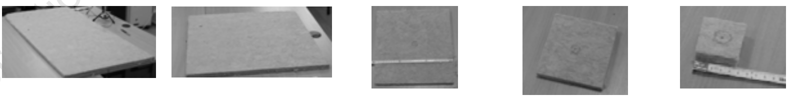


Figure 2 In – situ absorption set up [3, 5]

MEASUREMENT SET UP

For this experiment the chosen material is Isover 20 mm and one source-sample distances 32cm is used. To check the influence of the sample size several measurements were done (fig. 3):

a) a large sample of 120 cm x 60 cm was measured as reference,
b) a 60 cm x 60 cm sample that was cut free,
c) a smaller (30 cm x 30 cm) sample that was cut free,
d) a small (15 cm x 15 cm) sample that was cut free,
e) a very small (5 cm x 5cm) sample also cut free.



a) reference sample: 120 x 60 cm	b) sample size: 60 x 60 cm	c) sample size: 30 x 30 cm	d) sample size: 15 x 15 cm	e) sample size: 5 x 5 cm

Figure 3 Sample size reductions

The measurements were taken from the same measurement point, which was marked on the sample. The sample was cut gradually from the sides. 10 measurements were performed by each sample size to examine reproducibility and avoid measurement errors. During the measurement the probe was positioned close to the sample. The distance between the PU- probe and the samples was 1 cm.

The measurement settings were the followings:

- Measurement time: 4 s.
- Hardware correction: correction off.
- Haigh gain mode.
- Auto input gain control: on.
- Auto accept overload: off.

Before series of measurements DAQ calibration and calibration measurement were performed.

RESULTS AND DISCUSSION

In followings figures the measurement results are shown. In figure 4 the sound absorption coefficient of the reference sample from 10 measurements is presented.

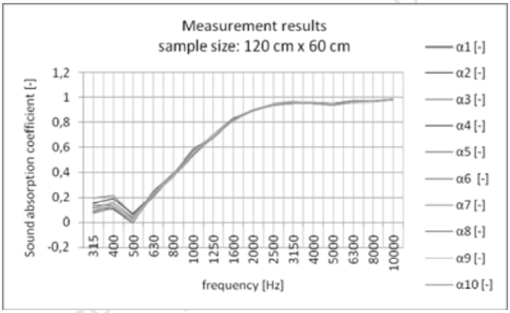


Figure 4 Sound absorption coefficient – reference sample

If the sample size is reduced to 60 x 60 cm (fig. 5), a deviation of the response is seen at frequency range 315 – 630 Hz.

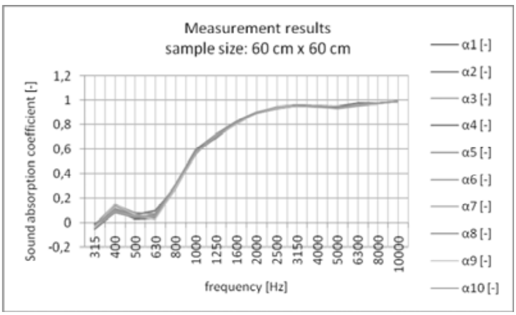


Figure 5 Sound absorption coefficient – sample size 60 x 60 cm

More deviations are seen if the size is reduced to 30 cm x 30 cm (fig. 6) and the deviation seen at frequencies from 315 Hz up to630 Hz increases.

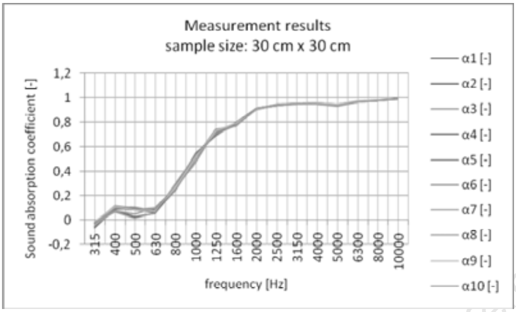


Figure 6 Sound absorption coefficient – sample size 30 x 30 cm

If the size is reduced to 15 cm x 15cm, the deviation of the response is seen at frequency range 315 – 1000 Hz (fig. 7).

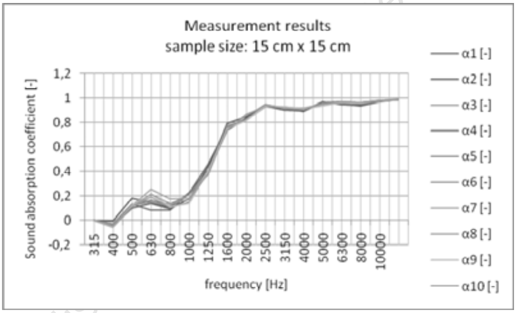


Figure 7 Sound absorption coefficient – sample size 15 x 15 cm

If the size is reduced to 5 cm x 5cm, the complete shape alters: the maximal absorption decreases (fig. 8). This effect was observed with free sample.

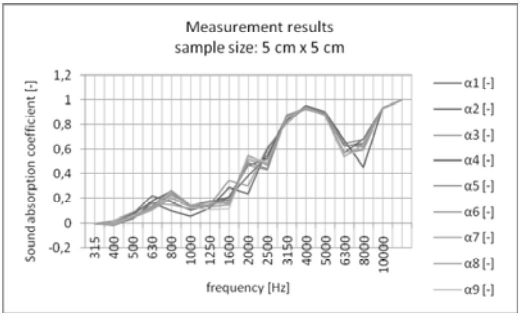


Figure 8 Sound absorption coefficient – sample size 5 x 5 cm

The averages of sound absorption coefficients are presented by different sample size in figure 9. It can be concluded that the sample size is influencing the measurement. However it is also probable that the acoustic properties of the sample change and that the free field measurement is valid.

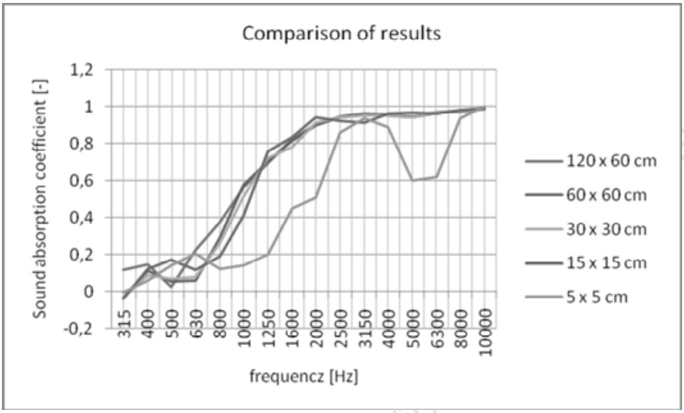


Figure 9 Comparison of measurement results

CONCLUSION

The method shows to be sensitive for sample size and especially at lower frequencies the results have a higher error. In general the reason for these errors can be found in:

- Wrong measurement distance: If the probe sample distance is underestimated the measurements results resemble better the tube results.
- Wrong source behavior: The real loudspeaker does have a behavior that only resembles a monopole. Increasing the source-probe distance must improve the measurement if the deviation in behavior at close distances is the cause of the inaccuracy. [3]
- Wrong calibration: Errors in the calibration can be expected at lower frequencies.
- Properties of the acoustic sample: A negative absorption can be a local effect.
- Sample size: If the sample is too small edge effects take place. The properties of the acoustic sample can be the reason for the measurement error.

ACKNOWLEDGEMENT

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REFERENCES

[1] E. Tijs & E. Druyvesteyn. An Intensity Method for Measuring Absorption Properties in situ. In.: Acta Acustica united with Acustica, vol. 98/issue 1, pp 342 – 353, 2012.

[2] E. Brandão & E.Tijs & A. Lenzi & H.E. de Bree. A Comparison of Three Methods to Calculate the Surface Impedance and Absorption Coefficient from Measurements

Under Free Field or in situ Conditions. In.: Acta Acustica united with Acustica, vol. 97, pp 1025 – 1033, 2011.

[3] H.E de Bree. The Microflovn E-Book. Chapter 6: Impedance. pp 36 – 41, 2008.

[4] R. Králiková & M. Rovňák & M. Králik. Visualisation of environmental data. In: SGEM 2008. - Sofia: SGEM, pp.577-584, 2008.

[5] E. Lumnitzer & M. Badida & M. Biľová. Porous sound absorbers and determination of their acoustical properties. In: Acta Mechanica Slovaca. Vol. 15/ issue 2, pp. 28-31, 2011.

[6] M. Badida & E. Lumnitzer & M. Románová. The application of recycled materials for products that provide noise reduction in living and working environment. In: Acta Acustica united with Acustica. Vol. 92, suppl. 1, pp. 108, 2006.

[7] M. Decký & A. Gavulová & D. Putirka & M. Pitoňák & J. Vangel & K Zgútová. Navrhovanie a rozpočtovanie asfaltových vozoviek. Vysokoškolské skriptá, Stavebná fakulta ŽU. pp. 185, 2010.

[8] M. Biľová & M. Badida. State of art in acoustical parameters determination of sound absorbing materials. In: Hodnotenie kvality prostredia 2010 : Vol 1. TU Košice, pp. 100-105, 2010.

[9] M. Biľová & E Lumnitzer. Acoustical parameters of porous materials and their measurement. In: Hodnotenie kvality prostredia 2010 : Vol 1. TU Košice, pp106-112. 2010.

LIGHTING INNOVATIONS FOR SAVING ENERGY IN INDUSTRY

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ABSTRACT

Any hearing on the current status and key trends in lighting technology can not start other than with saying, that it is a very dynamic nascent field with constant recharge of a new technically improved and more efficient lighting devices and light sources, being increasingly implemented in intelligent control systems. On the other hand, we consider the lighting technology as a large consumer of electricity, because of which we attribute it to environmental pollutants. This article discusses the possibilities ofreducing the energy consumption of lighting systems and points to the new trends and innovations in a lighting technology.

Keywords: lights sources, illumination, saving energy

INTRODUCTION

With the constant upgrading and improvement of working practices comes an increase of the requirements for creating and editing work environment, which consists of a set of tangible and intangible external factors directly affecting the employee and his/her work. Creation of a favorable working environment is a complex process, in which an important thing is the fact that the working man spends in this environment eight hours a day. Light is one of the factors for creation of the contentment. By investing in innovations improving the working environment, including lighting, the conditions for improving work performance are being created, thereby increasing the return of the invested funds.

ENERGETIC EFFICIENCY OF LIGHTING

Lighting conditions in industrial operations are currently at a level, which in many cases does not satisfy the requirements set out by legislation and standards. Slovakia has highly energy-intensive industrial structure, where dominates the engineering industry. The proportion of electricity attributable to theartificial lighting is significant and not negligible.

Installation and operation of energy efficient lighting systems is in most cases not yet considered a major priority, because the available funds are primarily used for the operation, modernization of production process, and other related activities, that are directly related to the production, and the existence of industrial enterprises andinstitutions.

Quality lighting solution includes perfect connection of human needs, technical requirements and regulations with architectonical solution of space and with appearance of illuminating system and it has influence on the person injured Fig.1.

Light sources and their operation significantly affect the efficiency of lighting, so with the designing of new lighting systems or with the reconstruction and modernization, an increased attention must be payed in their selection. Saving electricity is not only the result of pressure of the users to reduce their costs, but also becomes an obligation in accordance with policy of energy efficiency, defined in existing and newly prepared EU legislation [1].

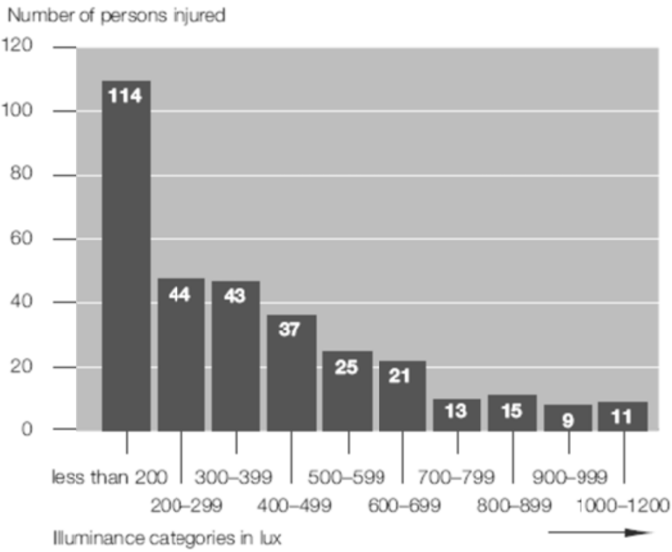

Fig.1 Number of person in accordance with illuminance

In the design phase, the evidence of lighting parameters are the protocols of a lighting calculations. In the already implemented buildings, the evidence are a protocols of the measurement of the lighting parameters [2]. Particularly in the energy audits can be seen, that energy savings when illuminating, are usually most obvious and easiest to achieve.

Approaches to considerations about lighting energy consumption varies, depending on whether the proposed, possibly newly implemented object, or if the energy consumption of existing building is assessed. For the choice of strategy to draft the energy saving measures, it is possible to proceed from the fundamental relationexpressing energy consumption for lighting, in a period of time, for example:

$$W = P_p \times t_o \qquad (\mathrm{kWh.\ year^{-1}}) \qquad (1)$$

Where:

P_p - is average operational wattage of lights (kW),

t_o - is operational time (h.year^{-1}).

From the relation listed above, it is clear, that the strategy in searching for savings in electricity consumption for lighting, can be based on finding savings in operating wattage, or in times when using lighting system, eventually. On a combination of both parameters. Strategies, on which may be based the saving measures are shown on Figure 2.

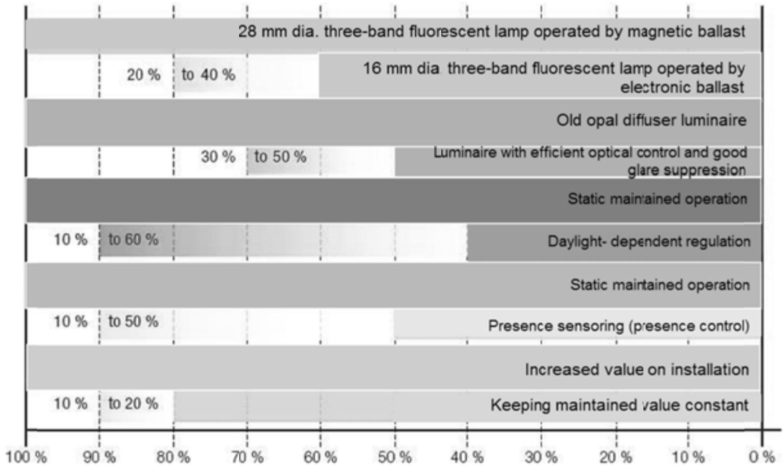

Fig.2 Possibilities to achieve financial savings on illumination

Lighting system for artificial lighting is a system of technical devices, consisting of lights, light sources, ballasts, control systems and accessories, which is primarily intended to create the desired light environment. Lighting systems can be distinguished according to their type, and according to their nature. The type and nature of the lighting system alike impact their energy consumption [3].

NEW TRENDS IN LIGHTING

Progressive lighting systems are using next-generation light sources that are environmentally managing, reliable, they are long-lasting, energy-saving, and so it is possible to achieve financial savings in lighting work areas up to 60%. Selection of light source, (see Table 1) is based on the basic requirements for lighting of the industrial operation. These requests are accepted in particular with an adequate intensity of lighting, appropriate brightness, contrast of brightness, and the colour and in the right direction of light incidence and the like. While fulfilling all quantitative and qualitative parameters of the lighting intensity during the design of a lighting system we must consider the principles of maximum efficiency. Assessing the energy efficiency of lighting makes sense only if the lighting and lighting parameters in the area correspond to its purpose and use.

Tab.1 Comparison of LED with existing Lighting technologies

	LED	Incandescent lamp	Halogen lamp	Compact fluorescent	Fluorescent	Metal Halide Lamp	High pressure sodium
Typ. Lumen output (lm/W)	real[1)] 94	10	20	50	75	80	120
Converter efficiency (%)	80 - 90	100	100	80 - 90	80 - 90	80 - 90	80 - 90
Luminiare efficiency (%)	80 - 90	30 - 50	30 - 50	50 - 60	50 - 70	40 - 80	40 – 80
System efficiency (lm/W)	**60 - 73**	**4**	**8**	**23**	**38**	**41**	**61**
Life time (h)	> 50.000	1.000	3.000	10.000	15.000	10.000	16.000

1) By using a LED (Cree XP-G) with min. 114 lm with typically 1,05 W (3,0V x 0,35A) power consumption and at "normal" (Tj = 80°C) operating conditions: 114 lm x 0,87 / 1,05W = 94 lm/W

Despite the reported examples, however, the best savings are achieved by combining artificial and natural light. Lighting during the day leads to high costs. That is why the lighting control in industry increasingly interests the operators. This is mainly meant for production facilities, storage facilities and associated offices. In these areas it is necessary to ensure the regulation of a constant light intensity and also with consideration of daylight, for example transoms and light guides [4]. These lighting control systems are based on:

- monitoring the presence,
- scheduling,
- dimming control, depending on the intensity of daylight,
- management of constant light levels.

Dimming of the light source is the best known and most basic form of lighting control. Options of how to creatively manage lighting are multiplying, as well as the ways of influencing the nature of light, with a purpose to create an ideal atmosphere for any activity, for example changing the temperature chromaticity, mixing the colors of light or a dynamic copying of a daylight.

With a implementation of a computer intelligence, environmental and economic aspects it is possible to optimize parameters of lighting systems and achieve energy savings, ranging from 30% up to 80%. By adapting the intensity of illumination in indoor environments, it is possible to evolve solutions, depending on the variability of daylight, the movement of people in the area as much as a time scheduling. An example of a simple and automatic control of lighting is the system DALI (Digital Addressable Lighting Interface - Digital addressable lightinginterface), which can be easily integrated into a comprehensive system of building management. In conjunction with the visualization software it is possible to monitor, adjust and control the entire system by the central unit, for example. touch panel or PC, and also monitor the operating hours of each lighting device and display their service life, allowing more effective planning of the maintenance of the entire lighting system and reduce energy consumption for lighting up to 80% (Figure 3). [5]

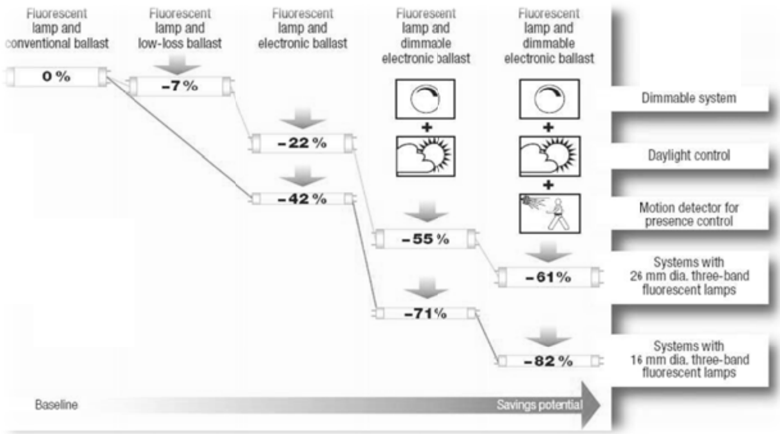

Fig.3 Reducing of energy consumption for lighting

RESULTS

As an example of innovation and optimization of illumination, can be presented a lighting renovation project of operation of the unnamed factory, in which the medium mounting work is carried out, where the requirement of illuminance is 300 lx, color submission (Ra) min. 80 and the flare index UGRL max. 25, and in which was implemented an exchange of a gas-discharge lighting with luminaires with fluorescent lamps. The original lighting system with halide lamps (900 units) was below the required illuminance values. The parameters of light sources are in Table 2.

Tab. 2 – Paramters of lighting source

Lighting source	Wattage	Specific wattage	Index of color submission (Ra)	Lumen depression during lifetime
Halide lamp with phosphor	400 W	71 lm/ W	Ra > 90	30% per 12 000 h
Fluorescent lamp	54 W	85 lm/ W	Ra > 80	10% per 24 000 h

Thanks to this innovative project of rationalization of lighting system in the operation of the process plant, where the greatest energy savings and the associated financial savings were achieved, mainly the implementation of smart lighting control systemlighting power consumption was reduced by 40%. In addition, the investor saved additional costs for a implementation of an additional illuminator for places, that did not meet operational standards with the previous gas-discharge lamps.

CONCLUSION

According to the main objectives of the European countries to reduce energy consumption in all the areas of its use, it is necessary to seek new solutions of the economical use of energy resources in the area of lighting. The requirements of current users of lighting systems grow as fast as consumption and price of electricity as a result of which we meet more frequently with the concept of management and control of lighting and it can be assumed, that in this exact area of lighting rationalization will be oriented its research and development.

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REFERENCES

[1] DLUGOVSKY, J.: Energy Efficiency, Lighting Control, Schneider Electric, In. AT&P Journal, No. 3/2008, BRATISLAVA, ISSN 1336-5010, pp. 24-25.

[2] ZAK, P.: Design of lighting and energy saving, In. Světlo, No. 2/2009, ISSN: 1212-0812, FCC Public s. r. o., Praha.

[3] HABEL, J., ZAK, P.: The energy performance of lighting systems, In. Světlo, No. 4/ 2010., ISSN 1212-0812, FCC Public s. r. o., Praha.

[4] DOLEJS, O.: Lighting control in industrial plants, In. Světlo, No. 5/2011, ISSN 1212-0812, FCC Public s. r. o., Praha.

[5] DLUGOPOLSKY, J.: Effective lighting control in intelligent buildings, Technologies for buildings, In. AT&P Journal, No. 3/2010, HMH, s.r.o, Bratislava

INVESTIGATION OF IMMOBILIZATION REGULARITY FOR HYDROCARBON OXIDIZING MICROORGANISMS ON MATRIX OBTAINED FROM CARBON-CONTAINING WASTE

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ABSTRACT

As a result of experimental studies, sorption materials from carbon-containing wastes were obtained. Physical and chemical characteristics of this material have been identified. Accumulative hydrocarbon oxidizing microorganism culture was obtained from oil-polluted soil. Physical immobilization of microorganisms on the porous structure of the sorbent was carried out.

Keywords: oil, biosorbents, immobilized microorganisms.

INTRODUCTION

Environmental pollution by hydrocarbons of oil is an urgent environmental problem for the countries related with oil production and refining. Various technologies and technical solutions are applied to eliminate contamination. Among the new and promising directions for cleaning natural waters and soils from oil are the applications of biosorbents made on the basis of porous materials with immobilized microbial cells on it.

Immobilization - fixing microorganisms or enzymes on a solid support in order to improve efficiency. There are two main methods of immobilization of microorganisms: physical and chemical [1].

Chemical immobilization compared to the physical one is less attractive because of the complexity and cost of the process. Various natural (carbon-black, coal, peat, pulp, wood chips) and synthetic (polymethylene, polyamide, polyester polymers) materials are used as the matrix [1, 2].

A new direction in the production of biosorbents is used as a carrier of modified hydrocarbon waste. Broadening the base of the secondary raw material for sorbent production allows obtaining materials with desired properties of sorption and required technical characteristics: high resistance to aggressive environments and effects of temperature, ability to sustain long periods of work, including the regeneration and reuse.

The efficiency of use biosorbents in purification technologies depends on the properties of the matrix, the number of immobilized microorganisms on it, the ability of biosorbents for long-term storage and rapid adaptation of microorganisms to process conditions. Achieving the required performance of biosorbents is determined by the immobilization method of microorganisms on the surface of the matrix, the mechanisms for non-traditional materials that are used as carriers, are not well investigated.

The aim of research was to develop an immobilization method of hydrocarbon oxidizing microorganisms on the surface of the carbonizate, which was obtained by pyrolysis of surplus sludge generated during biological treatment of oily wastewater.

To achieve this aim experimental studies have been made: sorption materials were obtained from carbon-bearing waste; physical and chemical characteristics were determined; hydrocarbon oxidizing of microorganisms was isolated; accumulative cultures of hydrocarbon oxidizing microorganisms was derived; experiments on the physical immobilization of microorganisms on the porous structure of the sorbent is held; immobilization process parameters are determined.

OBJECT AND METHODS

The subject of the study was the conditions of static microorganisms immobilization isolated from oil-polluted soil on the surface of the porous carbon sorbent.

Soil suspension was prepared for accumulation culture of hydrocarbon microorganisms (10 g of soil with the concentration of 26.6 g oil/kg to 90 ml of sterile liquid medium). The inoculated medium incubated at 30 ºC for 7 days [3, 4], and then spent a dense planting on the growth medium in dishes Petri. Synthetic medium Tauson with the addition of oil was used as the sole carbon source. The growth of microorganisms was registered in 7-10 days.

Further increase in biomass of microorganisms was carried out in a fermenter Biostat A plus. For this purpose, dishes Petri made flush microorganisms (the total number of microorganisms was made $8.63 * 10^4$ CFU/ml), add 10 ml of petroleum origin Orenburg and 2 liters of synthetic medium Tauson. Cultivation of microorganisms was carried out under constant conditions, which are automatically maintained in the fermenter: temperature of the internal environment of - 37° C, pH - 5,8, stirring speed - 100 rpm. Information about the process is displayed on the monitor (Fig. 1).

Microscopic studies of isolated microorganisms were carried out on microscope Carl Zeiss software increases 800 times.

To fix the microorganisms static method was used, which is achieved by contact of an aqueous solution with a carrier of microorganisms within the specified time without mixing [1, 2].

During the microorganisms' immobilization on the surface of the porous media, the matrix choice is of great importance. The matrix must have the appropriate characteristics and meet certain requirements [2]: high chemical and biological stability, non-toxicity, high chemical resistance, sufficient permeability to enzyme and substrate, porosity, large specific surface, rough surface layer, ability to get in a comfortable, technologically forms (pellets, membranes), light activation, low hydrophilicity; low cost.

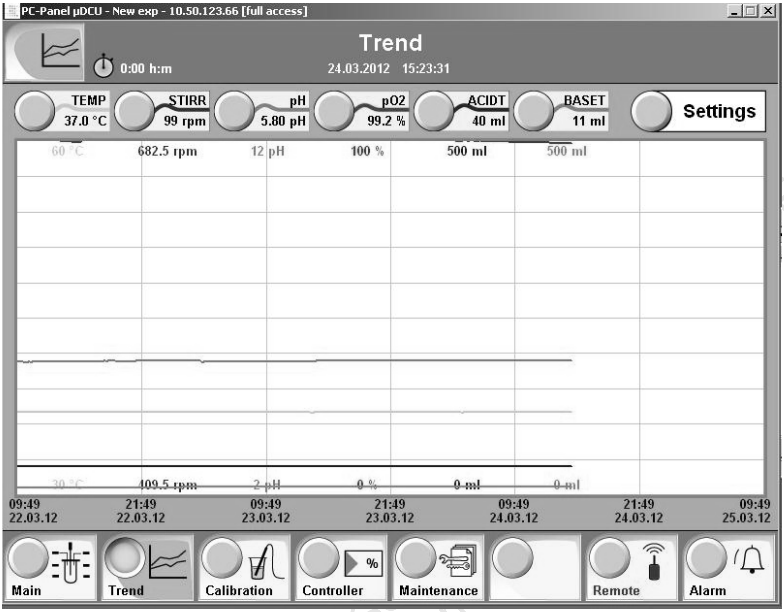


Fig. 1. The data defined fermenters and displayed on a computer

As the carbon matrix used carbonizate resulting from the low-temperature pyrolysis of excess activated sludge treatment plant biochemical petrochemical complex [5]. The physical and chemical characteristics carbonizate are presented in table 1.

Table 1. Physical and chemical characteristics carbonizate [5]

Characteristic	Unit of measurement	Value of the indicator
The content of pyrocarbon	%	40-45
Mineral matter	%	55-60
Heart cut	mm	5-10
Apparent density	g / dm^3	385
Specific surface	m^2/g	39,3 ± 0,6
Voidage	%	60,5
Water absorption capacity	%	61,5
Oil absorption capacity (petroleum origin Orenburg)	g/g	0,55
Mechanical strength to abrasion	%	50

An important value for the material derived from waste, and used as a carrier for microorganisms is the relative environmental risk of waste, which is installed on the extent of its possible negative impact on the environment. According to the results of experimental studies on the phytotoxicity of carbonizate, it was found that the material is inert with respect to living organisms.

Indicators of the content of pyrolytic carbon, voidage, oil absorption capacity and other physical and chemical characteristics indicate the presence of the sorption properties of carbonizate, it can be used as a matrix for immobilization of microorganisms [5]. Investigation of the surface of the sorbent after fixing microorganisms was performed using Scanning Electron Microscope S-3400N Hitachi software.

RESULTS AND DISCUSSION

Hydrocarbon oxidizing microorganisms that have been allocated to the medium Tauson are shown in Fig. 2. It is established that the structure of microbial biocenose forms mainly of the genera: *Pseudomonas, Rhodococcus, Micrococcus*.

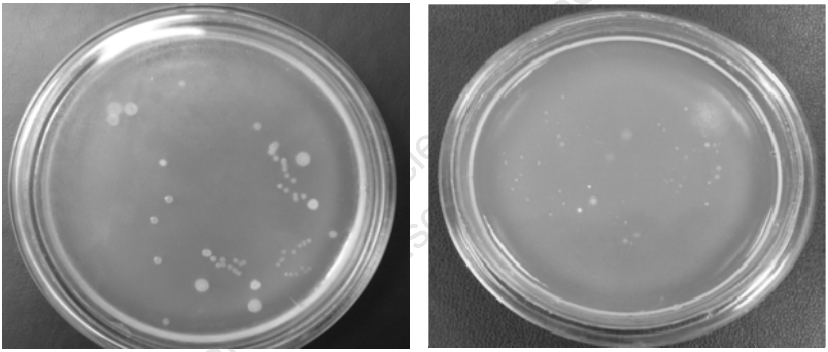


Fig. 2. Hydrocarbon oxidizing microorganisms that have been allocated to the medium Tauson

Periodic microscopic studies were performed in the fermenter to control the process of increasing the bacterial mass. In Fig. 3 a microbial suspension of bacteria from the fermenter is presented.

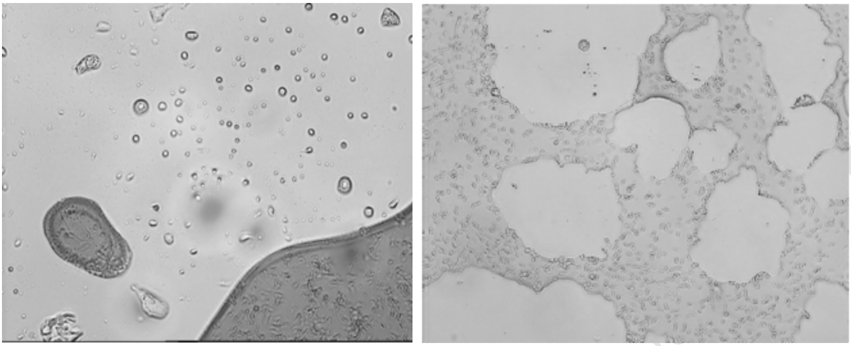
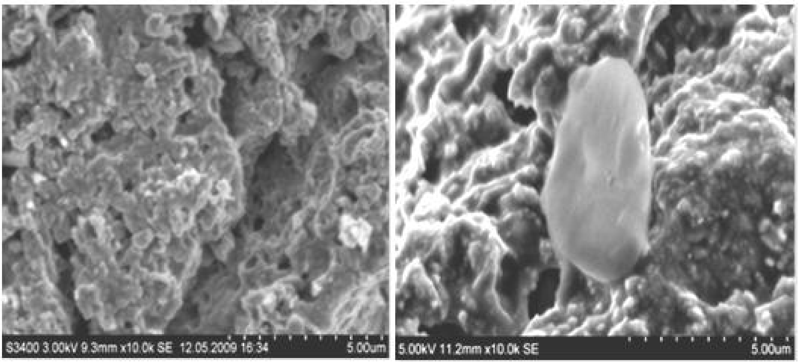


Fig. 3. Microbial suspension of bacteria from the fermenter

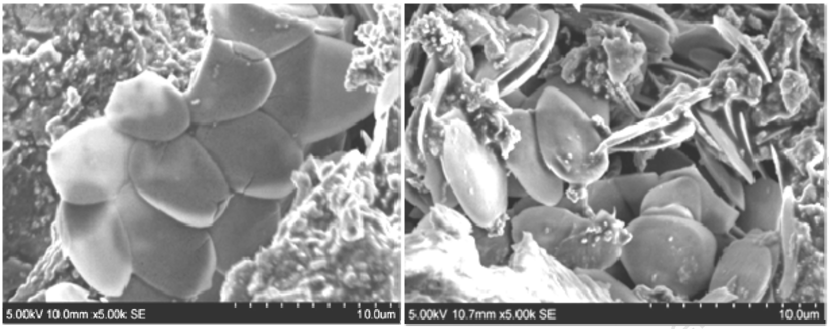
After receiving the accumulative culture of microorganisms in the fermenter, experiment by static immobilization of microorganisms on the porous surface of the sorbent was carried out.

To confirm the microorganisms immobilization on the porous surface of the sorbent samples were examined under a scanning electron microscope. On the surface carbonizate fixed spores of microorganisms' cells, whose identification is currently under way (Fig. 4).



a) carbonizate (an increase of 10 thousand times)

b) carbonizate immobilized on the surface of the cells of microorganisms (an increase of 10 thousand times)



c) carbonizate immobilized on the surface of the cells of microorganisms (an increase of 3 thousand times)

d) carbonizate immobilized on the surface of the cells of microorganisms (an increase of 5 thousand times)

Fig. 4. Change the appearance of carbonizate

The presence of bacterial spores in carbonizate provides conditions for long-term storage biosorbent with different mechanical, physical and chemical effects, and further use for the remediation of contaminated natural objects.

CONCLUSION

Currently, one of the most promising directions for cleaning natural waters and soils from petroleum and petroleum products is the use of biosorbents made on the basis of porous materials with immobilized microbial cells on it. To substantiate the possibility of physical immobilization of microorganisms on the surface of carbonizate obtained by pyrolysis of excess activated sludge generated during the biochemical treatment of oily wastewater, a series of experimental studies were carried out.

The experimental results indicate the possibility of using carbonizate as a matrix for the microorganisms' immobilization. This is confirmed by its physical and chemical properties, surface structure and toxicological characteristics. The parameters and conditions of immobilization of hydrocarbon oxidizing microorganisms were determined. Sorption mechanism for fixing microorganisms by using a static method is proved.

Improving the efficiency of immobilization can be reached by using a dynamic method of fixing the cells of microorganisms.

These results are the basis for the development of technology for obtaining biosorbents on the basis of carbon waste.

The proposed method for producing biosorbents on the basis of carbon-bearing waste allows using their material potential to reduce the amount of landfilled waste and efficient use of biosorbent obtained in environmental technologies (for example, natural and wastewaters purification from petroleum, bioremediation of contaminated soils).

REFERENCES

[1] Berezin I.V. & Klyachko N.L. & Levashev A.V. & Martinek K. & Mozhayev V.V. & Khmelnitsky Y.L. Biotechnology. Textbooks for high schools. In the 8th book, Higher school, Russia, 1987, p 159;

[2] Zhdanova E.S. & Rudakova L.V. Biotechnological methods of purification when elimination of oil pollution of natural objects, Perm State technical university. Urbanity bulletin, Russia, vol. 3, pp 97-107, 2011.

[3] Egorov N.S. Workshop on Microbiology, Russia, p 307, 1976.

[4] Netrusov A.I. & Egorov M.A. & Zakharchuk L.M. Workshop on Microbiology: Textbooks for students higher educational institutions, Russia, p 608, 2005.

[5] Vaisman I. & Glushankova I.S. & Dyakov M.S. & Hodyashev M.B. Environmentally safe disposal of sewage sludge treatment plant biochemistry to produce carbon sorption materials // All-Russian scientific-practical journal "Water: Chemistry and Ecology", Russia, vol. 3, pp 14-24, 2011.

INVESTIGATION OF REGULARITIES FOR INTEGRATED THERMAL PROCESSING OF WASTE POLYMER MATERIALS WITH RECEIPT SORPTION CARBON MATERIALS AND FUEL

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ABSTRACT

The paper covers results of investigations on thermal processing of waste polymer materials (made of PV and PC) with producing activated carbons similar by sorption characteristics to those used in practice of wastewater treatment. Carried out investigations allowed developing technical solutions for processing of waste polymer materials with receipt of nano-sorption materials.

Keywords: waste polymer materials, low-temperature pyrolysis, sorption carbon materials, activation, thermal and chemical processing.

INTRODUCTION

Last decades, production of polymer materials is increasing annually by 5-6% and in 2010 reached 250 mln. tons. In industrially developed countries, the consumption of polymer materials doubled and consists 90-100 kg per year. It is explained by unique characteristics of polymers, such as: strength, corrosion resistance, lightness, versatility and low cost.

It is known that the raw material for getting polymer material is oil and natural gas. As an example, it takes 1.75 kg of oil (total as feed stock and energy resource) to produce 1 kg of PP [1].

The widespread use of polymer materials in technics and residential use leads to the necessity for recovery and recycling of generated waste. More than 3.3 mln. tons of polymer waste are generated annually in RF. The proportion of recycling consists less than 10%.

Analysis of generated waste polymer materials showed that waste polyethylene and polypropylene (PP), PET, PVC and polycarbonate (PC) are their main constituents. A trend towards increasing of PP and PC using in various fields of technology and domestic consumption is observed and will lead to the growth of their proportion in total masse of polymer waste (table 1) [2].

Table 1. PP and PC application areas

PP application area	Share in total consumption, %	PC application area	Share in total consumption, %
Package	33	Automobile industry	20
Furniture	14	Optical glasses	20
Transport	12	Plain glasses	20
Consumer goods	10	Equipment	15
Electronics	9	Consumer goods	10
Building	6	Recreation industry	10
other	16	Medicine	5

The problem of waste polymer materials is actual from the standpoint of environmental protection and due to the fact that they are considered to be potential source of raw materials and energy resource. Therefore, in order to choose the scenario of polymer waste recycling, it is necessary to take into account the possibility of the best use of energy and resource waste potential.

OBJECT AND METHODS

Analyses of scientific and technical information and foreign experience have shown that the following methods can be used for waste polymer materials utilization: thermal recycling (combustion, pyrolysis); disposal; destruction with receipt initial low-molecular products (monomer, oligomer); processing (die cast, extrusion) [3]. At the moment, waste polymer materials disposal jointly with municipal waste is considered to be the main utilization method in RF. It is connected with the loss of resource and energy potential, environmental pollution by toxic products, generated within waste polymer materials destruction. Processing is frequently accompanied by decline of operation characteristics and utilization presents impossible [4].

In world practice utilization of waste polymer materials is mainly carried out by combustion. It should be underlined, that in order to prevent toxic compounds generation, it is necessary to implement complicated post-treatment systems and/or off-gases after-burning with high temperatures. It leads to the considerable rise in the cost, rapid wear and equipment failure.

As a result of low-temperature pyrolysis of polymer materials liquid phase, using as a fuel and pyrolytic carbon are generated. It permits with an additional treatment to get nano-structured sorption materials and to use in a fullest way resource and energy waste potential.

The thermal processing methods of PVC and PVC-based materials (textolit), polyurethane and PET waste with the receipt of carbon sorbents are rather examined [5]. But it is not given sufficient consideration to the processing of other plastic waste.

The purpose of the current paper is to conduct research for reducing environmental impact by development of resource and energy saving method for processing waste plastic products with obtaining sorption nanostructured carbon materials and liquid fuels.

RESULTS AND DISCUSSION

The investigation of regularities for thermal destruction of polymer materials and analysis of products characteristics, received within pyrolysis were conducted with the use of derivatograph Q1500D and laboratory facility which allows carrying out heating of samples in laboratory muffle furnace in carbon dioxide medium, condensation of produced organic matter and off-gases concentration. Analysis of nondensables was conducted by chromatographic method. The activation of pyrolyzed materials was made in laboratory rotary kiln with external electric heating, as well as in stationary muffle furnace at different temperatures. Carbon dioxide, water vapor and potassium hydroxide were used as activating agents.

Parameters of porous sorbents` structure, limiting micropore volume, characteristic energy of adsorption and half-width size of slit for slot-like micropore were determined with the use of standard methods on the base of isotherm derived within nitrogen adsorption on the investigated samples of activated carbons. Specific surface of samples was estimated by BET method. According to the t-method of de Boer and Lippens and with Sorbi-MS, surface area and volume of micropores were defined.

Approximating curve according to BET equation was plotted on four adsorption values P/P0=0.09, 0.06, 0.15, .2 for linearized BET equation:

$$A = K \cdot \left(\frac{P}{Po}\right) + M \qquad (1),$$

where

A – specific adsorption, K,M – coefficients of approximating curve for determination limit adsorption Am and surface area of adsorbent (m^2/g).

Approximating curve by de Boer and Lippens method is plotted on four spots in range P/P0=0.2-0.5 and permits to estimate area and volume of micropores.

It is known that the main production method of crushed carbon sorbents is two-stage process including raw material carbonization and carbonizates` activation by vapor or carbon dioxide [6].

To select and justify technological parameters for thermal utilization of polymer materials, derivatographic investigations of two samples were carried out: sample 1 – PP waste, sample 2 – PC waste.

The investigations of samples pyrolytic destruction is realized at 450-550 ^{o}C. Up to 80% of pyrolysis gases produced from pyrolytic destruction of waste samples based on PP and PC can be condensed with the formation of liquid fraction, representing the hydrocarbons with boiling temperature up to 400 ^{o}C and carbon material – pyrolytic carbon similar to semi-coke. The nondensables also have calorific value and pertain to medium-calorific fuel with such main compounds as: carbon oxide, C_nH_{2n+2}, H_2, CH_4, and can be used for heating pyrolysis furnace.

In order to obtain activated carbons, pyrolytic carbons were subjected to the additional activation in carbon dioxide medium at 900 ^{o}C. Influence of burning degree on sorption characteristics of carbon sorbents were investigated.

Main sorption characteristics of obtained samples of activated carbons with 60% burning degree in comparison with well-known brands of activated carbons are presented in table 2.

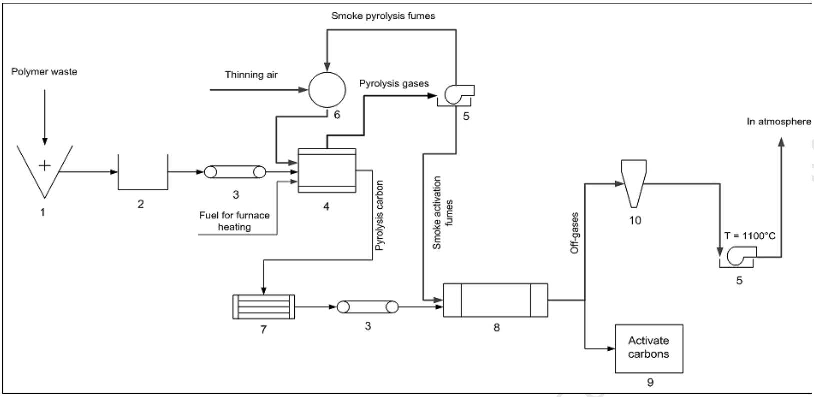
Table 2. Comparative characteristic of carbon adsorbents samples and well-known brands of activated carbons

Characteristic	Activated carbon - PP	Activated carbon (Sorber brand)	Activated carbon - PC	Stone activated carbon (КАУ-1)
Volume of micropores, *Vми*, cm^3/g	0,25	0,19-0,22	0,37	0,35-0,41
Volume of mesopores, *Vме*, cm^3/g	0,10	0,1-0,15	0,04	0,10-0,15
Volume of sorption area, *Ws*, cm^3/g	0,3	0,30-0,35	0,41	0,45-0,56
Cumulative volume of pores, cm^3/g		0,8-0,9		
Adsorption activation by iodine, %	63	60	91	103
Clarifying capacity by methylene, mg/g	201	---	183	260
Apparent density, g/dm^3	210	240	-	370
Ashes content, %	3,9	7	3,0	4-7
Abrasion resistance	61	60	-	89

Crushed low-ash carbon sorbents with a developed surface (600 m^2/g) similar to well-known brands of activated carbons are formed within activation of PP-based samples. Finely divided carbon adsorbents with a developed microporous structure are generated when activating PC-based samples. Analysis of sorption characteristics of carbon sorbents samples allows advising its use in wastewater treatment.

On the base of received data and calculated material balance, it is proved that processing of 1 ton of PP permits to obtain 720 kg of liquid fuel, 140 kg of pyrolysis nondensables and 60 kg of carbon low-ash sorbent. Thermal polymer processing could be fulfilled in autothermal conditions.

Laboratory tests of polymer processing allowed developing thermal module for activated carbons pyrolysis and activation, ensuring full utilization of heat and environmental safety (Fig. 1). Polymer materials waste are minced in cracker and are entered from storage bin to stationary pyrolysis muffle furnace. Initial heating of the furnace up to 500 ^oC is realized due to liquid and gas fuels burning. After implementing furnace in operating duty, its heating is carried out with the use of burning gases, generated within waste thermal destruction.



1 – cracker; 2 - storage bin for crushed waste; 3 - conveyor belt; 4 – pyrolysis furnace; 5 – burner; 6 - thinning cell; 7 – condenser for pyrolysis carbon; 8 - rotary kiln for activation; 9 – collector for finished product; 10 – cyclone

Fig. 1. Scheme of thermal module for polymer waste processing

The temperature of pyrolysis gases in thinning cell has to be reduced up to 700 ^{o}C before conveying to the furnace. Pyrolysis carbon is discharged from furnace to condenser, and then is conveying in furnace of activation - rotary kiln. Activation is fulfilled at 900 ^{o}C in smoke fumes medium. Rotary kiln for activation is equipped by secondary combustion cell, pyrolysis furnace – by input heat-transfer material unit. Activation off-gases are burned at temperature not less than 1100 ^{o}C for full oxidation of organic admixtures.

Investigations for the possibility of using chemical activation within PC waste processing (ester of carbonic acid) were carried out in order to simplify developed scheme and to reduce power inputs.

PC waste samples were processed by potassium hydroxide in specified proportion (from 0.5-1). Thermal processing was fulfilled in two stages: carbonization at temperature 430 ^{o}C during 30 minutes in muffle furnace with the heating rate 20 ^{o}C/min. with the following activation at 800 ^{o}C.

For most, influence of preliminary reagent processing of PC waste on formation of samples porous structure was examined with the view to accelerate carbonization, to reduce power inputs and to simplify technology. Substances with high oxidizing and dehydrating ability, namely concentrated sulfuric and nitric acids, 60% phosphoric acid, were used as reagents [7, 8, 9].

Influence of reagent dose, processing duration and temperature on the formation of porous structure was investigated. Chemically processed samples were subjected by vapor activation at temperature 600-800 ^{o}C.

Quality control of obtained sorption materials was carried out by sorption activity on iodine. Surface area and micropore volume of samples were determined with Sorbi-MS according to the BET method and t-method of de Boer and Lippens. Samples characteristics obtained under optimal terms in relation to well-known activate carbon under brand Sorber are presented in table 3.

Table 3. Characteristic of porous structure and sorption characteristics of activated carbons samples on the PC base

Characteristic	Activated carbon – PC - HNO_3	Activated carbon – PC - H_3PO_4	Activated carbon – PC – KOH	Activated carbon (brand Sorber)
Adsorption activation by iodine, %	560	480	650	620-650
Specific surface on BET, m^2/g	550	200	436.4	689.0
Specific surface by t-method, m^2/g	180.5	136.1	259.2	425.9
Volume of micropores by t-method, cm^2/g	0.119	0.08	0.129	0.142

According to the presented data, preliminary processing of samples by nitric acid with the following vapor activation at 700 ^oC and permits to obtain samples similar to well-known brands of activated carbons. Besides technological scheme is simplifying considerably and energy inputs are reducing.

Conducted complex investigations allow developing physical and chemical bases for processing polymer waste on PP and PC base with obtaining sorption carban materials and liquid fuel.

Developed approaches and methods of polymer materials processing permit to reduce environmental impact, as a result of tonnage waste utilization, and to obtain final products: sorption materials with required characteristics and liquid fuel.

REFERENCES

[1] Greg C. & Sing K. Adsorption, specific surface, porosity: Transl. from English. 2^{nd} edition, Russia, p. 114,1984.

[2] Kinlet H. & Bader E. Activated carbons and its industrial use: Transl. from German, Russia, p. 216,1984.

[3] Surkov A.A. & Makhles R.M. & Glushankova I.S. & Dyakov M.S. Thermal processing of polymer waste with obtaining liquid fuel and nano-sorption carbon materials, Environmental Protection in Oil and Gas Industry, No.7, pp 9-12, 2011.

[4] Parra J.B. & Ania C.O. & Arenillas A. & Rubeira F. & Pis J.J. Texture development during activation of carbonaceous materials derived from polyethyleneterephthalate. Abstracts, Intern. Conf. on Carbon, Oviedo (Spain): July 6-10, 2003.

[5] Laszlo K. & Szocs A. Surface characterization of polyethyleneterephthalate (PET) based activated carbon and the effect of pH on its adsorption capacity from aqueous phenol and 2,3,4-trichlorophenol solutions. Carbon 2001.

[6] Mui E.L.K. & Ko D.C.K. & McKay G. Production of active carbons from waste tyres – a review, Carbon, vol. 42, pp 2789-2805, 2004.

[7] Wang Q. & Liang X.Y. & Qiao W.M. & Liu C.J. & Liu X.J. Preparation ofpolystyrene-based activated carbon spheres with high surface area and their adsorption to dibenzothiophene, Fuel Processing Technology, vol. 90, pp 381-387, 2009.

[8] Hayashi J. & Yamamoto N. & Horikawa T. & Muroyama K. & Gomes V.G. Preparation and characterization of high-specific-surface-area activated carbons from K_2CO_3-treated waste polyurethane, Journal of Colloid and Interface Science, vol. 281, pp 437-443, 2009.

[9] Stavitskaya S.S. Influence of certain modifying additives on structure, sorption, and catalytic properties of activated carbons, Russian Journal of Applied Chemistry, vol. 83, No 11, pp 1761-1769, 2010.

LANDSCAPE CHANGES IN THE CULTURAL LANDSCAPE OF NORTH-WEST BOHEMIA

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ABSTRACT

The European landscape and its heritage surely correspond by their characters into the cultural landscape that develops for thousands of years. Each phase of landscape development is characteristically reflected in the current landscape. There are many specifics elements of cultural landscape, for example castle gardens and parks. In the Czech Republic there exist over 800 castles. Construction of a dense network of aristocratic residences has its historical and social roots. In their building there often coincided our beautiful and diverse nature. Therefore, most of the castle buildings are connected with their neighborhood and it makes together a unit.

On the northwest of the Czech Republic there are large deposits of brown coal. This fact caused that many villages and towns, as well as open countryside were already destroyed. Today, there exists a will, to restore this destroyed landscape and to return of the life into it. It is desirable to restore it and bring back landscape elements that have been destroyed - historical-cultural elements. Parks and gardens are ideal segment that can be recovered and have its cultural, aesthetic, as well as ecological importance in the landscape.

We deal with parks in the northwest of the Czech Republic, which were completely destroyed due to mining or have been impacted by mining directly or indirectly. We monitored their progress from year 1841 to the present time. It is possible to make this research due to unique historical maps of stable cadastre and historic aerial imagery and mapping, and at last but not least due to the field mapping. We focus on the distribution of vegetation in the park or garden, the location of the park in the cadastre and land use of the whole cadastre and of the region.

Keywords: Landscape changes, cultural landscape, castle park and garden

INTRODUCTION

Historic parks and gardens are a mixture of elements which are characteristic for different periods. This points their age, development and thus the changing fashion in time. Historic parks and gardens, however, require special management and activities suitable for dignified and cultural monuments. The most important functions that could be undermined by improper access include: providing shelter for wildlife, provide quiet recreation, education source, the source of valuable "green network" and economic uplift of the region, which is due to historic parks and gardens more attractive from tourism point of view [1] .

Construction of a dense network of aristocratic residences has its historical and social roots. In their construction there often co-decided our beautiful and diverse nature [2].

Therefore, most of the castle buildings are connected to their surrounding and form a single unit with it. Gardens and parks are an integral part of Czech cultural landscape. They enrich its structure, character and diversity. They also form a unique record of social, cultural and economic changes. To demonstrate this, we use as an example the complex of gardens and the castle park Jezeri in North West Bohemia.

Park and Garden as a specific part of the landscape

The word "park" comes from the Persian fleet "pardes", which was first used by the Greek writer Xenophon (430-355 BC). [3]. It is specifically and knowingly shaped green landscape with emphasis on the artistic effect which often nicely complements the exceptional real estate space. Novakova [4] observes the definition of a park rather from its recreational function, and says that it is a specialized, continuous and spatially defined unit of greenery, which aims to create optimal conditions for active and passive form of relaxation in a natural environment. Otruba [5] agrees with this definition and as a landscape architect he adds that the resulting work is an artistic creation activity which subject to opinion changes in the time period.

Otruba [5] speaks about one of the oldest elements of gardens which are sacred fountains, groves, caves and trees. Garden area is usually defined by a fence or ditch. Most people grow plants in their gardens, but it is possible that we can find here a swimming pool, pergola, fireplace and other devices intended for regeneration and relaxation.

Pacakova [3] defines a historic garden as a work constituting a major stylistic development series, which is an integral part of the castles, palaces, monasteries, palaces, town houses, villas and urban agglomerations. Otruba [5] presents a continual gardening creation and creative process which must never stagnate. He considers it as a sad fact, if a garden must be protected against vandalism by fence or wall. Ideally, garden should pass freely in the countryside and vice versa.

Garden expresses the close relationship between civilization and nature. It is perceived as a appropriate place for thoughts or dreaming. Everything should have its own place in the garden. There has to be given freedom to trees and space for flowers. So, that human could enjoy all of it.

Care of historic gardens solve at international level the Charter of Florence which was declared by ICOMOS (International Council on Monuments and historical sites) at the UNESCO in 1981.

Styles of parks and gardens

Park and garden styles developed in parallel with architectural styles. Each style has its own characteristics (Table 1)

Table 1: Summary characteristics of gardens and parks

TYPES OF GARDENS AND PARKS	IN RELATION TO THE COUNTRYSIDE	AREA, LOCATION	IMPORTANCE	MAIN CHARACTERISTICS
Midieval garden	closed	Little area, sometimes out oft he castle complex	Mainly productive, less ornamental	Regular beds with one species of plants well, fountain - symbol of life, a tree - a symbol of resurrection, turf benches, arbor vines, a stone table, gloriette
Renesance garden	Closed, view of the landscape	Little area in the castle, bigger out of the castle	Productive, collections of ornamental plants from foreign countries, social function	Regularity, following axis, symmetry, balance, terraced fountains, wells, pools, reservoirs, fountains, cascades hedge, an arcade, giardinetto, a maze of statues, sculptures, ceramic vases, shaped trees,ballroom, greenhouses, an orangery, an aviary, cages with animals
Mannerism garden	Connection with forests and deer-parks	Little area in the castle, bigger out of the castle	Productive, collections of ornamental plants from foreign countries, social function	Similar to the formation of Renaissance gardens, formation along the longitudinal axis of the fountain, fountains, cascades, water organ grotto, nymfea, Exedra, Teatro, pergolas, mechanic puns and mechanical movements
Baroque garden	Open to the countryside	Large areas	Representative sicial	Highlight of axis, pools, ponds, canals, fountains, waterfalls, water organ, brodery, parterre, alley, forming a cut vegetation, sculptures in motion treillage, Belvedere, eremitage
English park	Open	Large areas	Relaxation and social function	Asymmetry, irregularity, simple composition modeling terrain, riverbeds and streams., large lawns, domestic trees, solitary trees, pavilions
Landscape natural park	Open	Large areas	Collection of exotic plants and trees common feature relaxation function	Same as the English park, also ornamental vessels, baskets with plants, aviaries, caves, Summer Palace, the ruins of castle, tombs, monuments, statues, verse inscriptions

Source: [7, 8, 3, 9]

Specifics of rated landscape

Surface mining is an activity that can occur almost everywhere [8] and around the world there are seriously disturbed cultural landscapes by it [9]. It's not just a destruction of natural systems, but also irreversible aesthetic and spatial changes and loss of cultural landscape values. The brown coal is the most important resource of energy in the Czech Republic. Raw material extraction directly and indirectly changed the character of the landscape of large areas [10]. The dynamic equilibrium of the original landscape is replaced by surface mining and in particular supports the development of new ecosystems in areas of Sokolov and Most [11]. Post-mining landscapes are often be left and abandoned.

An important peculiarity of the area is three times repeated displacement of the landscape during the 20th century. The first displacement came in 1938, when the Munich Agreement that undergo the border of Czechoslovakia to German Empire. A further displacement occurred after the Second World War, when they were shunted around 3miliony German-speaking people. The third wave came in 1948 with the Communist government and the building of the Iron Curtain. It was up to ten kilometers zone along the German and Austrian border, where entire villages were razed [12]. Previously cultivated and cultural landscape became gradually abandoned and neglected.

METHODOLOGY

The area is located on the northwest of the Czech Republic (Figure 1) in three regions, the Most, Sokolov and Doupov. Due to its rich history there is abundant network of castles, manor houses and monasteries, which are connected to the surrounding landscape by parks and gardens. Each park and garden has its own specific history and development, which was influenced by many factors, despite the social changes to the mining of brown coal.

Figure 1: Distribution of parks in the north of the Czech Republic

source: Helena Justová

Most and Doupov area

Area of interest is part of the Usti Region. Its natural conditions are very diverse and they strongly influenced the settlement and economic land use. West part of the Region is situated on the border with Germany. There are sparsely populated Ore Mountains. Towards the interior of the Czech Republic, Ore mountains fall steeply to North Czech Coal Basin area which has significant reserves of brown coal, and thus also a significant concentration of industry [12].

The Usti region is the most represented land use the arable land with 34.9%. This is followed by forests with 29.8%. The largest watercourse in the region is the river Elbe, which it enters into a deep canyon valley called Porta Bohemica. The area of the Usti region also includes a complex of gardens and parks Jezeri.

Sokolov area

Sokolov Basin belongs to the Ore Mountains block of the Bohemian Massif. The first mention of the brown coal mining dates back to 17 century. Before, there was a fertile agricultural area [13]. The main axis of the Karlovy Vary region is Eger River, which flows from southwest to northeast through the large depression of the North Coal Czech Basin.

SOURCE DATA

Imperial prints of stable land

Imperial prints of stable land are compulsorily made color copies of maps of stable land to be archived in a central archive of the land register in Vienna. These prints were provided by numbers of plots and drawn in the scale of 1: 2880. Mapping work in the Czech Republic was done during the years 1826 - 1830 and 1837 – 1843. The reason was a simple and equitable property tax assessment [14]. Maps contain valuable historical information about represented ecosystems and important spatial properties [15].

Aerial images

The Czech Republic has a unique and very valuable data source in the form of historical aerial photographs. It is a black and white aerial negatives acquired since 1935 continuously every 10 years until 1990 for military needs and the needs of civilians, mostly state-owned enterprises and organizations [16].

Current orthophoto maps

The latest available imaging of the area of our interest took place in 2007. Maps are available in a GIS environment using IMS and WMS services, provided by the Czech Environmental Information Agency [16].

Old maps and aerial photographs interpretation

Geographic data are displayed as map layers that contain only one data type (point, line or polygon). In our case, we worked with surfaces, so the polygons, which were created on a raster surface bases. Polygonization took place in the ArcGIS 3.9.

RESULTS

The complex of castle gardens and parks (Arboretum) Jezeri.

Cadastral area Jezeri is located in the Usti region, on the boundary of Chomutov town and Most town cadastral area. Sloping area has the lowest dimension to 228 m., maximum 921 m above the sea level. As we can see in stable register maps of the cadastral territories, there was inhabited by approximately one-tenth of entire area. These were just a very steep slopes of Ore mountains, which prevented the expansion of settlements at higher altitudes. Just the castle Jezeri was composed in this difficult terrain.

To create the fantastic scenery there were used stands the original home of trees (oak, beech, hornbeam, lime, etc.) in the arboretum. After there were added cultivars of ornamental and exotic trees. Among the rare specimens of species included eg Castanea sativa, Cercidiphyllum japonicum, Liriodendron tulipifera, Platanus hispanica, torminalis Sorbus, Magnolia sp. One component of arboretum was the 1000 year old oak Albrechticky which existed up to the 60th the 20 century [17].

Castle Park and Arboretum have changed dramatically over the past 150 years. The picturesque surroundings of the Jezeri and the building plans of Lobkowicz family allowed extensive landscaping in the 1st half of the 19th century. An English park, tree nursery, deer-park and arboretum changed ferocity of the Ore Mountains base into the picturesque and romantic atmosphere with thematically tuned corners. Their present appearance is very different if we compare it with its state in the second half of the 19th century. Arboretum use to be a place for taking a rest but it was also a showcase for valuable trees. Some of them survived until today.

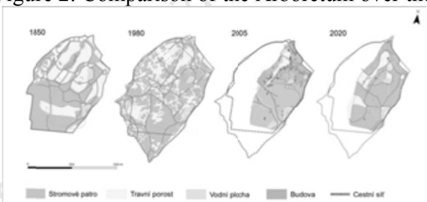
Village Jezeri and other municipalities doesn´t exist anymore. This is due to extensive surface mining of brown coal since 2nd half of the 20th century. As the mining occurred, in the southern part of the Jezeri cadastre, the complex area of rare arboretum was reduced as well as gardens, fewer arable land, meadows and orchards. English landscape park was located at the foot of Castle Hill from the extinct settlement of the Jezeri to Albrechtice. It occupied an area of 50 ha in 1838. Composition of arboretum naturally followed the landscaping of surrounding areas. The park consisted of a large meadow areas which were supplemented by three ponds fed by water of Sramnickeho and Albrechtickeho stream. Some of the pits were revived by floral plantings, or fountains [18].

After the 2nd World War, due process of brown coal surface mining method, there was a gradual devastation of the entire area around the castle. The danger to Jezeri, particularly in the gardens, were landslides caused by the opening of the Ore Mountains base to huge quarry mining. These changes, which occurred in the second half of the 20th century continued with liquidation of the lower part of the park and the 70th years. It was even considered for disposal of the castle. The idea was abandoned in 1987.

In connection with mining there was a will for cancellation of conservation of the castle Jezeri. Protection was abolished at the top of the park in 1985. Several specimens of rare trees (300 years old lilac and magnolia) were replanted to the park in Krasny Dvur. The rescue operations have negligible value compared with interventions that were performed during the liquidation of individual parts of the park. The park was declared as monument until 1990. Unfortunately, interventions lowering historical and aesthetic value, took their place until 1990, too.

Original composition is almost slurred on currently situational display. From architecturally a very interesting solved the park it has become almost indistinguishable from the forest. When comparing the arboretum conditions (Figure 2) in each year demonstrates the significant reduction in diversity, division and continuity of individual parts of the arboretum. Gradually decreasing the length of road network.

Figure 2: Comparison of the Arboretum over the past approximately 170 years



Zdroj: Justová Helena

The castle was abandoned since the first half of the 20th century. That is the reason why French parterre garden were not preserved. Also important buildings such as greenhouses are gone. Grassland rapidly decreased by 95%. There were 16 ha of grassland in the 19th century. Their representation has fallen to less than 1% in 2005. Forest stands thinned in comparison with 1980 by 25%, but with the reduction of total area of arboretum there is still preserved most of the area of forests, which also gradually grown, so has increased self-seeded trees and vegetation cover. The planned elimination of these self-seeded and old trees which have been statically disturbed will not change significantly the final area of forest formations. Intended recovery of Jezeri complex applies only to its southern tip. The reclamation plans also include the area of arboretum.

The total area which ultimately passes through rehabilitation, count to 110 ha which a tenth of the total area of the original land surface mostly consists of so called "other vegetation". These lead to forests that naturally build on the current forest. Only 3.6 hectares will be left to natural succession.

The surface mining problems are associated to the residual pit which in this case will be flooded. Created lake with an area of 680 ha and complex of Jezeri castle will be again above the lake.

Conclusion

Data Processing in GIS allowed further understanding of the historical development in the Jezeri cadastre that has undergone of dramatic change over the past 150 years. We could probably see this trend also in other cadastres which borders directly with areas of surface mines. The Jezeri castle is special and unique thanks to its deep history. There is the apparent reduction in diversity and human potential departure which we can see on the processed maps. Loss of forest area, arable land, orchards and urbanized area is easy to remark from 2 half of the 20th century. The results of reseach show that the influence of advancing mining decreased diversity of landscape structure. Since the second half of the 20th century decreased acreage of meadows and gardens as well as number of houses. Albrechtice village which is situated in the most southern tip of cadastre as well as Jezeri settlement were displaced torn down due to extraction procedure. We can see apparent approach of surface mine towards the foot of the Ore Mountains already on maps dating from 1978. This trend was maintained until the 90th of the 20 century. Mining stopped in notional boundary under the Jezeri castle and it is questionable whether the mining will be stopped in 2020 or if it will continue over the existing mining limits. In this case the Jezeri castle and the arboretum won´t be at risk, but with the permission of extraction in II. phase in this area would extended until the year 2068.

It will take a long time to restore forests damaged by emission. The reclamation of active mining pit will also take some time. The most important of all is the attitude to the landscape. Reclamation which will respect the landscape as a living organism has the ability to reform the Jezeri cadastral area and its surroundings.

Acknowledgement

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REFERENCES

[1] HISTORIC SCOTLAND Alba Aosmhor. Gardens & designed landscapes [online]. 2012, 11.4. 2012 [cit. 2012-04-11]. Dostupné z: http://www.historic-scotland.gov.uk/

[2] HIEKE, K. Czech castle parks and trees. Prague: Pergamon Press,1984, 460 p. ISBN 04/40-07-036-84.

[3] PACÁKOVÁ, B. Parks and Gardens in Bohemia, Moravia and Silesia. Second edition, Prague: Libri, 2004, 526 p. ISBN 80-727-7279-1.

[4] NOVÁKOVÁ, M. Retrospective and perspective Husovy orchards and park in Sokolov: The concept of planting. Sokolov. Sokolov, 2006.

[5] OTRUBA, I. Garden design: creating gardens and parks. First edition, Šlapanice: ERA, 2002, 357 p. ISBN 80-865-1713-6.

[6] KUPKA, J. Greenery in the city's history. First edition, Prague: Publishing House Czech Technical University, 2006, 146 p. ISBN 80-010-3443-7.

[7] VLČEK, P. Encyclopedia of Czech monasteries. First edition, Prague: Libri, 1997, 778 p. ISBN 80-859-8317-6.

[8] BURLEY, J. Post-mining land-use reclamation: an introduction from a planning and design perspective. In: Burley, J. [eds.] Environmental Design for Reclaiming Surface Mines. 2001

[9] WALKER,L.R. et WILLIG,M.R. An introduction to terrestrial disturbances. In:Walker, L.R. (Ed.), Ecosystems of Disturbed Ground, vol. 16. Ecosystems of the World, Amsterdam, 1999, pp. 1–16.

[10] KOVÁŘ, P. 2004. Industrial Deposits of Abandoned Sedimentation Basis – Technology of the Origin and Vegetation. In: Kovář, P. (Ed.). Natural Recovery of Human-Made Deposits in Landscape (Biotic Interactions and Ore/Ash-Slag Artificial Ecosystems). Academia, Praha, Czech Republic.

[11] ŘEHOUNEK J., ŘEHOUNKOVÁ K., PRACH K., Ecological restoration of areas disturbed by mining and industrial repository.Calla, 2010,Czecz Budejovice.

[12] BARTOŠ, L. et al Environment - the environment of each of us?: Czech Republic, Prague: CENIA, 2009, 130 p. ISBN 978-80-85087-71-0.

[13] PROKOP, V. Chapters from the History of Sokolov. Sokolov District Museum: Sokolov, 1994, 273 p.

[14] TRPÁKOVÁ, I. Reconstruction of historical land use Sokolov - landscape in the mirror stable cadastre maps. First edition, Kostelec nad Černými lesy: Lesnická práce, 2009, 107 p. ISBN 978-80-87154-89-2.

[15] ČÚZK, 2009: Czech Office Geodesy and Cadastre. Imperial prints of stable land. 1:2880. The 1841st Prague: COGC, 2009. Available from: www.cuzk.cz

[16] CENIA, 2011: Czech Information Agency Environment. Orthoimagery - Contamination. The 1953rd Prague: CENIA, 2011. Available from: http://kontaminace.cenia.cz

[17] FÉR, F. Assessing the growth and health of trees in the "Arboretum Lake" and their awards: Expertizijní expression. Prague: CULS Prague - Suchdol, 2004.

[18] MINING PROJECTS TEPLICE OJSC Aggregate plan remediation and reclamation of the quarry CSA - Update 2008 - The accompanying message. Teplice, 2008.

LOCATION OF A LANDFILL FOR HAZARDOUS WASTE IN THE REPUBLIC OF MACEDONIA - PLANNING AND DEVELOPMENT

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ABSTRACT:

One of the basic problems in Macedonian industry is disposal of the hazardous waste from the mining industrial complexes. Choice of locations for deposition of the dangerous waste is priority for future development of Macedonian economy and it is a subject of many public hearing. Today we are witness daily debates, discussions, opinions of professional and political public, directly related to the location of future sites for the disposal of solid waste. This paper is an attempt to analyze the current state of the places - future sites for hazardous waste landfills, their importance of economically and from an ecological point of view. Minimizing the negative impact of landfills for solid waste is imperative for the further development of a region or area in the Republic of Macedonia.

Keywords: landfills, hazardous waste, location - allocation methods, choice

1. INTRODUCTION

Environment is treated as a complex and dynamic system, where each element directly or indirectly affect other elements of the system, which itself suffers change, is exposed to everyday processes in space, of which the dominant influences on qualities have: populating the area, urbanization, production processes and industrialization, agriculture, development of traffic, changes in use of land use, the use of natural resources and dispersion of infrastructure corridors. The basic conflicts in the environment, which are also characteristic for Macedonia, are:

- Deepening the differences between developed and undeveloped areas;
- Effects of industrialization on some basic natural processes;
- Capture valuable parts of space, their no rational, extensive, or spontaneously use;
- Excessive concentration of population in areas with no adequate or inadequate functional organization and infrastructure;

- Imbalance between material production and natural assumptions about quality of life, air, water, space for recreation and others.

The paper will present an analysis of potential sites for hazardous waste landfills in the Republic of Macedonia. Finally, the conclusion will be given and a proposal for further research in the field of location - allocation methods for determining the optimum sites for disposal of hazardous waste.

2. SPATIAL PLAN OF REPUBLIC OF MACEDONIA IN TERMS OF LOCATIONS OF LANDFILLS

Spatial Plan is a managed document, in character is a integral development project which helped to define the spatial organization of state, goals and concepts of spatial development of certain areas and conditions for their realization. Spatial plan is defined as a document with lasting value, and will align with all development documents which will be prepared and bring.
Based on perceived global conditions and trends in the country, the Plan defines the primary goals for solving problems in the organization, use and spatial development and environmental protection [1]. Spatial Plan is with a long-term character, i.e. the timeframe to 2020. But is based on the principle of flexibility and adaptability of developmental processes and structural changes in the near future will occur.

2.1 BASIC GOALS AND ASSUMPTIONS OF THE PLAN

The main strategic goal of the Spatial Plan of Macedonia is achieving a higher degree of overall functional integrity of the state space, and providing conditions for significantly more infrastructure and economic integration with neighboring and other European countries. Long term development of the country will largely be determined by the changes to be made in the political system and the creation of stable political conditions in the country, implementation of radical activities in the economic system, increasing the reproductive capacity of the economy, higher economic efficiency, qualitative changes the socio-economic structure, development of villages and areas, saving and rational use of natural resources, protection of agricultural lands**.** The basic strategy of the organization and use of space in terms of supporting the development of the economy consist such solutions in the space that allow:

- Greater attractiveness of the area and a wider choice of solutions, from aspect of investing in the domestic and foreign capital;

- Protection of natural and man-made resources and wealth, in terms of economic interests for the preservation of environmental quality;

- Transport, information and control connection as a prerequisite for efficient production and social development;

- Development of an information system for the space and environment;

- Location flexibility in making investment decisions.

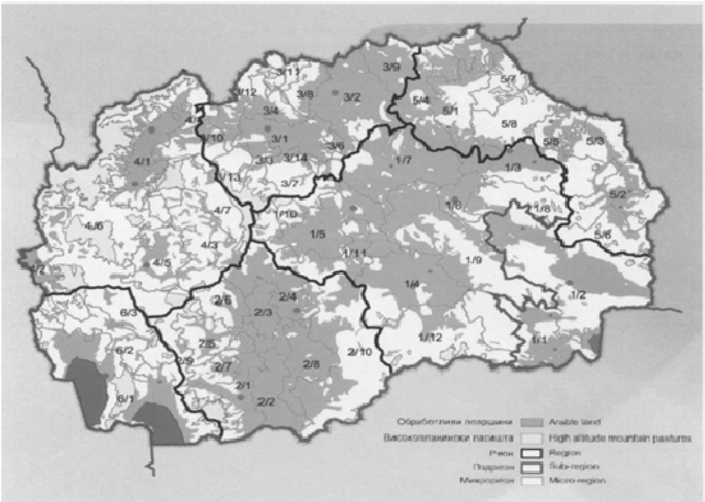

Fig.1 Use and protection of natural resources-farmland

3. LEGISLATION AND WASTE MENAGMENT

This Law regulates the management of waste, principles and objectives waste management, plans and programs for managing waste; rights and obligations of legal and natural persons in connection with waste management, requirements and obligations of legal and natural persons, manufactured products and packaging and that the end of life cycle environmental burden, ways and conditions under which it can be done collection, transportation, treatment, storage, processing and disposal waste import, export and transit of waste, monitoring, financing and supervision of waste management. management. Law of waste Management classifies three types of landfill: hazardous, non-hazardous and inert waste.

3.1. STRATEGY FOR WASTE MANAGEMENT

Strategy for waste management reflects national policy in the field of waste management and represented the base for preparing and implementing integrated waste management, which will be effective in terms of cost. With this strategic document, the Republic of Macedonia defines the fundamental directions in the field of waste management for the next 12 years (2008-2020) [1]. The strategy determines the basic guidelines for the gradual establishment of a system for waste management, and basic principles of sustainable use of natural resources. The success and effectiveness of the implementation of the strategy depends from capital investment and space limitations, primarily in the proper balance between the legal, institutional, organizational and sociological particular economic / financial instruments. Strategy for waste management in the Republic of Macedonia was adopted by the government in 2008.

4. SELECTION OF LOCATION FOR SOLID WASTE

The level of environmental awareness and waste problem in Macedonia is on the lowest level [2]. Most of the municipal solid waste and other collected waste are disposed without prior treatment of municipal landfills such as: old tires, car batteries, car oil and other waste components. Landfills are working without work permits, without any techniques that apply to landfills and no regular monitoring in terms of environmental impact. There is no record of delivered waste, not any visual inspection of the characteristics of waste that is deposited. Deposition of mixed hazardous and not hazardous waste and incineration of municipal waste, waste plastics plant tissues and the open space, represent the most serious risks and consequences for the environment. Landfills in our country are often improperly managed and do not pleased minimum standards regarding the environment and human health. Municipalities are generally responsible for organizing an effective system for managing of solid waste on their territories, except for hazardous waste, which is under responsibility of legislation is the state. The management of waste in our country is still a problem because the quantity of waste is increasing steadily, and legislation in some cases is poorly implemented. In recent years in Macedonia were developed several strategic and planning documents (Legislation in the Republic of Macedonia in the part of waste management) that analyzed the issue of managing hazardous waste. The first step in realizing the goals should be preparing a feasibility study which will analyze the performance of the natural area of the Krivolak, in geographical boundaries of an area of about 400 km^2. The choice of this region is the result of complex analysis based on modern criteria for selecting these locations, using the results of previous research in this area [3]. Also, the choice of analysis of this region, respected in the settings of the study of the Spatial Plan of Republic of Macedonia, where ranking is made of space in the country in terms of distribution of water resources, water management, natural heritage, agricultural areas and areas with mineral and geothermal water. As basic criteria for the analysis of the proposed region are used:

- Geological environment,
- Configuration of the terrain,
- Hydro geological characteristics of the environment,
- Seismotectonic characteristics,
- Presents of natural built objects,
- Potential resource,
- Concentration of population.

According to previous findings, the area of Krivolak has emerged as the most suitable from many aspects, for which priority is given to analyze a possible landfill site for hazardous waste to the Republic of Macedonia. This area has exceptional advantages, which ultimately means the integral protection of the environment and human health in terms of locating a landfill for hazardous waste and long-term function of the same. This is conditioned by the specific geological structure which is introduced with a homogeneous structure, then outstanding hydro-geological features that point to run without setting inside or negligible waters in the deep parts. These data are known from the period 1967-1972, when the area of Krivolak was research for oil. According to the technical documentation that results from drilling are not registered tanks of groundwater, nor changing geological conditions and the derived depths, giving a special quality of the area in relation to most priority criterion.

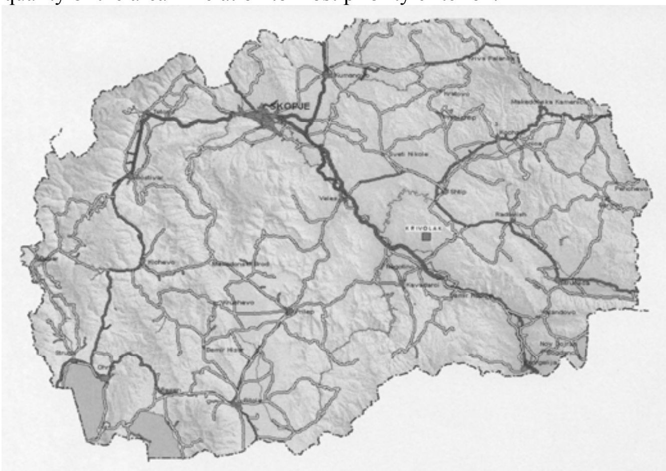

Fig. 2 Map of Republic of Macedonia with location of Krivolak

Agricultural land in the area and quality forest stands are not known, but most of it is an area of steppe, the local and semi-arid character. This atmospheric feature can be priced as a quality of space, because it is a unique phenomenon in country, but despite the eventual construction of the landfill will remain large areas with no disturbed original setting.

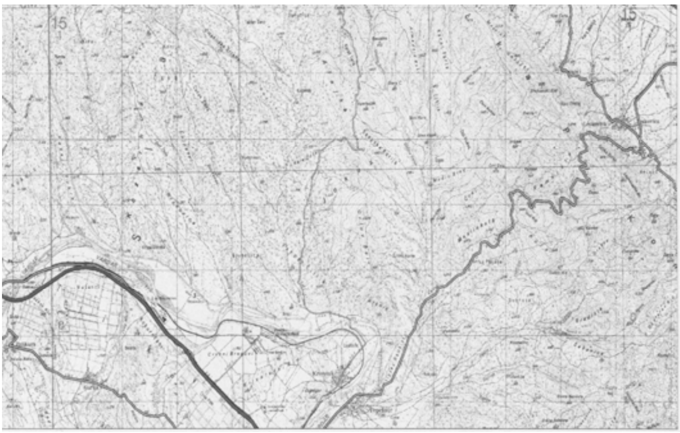

Fig. 3 Map of the area of Krivolak

Also, the hydrographical grid of the area is very poorly developed and practically represented by the Bregalnica and possible occurrences of temporary watercourses in conditions of intense atmospheric precipitation, which were in this area showed minimum. The concentration of population in this area is the lowest compared to the rest of the country; this area is populated as a area for military training.

5. DISCUSSION AND CONCLUSION

In Macedonia, the quantities, types and condition of hazardous substances has generated very little known. In other countries, where is established system for managing hazardous waste, we have found that this quantity is about 2% of the total waste.
Existing facilities and capacitates for treatment and disposal of waste are inadequate, legislation and standards are not applied effectively, and current practices of waste management contribute to air pollution, water resources and soil. In the world there are many technical and technological solutions for treatment and disposal of hazardous waste. In this paper, as already mentioned above, the construction of a landfill for hazardous waste is treated only in terms of function and successful implementation of planed decisions in the spatial plan for the provision of choice for a possible landfill site and the adoption of methodology and criteria for final selection of micro locations for landfill for hazardous waste [4]. According to the information for making this paper, area of Krivolak has ideal conditions for the construction of a landfill for hazardous waste. Taking into account the obvious environmental damage caused by past practice in the management of hazardous waste, it is necessary to begin preparation of feasibility studies for construction of a landfill for hazardous waste in the area of Krivolak.

REFERENCES

[1] European waste management- waste policy and legislation
[2] Strategy of waste management in Republic of Macedonia
[3] Waste- annual report from 2010 in Republic of Macedonia
[4] Practical guide to environmental legislation, REC 2007

MAPPING OF REAL VEGETATION IN ŠTĚPÁN RESERVE

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ABSTRACT

The paper deals with mapping of real vegetation in the Štěpán Nature Reserve between 2007 and 2009. The major objective of the survey is detailed phytosociological photography and mapping of real vegetation of the water column and littoral zone, including a study of the ground cover of the water body surroundings. The paper states basic characteristics of the Štěpán Nature Reserve, phytosociological survey methods and results of the plant community study along with work outputs. It also evaluates specially protected and invasive plant species occurring in the locality in question.

Keywords: Real vegetation, nature reserve, plant communities, specially protected plant species, invasive plant species.

INTRODUCTION

The nature reserve (NR) Štěpán (see fig.1) is found on the boundary of Děhylov municipality (Opava District) and the City of Ostrava. It is situated on the right bank of the Opava River, in its narrow river flat, 5 km ahead of the confluence with the Odra River [10]. The nature reserve includes a water body with reeds, sedge vegetation and communities of freshwater plants as well as wet alder groves, wood stands on the pond dikes and meadows of alternately wet stands [8].

Fig. 1 Štěpán Pond

The role of the nature reserve is to preserve a very valuable area in the river flat of the Opava River. The major subjects of conservation are water and wetland biotopes of a shallow pond and its environs colonized by specially protected species of plants and animals [3]. Rare wetland communities are connected with the Štěpán Reserve and the nature reserve is thus classified in the category of wetlands of supra-regional significance in the Czech Republic – the Ramsar Convention.

The area also pays a role of a supra-regional biocorridor within the Territorial System of Ecological Stability (TSES) [8] and makes part of European important localities ranked into the National List as the “Děhylovský Brook – Štěpán”. The protected species are a fire-bellied toad and European weatherfish [4].

MATERIAL AND METHODS

Phytosociological survey methods

The phytosociological data were obtained during three years in the locality in question, namely between 2007 and 2009. Information on the vegetation character was surveyed in the field in set sites distributed around the individual plant communities. A total of 81 study sites, the so-called phytosociological photographs, were distributed within the Štěpán NR and its protection zone, which had the character of squares or rectangles. The littoral was mapped by means of line transects. Each site was located by means of GPS and its basic characteristics were described (area size, altitude, slope, exposure). The individual sites were continuously studied during the overall vegetation period. In each study site details on the floristic composition, different layers, frequency and cover of the individual species were recorded. Inventories of all species in the study sites were made. Different vertical layers were recorded in wood communities (multi-storiness) and each layer was described for its total cover and the cover of the individual species. The total cover and the cover of the individual species were also determined in non-forest communities. The Braun-Blanquet cover-abundance scale was used to evaluate stratification (multi-storiness) of the vegetation and to determine the cover of the individual species [1]. The occurrence of both specially protected and invasive plant species was also mapped.

Zurich–Montpellier school of phytosociology was used to classify plant communities. The presence of diagnostic species was identified from the phytosociological photographs, on the basis of which a community was ranked into the relevant alliance, association or sub-association [5].

RESULTS AND DISCUSSION

Results of plant community studies

Within the survey of the Štěpán NR, a total of 231 plant species were found, out of which 13 were specially protected and 4 were invasive species. There were 19 alliances and 24 associations of plant communities distinguished.

Among wood stands dominant are oak-hornbeam groves of *Carpinion* alliance on the pond dikes, the eastern pond dikes having the character of linden oak-hornbeam groves. In wetter stands below the dikes there are bottom land forests of *Pruno-Fraxinetum* association, in waterlogged stands there are paludal alder groves of *Carici elongate-Alnetum* association. In patches there is an abundant occurrence of willow shrubs of *Salicion cinereae* alliance. Along the brook on the south-western edge of the nature reserve there are willow meadows of *Salicetum triandrae* association.

In the section called Žabinec there is an oat grass meadow of *Arrhenatheretum elatioris* association, onto which links an alternately wet thistle meadow of *Cirsietum rivularis* association from the south. On the "small meadow" in the northern part of Žabinec there is a meadowsweet heath with *Lysimachio vulgaris-Filipenduletum* association. The dominant part of the nature reserve is covered with species-poor reed stands of *Phragmitetum communis* association, among the reed stands there are patches of tall sedge communities. These are communities with dominant greater pond sedge (Carex riparia) and blister sedge (*Carex vesicaria*), followed by stands with purple small reed (*Calamagrostis canescens*) and reed canary grass (*Phalaris arundinaceae*).

In the pond's littoral there are patches of communities of manna grass of *Glycerietum maximae* association and stands of *Typhetum latifoliae* association with dominant cattail. In 2007 communities of tall-herb fens of *Oenanthion aquaticae* alliance were identified, which colonized the bare pond's bottom along the eastern dike, the north-eastern corner of the pond was colonized by stands with dominant arrowhead of *Sagittario-Sparganietum emersi* association. At higher water levels in 2008 and 2009 at the site of the communities, communities of duckweed plants of *Salvinio-Sporodeletum polyrrhizae* association developed. In the littoral of the Bezedný Pool communities of unconsolidated soils of *Carici-Rumicion hydrolapathi* alliance with dominant *Rumex hydrolapathum* were registered.

The survey also mapped fresh-water plant communities of *Nymphaeion albae* alliance. The Bezedný Pool in the south-eastern part of the nature reserve is colonized by a community of *Nupharo lutei-Nymphaeetum albae* association, and a community of *Trapetum natantis* association with dominant water caltrop (*Trapa natans*) then occupies a prevailing part of the pond's water surface. In the pond there are also few communities of submerged aquatic plants of *Parvopotamion* alliance, *Najadetum marinae* association and communities of free-floating submerged carnivorous plants of *Utricularion vulgaris* alliance, *Utricularietum australis* association. Water-logged ground depressions along the railway under the railway embankment are colonized by communities of duckweed plants of *Lemnion minoris* alliance, *Lemnetum minoris* association with dominant *Lemna minor*. Those depressions are concurrently colonized by shrub willows of *Salicion cinereae* alliance. In the locality the alliance of *Lemnion minoris* is further represented by *Salvinio-Spirodeletum polyrrhizae* association with dominant species of *Spirodela polyrhiza* and *Salvinia natans*. These communities colonize the pond's littoral in the eastern part and form thick stands in the reed fringes and fill the lagoons on the reed borders.

Fig. 2 Lagoon in the reed complex

In 2007 when the pond's water level was low it was possible to identify communities of bare bottoms of *Eleocharition ovatae* alliance, *Eleocharito ovatae-Caricetum bohemicae* association. The community colonized the lagoon's bare bottom on the reed boundary; later on, the stand was submerged and duckweed plant communities of *Salvinio-Spirodeletum polyrrhizae* association developed there (see fig. 2).

Communities of ruderal herbs were also identified in the Štěpán NR. The railway embankment is colonized by a community of *Echio-Melilotetum* association. The southern dike of the pond is colonized by nitrophilous fringe communities of perennial plants growing in wetter ruderalized stands. These are communities of *Aegopodion podagrariae* alliance, *Urtico-Aegopodietum* association with dominant *Urtica dioica* species.

The survey implies that the vegetation character in the individual years changed only slightly, dominant species remain stable in the communities and minor changes in the cover abundance result from natural fluctuations. Due to such fluctuations, species with a very low cover abundance, occurring only as few specimens, need not occur in the forthcoming years but may reappear in a longer time period. For example, this concerns *Carex pseudocyperus* which regionally ranks among severely endangered species. Its occurrence was registered only in 2007 as several specimens in the littoral of the pond and the Bezedný Pool. Later on, its occurrence was not confirmed, similarly to *Bidens cernua*, also in the littoral of the Bezedný Pool. When compared with previous surveys [7], [9], [10] it was discovered that between 1994 and 1995 the species were rather abundant there and they were also recorded in 2004. The results of this mapping thus point at possible vanishing of the species from the locality in question. A similar example is an endangered western marsh orchid (*Dactylorhiza majalis*) whose occurrence was neither registered this time and was stated as rare species in previous surveys [10]. Special examples are *Alopecurus aequalis, Oenanthe aquatica, Eleocharis mamillata subsp. mamillata* and *Carex bohemica*, from the regional point of view. These species form communities of bare bottoms; their occurrence was noted again only in 2007 when the pond's water level was very low due to absent rain falls and thus there were optimal conditions for such species. In the years after, the species could not be identified because of higher water levels and they were replaced by duckweed plant communities. When compared with previous surveys their occurrence was mapped in 1994 and 1995; in the survey of 2004 there is no mention of *Alopecurus aequalis* or *Carex bohemica*. The water level also affected the littoral communities in the Bezedný Pool where their species richness was considerably lower in the drier year of 2007.

Occurrence of specially protected plant species

The occurrence of specially protected plant species was evaluated according to Ministry of the Environment (ME) Regulation 395/1992 Coll., §1 – critically endangered, §2 – severely endangered, and §3 – endangered. Observed were also species classified in the Black List and Red List of Vascular Plants of the Czech Republic [6] and in the Red List of Plants of the Moravia-Silesian Region [11], [12]. The lists also state extinct or missing species (A) and taxa of various extinction risks (C). The survey also evaluated species in C category: found were species C1 critically endangered, C2 severely endangered, C3 endangered, C4 and rarer taxa requiring further attention - vulnerable. Certain species registered in the locality are also classified in section 5 (higher plants) of the Red Data Book of Threatened and Rare Plants and Animals of the CR and SR [2], Taxa stated in the Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats) and in the Washington Convention (Convention on

International Trade in Endangered Species of Wild Fauna and Flora) were also found [10].

Specially protected plant species in the studied area

On the pond's surface there are extensive vegetations of *Trapa natans* (water caltrop) (see fig.3), in the pond, in the reed fringe and the littoral there are patches of *Utricularia australis* (bladderwort) and *Najas marina* (spiny naiad). On the surface of the pond and of the Bezedný Pool *Lemna trisulca* (star duckweed) was also identified. *Salvinia natans* (floating fern) forms thick growths in the reed fringes, occurs in the pond's littoral and also fills the lagoons in the pond. *Nymphaea candida* (dwarf white water lily) colonizes the Bezedný Pool and *Hydrocharis morsus-ranae* (frogbit) was spotted in its littoral.

Fig. 3 Water caltrop (Trapa natans)

In 2007 several specimens of *Carex bohemica* and *Eleocharis mamillata subsp. Mamillata* (spikesedge) were observed in the north-western and improved part of the pond. In the littoral of the pond and of the Bezedný Pool there were several specimens of *Carex pseudocyperus* (Cyperus-like sedge) that year too. The water-logged area in the northern part of the Žabinec section is colonized by *Carex riparia* (greater pond sedge). On the eastern dike of the pond there is a straggly occurrence of *Ulmus minor* (field elm), and on the tree species on the eastern dike it is possible to come across *Viscum album* (European mistletoe).

Occurrence of invasive plant species

Occurrences of invasive plants were registered not only in the protection zone of the nature reserve but also in the special protection area itself. The following invasive plant species were discovered:

Impatiens glandulifera (Himalayan balsam) – occurs mainly in the protection zone of the nature reserve and the seed source is the littoral of the Opava River. In the nature reserve it was spotted in the surroundings of the Bezedný Pool and an extensive population colonizes also the ditch on the northern border of the special protection area (SPA). From there several specimens spread into the woods of the nature reserve as well as into the pond's littoral.

Solidago canadensis (Canada golden-rod) – colonizes the railway embankment and the elevated hill on the western border of the nature reserve. In the SPA there are only few straggly specimens on the dikes in the south-eastern and north-eastern corners of the pond and in the wood stands on the northern dike. Its occurrence was also recorded along the Opava River.

Impatiens parviflora (small-flowered touch-me-not) – occurs as straggly within the overall nature reserve, predominantly in wood stands as well as in the protection zone of the reserve and along the Opava River.

Quercus rubra (northern red oak) – within the Štěpán NR only few specimens were identified on the south-eastern dike of the pond.

CONCLUSION

The survey results provide detailed information on the character of vegetation in the studied area and confirm the significance of the area and the necessity of its protection. They may contribute to botanic surveys carried out in the past. It is the graphic representation of the evaluated data to which we attribute importance as the produced map of real vegetation pictures specific occurrences of the individual communities on the level of associations. The maps also locate occurrences of specially protected and invasive plant species. GPS orientation of the studied sites is also a great benefit. It will be possible to look up the sites in future and therefore, development of vegetation may be monitored in longer time periods. The results of mapping may be grounds for a further study of the locality in question.

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REFERENCES

[1.] Absolon K. et al. Metodika sběru dat pro biomonitoring v chráněných územích, Praha, pp. 70, 1994.

[2.] Čeřovský J. & Feráková V. & Holub J. & Maglocký Š. & Procházka F. Červená kniha ohrožených a vzácných druhů rostlin a živočichů ČR a SR, Vyšší rostliny, vol. 5, Bratislava, pp. 456, 1999.

[3.] Koutecká V. Přírodní rezervace Štěpán - plán péče na období 1998 – 2007, Krajský úřad Ms. kraje, odbor ŽP a Z, Ostrava, pp. 17, 1997.

[4.] Koutecká V. Hospodářské zásahy v PR Štěpán - Biologické hodnocení podle ustanovení § 67 zákona č. 114/1992 Sb. a §18 vyhlášky č. 395/1992 Sb., Krajský úřad Ms. kraje, odbor ŽP a Z, Ostrava, pp.42, 2007.

[5.] Moravec J. et al. Rostlinná společenstva České republiky a jejich ohrožení, Litoměřice: Severočeskou přírodou, pp. 206, 1995.

[6.] Prochazka F. et. al. Černý a červený seznam cévnatých rostlin České republiky (stav v roce 2000), Praha: Příroda, pp. 166, 2001.

[7.] Prymusová Z. & Stolarczyk J. Botanický a zoologický průzkum v PR Štěpán, Krajský úřad Ms. kraje, odbor ŽP a Z, Ostrava: KÚ – MSK, pp. 59, 2004.

[8.] Prymusová Z. Vegetace přírodní rezervace Štěpán, Vlastivědné listy – Matice Slezská, vol. 31, pp. 38-39, 2005.

[9.] Prymusová Z. Přírodní rezervace Štěpán. Závěrečná zpráva inventarizačního průzkumu botanického podle metodiky SÚPOP 1987, Krajský úřad Ms. kraje, odbor ŽP a Z, Ostrava, pp. 49, 1996.

[10.] Prymusová Z. & Stolarczyk J. Botanický a zoologický průzkum v PR Štěpán, Krajský úřad Ms. kraje, odbor ŽP a Z, Ostrava: KÚ – MSK, pp. 2-30, 2004

[11.] Prymusová Z. Červený seznam rostlin Moravskoslezského kraje, Zpravodaj Ostravského muzea, vol 10/issue 1, pp. 28-32, 2005.

[12.] Sedláčková M. & Plášek V. Červený seznam cévnatých rostlin Moravskoslezského kraje (2005), Časopis Slezského zemského muzea, vol. 54/issue 2, pp. 97-120, 2005.

METHODS AND MEANS OF EVALUATING THE PERCEPTION CONCERNING THE ENVIRONMENTAL CONDITION. CASE STUDY: THE URBAN ECOSYSTEM OF TÂRGOVIŞTE (ROMANIA)

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ABSTRACT

The paper highlights the role of participatory research in the evaluation of urban environment, through a theoretical approach, with examples drawn from a questionnaire applied in Târgovişte urban ecosystem. The main goal of the research was the evaluation of the perception and attitude of the population from the urban ecosystem of Târgovişte concerning the environmental condition. In order to achieve this goal, we have used the method of the social survey and the investigation instrument represented by the questionnaire.

The questionnaire, as an adaptable research tool, allows the collection of primary data by means of certain questions, structured according to well defined principles, so as to arouse the subjects' interest and to determine them to answer as sincerely and as clearly as possible to the questions addressed to them by means of it. Among the advantages of its use, one can enumerate: the thematic richness of the data that can be collected through it, an easy handling and processing, the possibility of administering it repeatedly on the same subjects or on different subjects, the capacity to collect both quantitative and qualitative information.

In order to respect the sociological procedure, the survey was carried out going through all the necessary stages, based on a critical analysis, which improved the operations: determining the theme, establishing the goals, preliminary documentation, elaborating the hypotheses, defining the concepts, operationalization, quantification; determining the sample, establishing the techniques and procedures to be used during the survey, putting together the working tools, pilot inquiry, constituting the inquiry team, drawing the calendar for the completion of the inquiry, collecting the data, checking on the information gathered and preserving the valid forms in order to process and codify the information; drawing a model for the data processing, data processing; analysis and interpretation of the information, drawing the inquiry report.

Following this questionnaire, we have reached the conclusion that the population is aware of the existence of the environmental problems, of the reasons that lead to their occurrence and of the present condition of the environment from the urban ecosystem of Târgovişte.

Key words: questionnaire, evaluation of the environmental condition, urban ecosystem

INTRODUCTION

The concern for the evaluation of the environmental state in an urban ecosystem is particularly important, the results of such analyses being able to lie at the basis of the socioeconomic development policies and strategies of the urban administrative-territorial units.

The methodological approach of the present study started from the principle according to which the environment can be understood as well as a mental construction[5], being imagined differently by different persons. The perception of the environment supposes a complex interpretative process, influenced by philters such as the subjects' age[1], gender differences, cultural and educational differences.

The studies on the perception of the urban environment are situated at the crossroads of the concerns from the area of environmental geography, social and cultural geography and urban geography. So, in order to obtain a correct image on the quality of the urban environment, one has to associate the objective and the subjective evaluations, taking into account both the "real town/city" and the town/city projected on a mental level[6] .

So far, the recent research concerning the perception of the urban environment has approached various aspects, such as: individual, cultural or group differences in the mental representation of the urban environment (Tomuletiu et al., 2010), representations on different scales (the whole town/ city versus its immediate vicinity), the modification of the perception of the urban environment throughout people's lives, the aesthetic preferences of the inhabitants of the urban area or the perception concerning certain elements of the urban environment (ex.: green areas – Gobster, 1995).

The study has been carried out in the urban ecosystem of Târgovişte Town (88,334 inhabitants in 2011), which, from a physical-geographic perspective, is part of the piedmont plain bearing the same name. The urban ecosystem appears as a local type of human ecosystem made up of the population's interaction with the complex set of the environmental factors. The urban ecosystem, functioning as an open system, needs to be studied as an important consumer of energy, matter and information; they get in or out of this system, which is the most dynamic of the ecological systems, because the urban human communities continually transform the environment in order to meet their current needs. The urban ecosystem of Târgovişte has gone through a process of continual change.

The main goal of the present paper has been to highlight the population's perception on the environmental quality in the urban ecosystem of Târgovişte, to identify the disfunctionalities present in it and to detect the ways of responsibilizing and getting the population involved in the sustainable management of the urban area. At the same time, in our approach, we have aimed to prove that the questionnaires are an efficient method for assessing the population's perception and attitude concerning the environmental condition, the results obtained highlighting the complexity of the urban ecosystem.

CONCEPTUAL BACKGROUND: METHODS AND MEANS OF ASSESSING THE PERCEPTION OF THE ENVIRONEMNTAL CONDITION

The evaluation of the environmental condition supposes a deep and long-term research, with the help of specific methods, techniques and means.

The term ***method***, etymologically derived from the Greek *methodos* (*metha* = to, towards and *odos* = way, road), has the meaning of *road (to), way (towards),* road to follow in order to attain a determined goal or way of pursuing, searching, researching and discovering the truth.

The method is defined as *way and system of procedures by which a result is reached, either by means of an anticipative method, or by retroactive observation; a set of procedures, approaches or rules adopted while directing a research or practical activity* . In other words, the method can be characterized as a system of norms mentally organizing the knowledge or the practical-material approach and contributing to the identification and transformation of reality.

The main methods for gathering empirical data are: survey, document analysis, observation and experiment and to each of them corresponds a set of techniques.

The techniques represent a set of methodological prescriptions (rules, procedures) for an efficient action both in the area of material production and in the domain of spiritual production (Dictionary of Philosophy, 1978), or a set of *operations integrated in a particular way of identifying, collecting and processing empirical data* (Dictionary of Sociology, 2006). The techniques are subsumed to the methods and *refer to the operational approach of the phenomenon under analysis* [4] . Most researchers make a clear distinction between **method** and **technique**, yet there are also exceptions, when the technique is assimilated to the method.

The procedure is a way of using the **investigation tools** (observation or record sheet, test, photo camera, reportophone etc.). A hierarchy of these terms would comprise the following examples: the survey is a method; the questionnaire used represents a technique; the self-administration of the questionnaire is a procedure; the list of questions in the questionnaire is an investigation tool**.** The use of different methods, techniques, procedures and investigation tools needs to be correlated to the nature and the extension of the phenomena under analysis, with the time available for the research and the anticipated results. One can say that the research methods fall into two categories: ***quantitative methods*:** *survey, inquiry, documentary analysis;* ***qualitative methods***: *observation (direct and participative), case study.* All these methods have a particular value and complete one another within the scientific approach meant to directly or indirectly investigate reality.

The sociological survey represents a very common research method incorporating techniques, procedures and interrogative tools for gathering information using the sociological interview and the survey. In order to obtain pertinent results, the **sociological survey** can combine the techniques and procedures used as part of the interview or questionnaire with other methods such as observation or documentary analysis. There may appear errors, sometimes, because the subjects do not collaborate sufficiently or those who carry out the survey hold on to what they would like to obtain as an answer and not to what reality represents. So, it is necessary to use several methods in order to obtain a result as close to reality as possible.

The choice of the type of survey is made in agreement to the proposed goal:

- *inquiry through the application of questionnaires asking for the respondents' opinions*. The elaboration of the questionnaire will take into account the way in which it is composed (without general, hermetic or allusive questions; they should be accessible, adequate, equidistant), applied and interpreted (by reference to standard values).
- *inquiry through interview*. The interview supposes the realization of a connection with the subject, in which the researcher elaborates a plan and a set of questions that he/she asks in order to gather primary information according to the aim proposed. According to the type of questions, one can distinguish: *the structured* (standardized) *interview* and the *semi-structured interview*, in which case it is permitted to reformulate certain questions.

The survey comprises a certain type of less elaborated inquiry, carried out concerning certain issues of great public interest, and which aims to grasp the population's opinions (impressions, attitudes, evaluations etc.) and tendencies in relation to these problems. The survey is considered by certain authors as a variant of the inquiry, while others consider it an investigation tool. The survey's results have the role of informing the large public about the tendencies animating the collective conscience. The data obtained by the survey are processed statistically, and their analysis may be simply descriptive or may end with explanations and descriptions.

The documentary analysis supposes the consulting of certain sources: archive, correspondence, yearbooks etc., which can give data and information needed for the purpose pursued by the researchers. The method relies on the technique used to investigate the documents with a historical, literary, geographic, toponymic, socio-political, economic etc. value. The documents mentioned above are official acts providing information or data needed for the goal proposed, thanks to which reality can be tested.

The observation and data recording method is characteristic for all the scientific knowledge domains, being used in geography, biology, sociology, anthropology etc. To observe means to focus on, to monitor objects, phenomena, processes, facts etc. in order to research them and to know them better. Scientific research uses organized **observation**, which is subordinated to the logical scheme of the scientific knowledge: it refers to a concrete object, it is always subordinated to a hypothesis, it unfolds over a longer period of time, the pieces of information obtained are faithfully recorded, and their processing is made especially by relating them to certain criteria. Their advantages are: the facility of analyzing nonverbal behaviors and the possibility to analyze the subjects' behaviors right at the moment when they unfold, and their disadvantages: the study is carried out on small samples, it is hard to quantify the observations, and there may appear external variables.

The sociologist Chelcea S. [2] makes another classification, based on the following criteria: a) *According to the structuring degree*: observation may be structured and unstructured; b) *According to the researcher's degree of involvement*: participative and non-participative observation; c) *According to the duration of the observation*: continual observation and spaced out observation.

The case study is a method relying on the inductive knowledge of reality, which facilitates the passage from particular to general. The case is taken from reality, submitted to analysis, in order to identify its elements, to determine the causes and the effects, to formulate a diagnosis, a prognosis and to propose solutions or a decision. This method allows the passage from authentic particular examples to generalizations or from general aspects to particular ones, while the conclusions formulated allow the solution of the problem-situation.

The questionnaire is appreciated, in sociological literature, as the most important, the most frequent and the most efficient tool used to collect the necessary information in all the activity domains.The questionnaire as an adaptable research tool allows for the gathering of the primary data by means of questions, structured according to well defined principles, so as to arouse the subjects' interest and to get them to answer as sincerely and clearly as possible to the questions addressed to them by means of it. Among the advantages of its use, there are: the thematic richness of the data that can be collected using it, the accessible processing or maneuvering, the possibility to administrate it repeatedly to the same subjects or to different subjects, the ability to collect both quantitative and qualitative information.

The research questionnaire is characterized as an investigation technique and tool consisting in a rigorous succession of written questions and, eventually, graphic images, ordered logically and psychologically, which, through their administration by the inquiry operators or by self-administration, determines from the part of the questioned persons answers that are to be recorded in writing [3] . It is used to record objective data (age, school level, etc.) or subjective data (opinions, attitudes, operations, needs, etc.), and the questions and/or the images have the role of *indicators* .

According to their function, the questions [2]used in the structure of a questionnaire are: *introductive,* contact questions, addressed in order to gain the respondent's trust in the operator of the questionnaire; it is recommended that the first question be closed (with a YES/NO answer); *passage or buffer questions,* having the role of announcing respectively a new group of questions or the passage to another problem; *philter questions,* which prevent the passage of certain categories of subjects to the following questions and represent a control of the answers' quality; *split questions, separating the* "pro" and "against" meanings in the subjects' answers; *"why" questions;* they request explanations in relations to the opinions expressed; their number must not be very large, in order not to oblige the subject to justify himself too much; *control questions,* checking the fidelity of the opinions expressed; *identification questions,* by which one requests data concerning the subjects.

According to their **recording form**, there are *closed questions* (pre-codification) and *open questions* (formulated by the subjects).

CASE STUDY: THE URBAN ECOSYSTEM OF TÂRGOVIŞTE

This scientific paper presents the results of the pilot-survey carried out during the interval September 2011-March 2012 in the urban ecosystem under analysis. The survey was applied on a random sample of 140 respondents, the results obtained being extremely useful in delineating the hypotheses for the final questionnaire, which is to be applied on a much more extended representative sample.

The specific goals pursued in our study were: analysis of the level of perception of the environmental problems by the population of the urban ecosystem of Târgovişte; analysis of the way in which the population is aware of the danger represented by pollution for the population's health condition; identification of the subjects' possibilities of information, interest and level of involvement in environmental protection activities; the situation of the urban green and its role in fighting off the urban stress and pollution; the research of the respondents' attitude towards the responsible factors obliged to take care of the environmental protection.
To these specific goals, we have added other subordinated ones:

- educating the respondents: reminding them certain terms, determining them to ask themselves questions, to reflect on the environmental problems in the urban ecosystem of Târgovişte; identifying the satisfaction level as far as the environmental condition is concerned; identifying the need to get involved in environmental protection actions;

In order to respect the sociological procedure, the pilot survey was carried out going through the obligatory stages, based on a critical analysis, which improved the operations: determining the topic; determining the objectives; previous documentation; elaborating the hypotheses; defining the concepts; operationalization; quantification; determining the sample; determining the survey techniques and procedures; creating the work tool; constituting the team of surveyors; drawing the calendar according to which the survey is to take place; gathering the data – the pilot survey; checking the information gathered and preserving the valid forms in order to process them; codifying the information; creating the data-processing model; processing the data; analyzing and interpreting the information; drawing the report of the pilot survey.

The gathering of the information occurred after having motivated the subjects by the explanations given and after having mentioned the goal pursued. The attitude of the selected subjects was in most of the cases cooperative, most of them showing interest in this subject.

The questionnaire applied within the pilot survey includes 31 items, being an omnibus questionnaire, structured in five big chapters: 1)Questions relating to the environment and its components in the entire urban ecosystem, but also in the different districts of the residential area; 2)Questions about pollution sources and their perceived impact; 3)Questions related to urban waste management; 4)Questions aimed to highlight the people perception on urban green spaces and their role in recreational activities; 5)Questions aimed to assess awareness of residents on programs designed to improve environmental quality and questions showing willingness to volunteer.

There were applied both structured questions and open-ended questions, in order to enable respondents to express themselves outside the set of questions, thus obtaining more details, useful in shaping the final version of the questionnaire. Special attention was given to the control questions, inserted in each chapter of the questionnaire.

The questionnaires were applied by interviewers, except the sub-sample of students for whom the questionnaires were distributed by teachers, in the classroom, and self-administered.

In the surveyed sample, the sub-sample population (students enrolled in high school, aged 16-19 years) held a share of 54%, which influenced the average age of the entire sample (29 years) and the structure of the sample by level of education (32% graduates, 54% secondary school graduates). The structure of the sample according to the district of residence was of particular interest in terms of correlations between area of residence of respondents and the perception of the environment. 25% of the respondents were residing in the central districts of the town, and 50% of respondents were from districts with a higher concentration of Roma population (XII, XI, VI), some of them peripheral.

Following the centralization of the questionnaires and the analysis of the results, there were highlighted a number of interesting aspects to be taken into account to the final form of the questionnaire:

a. In the chapter *Environmental quality*, the respondents were asked to assess the environmental quality in the urban ecosystem of Târgovişte. 89% of respondents indicated that the environmental quality is now good or satisfactory, while 61% of them thought that there was recorded an improvement in environmental quality in the last decade. It is significant that 21% of respondents could not appreciate how the environmental quality has evolved in the specified period, the structure of responses being influenced by the large share of adolescents in the sample (83% of answers "do not know" to this question came from the sub-sample of students). The introductory item (Q1 - How Would You Assess the Environmental quality in the town of Târgovişte?) was followed at a distance of three questions, by a question asking specific details about certain components of environment, at different scales (first the entire city, then the district of residence). This question was aimed to verify the validity of the answers received at the first question, and also to identify how the perception of certain components (air, vegetation, green spaces) influence the overall perception of the environment. By comparing the answers to items Q1 and Q5, it was found that there are cases where the perception of respondents on the environment in the city is influenced by the situation in close proximity. Thus, at the question Q1 the respondents have opted for the answer “bad quality”, indicating a negative perception of environmental components in the municipality. At the control question (Q5), their answer has changed, because the structure of the question required to distinguish between the situation in the municipality (which was appreciated this time as “satisfactory”), and the situation in the district of residence (which was indicated it as “bad”). This conclusion will be further investigated in the final questionnaire, in order to identify those components of the environment that have the greatest influence on the perception of the environment as a whole.

b. The results from the pilot survey also revealed the answers recorded from the two items meant to highlight the territorial differences in perception of the environment: Q7 - *There are differences, in terms of environmental quality, between neighborhoods?,* and Q8 - *In your opinion, which districts are facing significant environmental problems?*. 86% of respondents considered that there are differences between city neighborhoods in terms of environmental quality, the most serious problems characterizing the districts XI, VI and XII (indicated by 46%, 43% and 39% of respondents). In 36% of the cases the respondents indicated the neighborhood of residence among those with significant environmental problems. In 18% of cases the residents of central neighborhoods included only the suburbs in the category of the districts with environmental problems.

It should be noted that the concept of peripheral or marginal was sometimes used with pejorative connotations, being associated to those neighborhoods with a higher share of Roma population (perceived as having greater social vulnerability). Thus emerged the hypothesis that the neighborhoods with a greater concentration of stigmatized social groups, like the Roma, are perceived negatively by the townsfolk and this perception is transferred to other characteristics of those neighborhoods. The validity of the hypothesis and the possible causes of this process will be carefully investigated in the final questionnaire.

c. Since one of the original purposes of the research was to identify ways of empowerment and involvement of the population and revealing willingness to volunteer, several items concerning those matters were included in the questionnaire. According to the pilot survey, 96% of subjects considered necessary measures to improve environmental quality in the urban ecosystem of Târgovişte, the most frequently mentioned being: education (105 responses), proper waste management (90) and street cleaning to remove dust (80). The implementation of these measures should be undertaken, according to respondents, by the local authorities – the city hall and local council (75% of responses). In the case of this chapter, the centralization of the questionnaires from the sub-sample students has showed a similarity of responses, especially for the open-ended questions. It is therefore necessary for interviewers to improve the training of the students before the final questionnaire, stressing the importance of formulating their own responses.

d. The respondents' tendency to transfer responsibility to the authorities also results from the responses to the items related to participation in voluntary action. 57% of respondents indicated that they volunteer, while 21% responded negatively, saying that they are not responsible for the implementation of voluntary actions aimed to improve environmental quality. Participation in voluntary actions is higher in the sub-sample of students (67%), due to their involvement through the schools in national actions (such as *Let's do it, Romania!*), or in the initiatives of nongovernmental organizations. In the case of the sub-sample of students, the questionnaire was applied in a formal environment (in the classroom, the teacher being present), which has had an impact on the results. The obvious concern of the questioned students to give the "correct" responses (e.g., all variants are checked to some structured questions with multiple answers) should be prevented by training, in the final survey.

REFERENCES

[1]Bogner, F.X., (1999), *Toward measuring adolescent environmental perception*, European Psychologist, vol. 4, no. 3, pp. 139-151

[2]Chelcea, S. (2001), Sociological research techniques, Editura SNSPA, Bucureşti

[3]Chelcea, S. (2004), An initiation in sociological research, Editura Comunicare.ro, Bucureşti

[4]Chelcea, S. (2007), The methodology of sociological research, Editura Economică, Bucureşti

[5]Moore, G.T., (1979), *Knowing about environmental knowing. The current state of theory and reaseach on environmental cognition*, Environment and Behavoiur, vol. 11, no. 1, pp. 33-70

[6]Pacione, M., (2003), *Urban environmental quality and human wellbeing – a social geographical perspective*, Landscape and Urban Planning 65 (2003), pp. 19-30

MIXING ZONES DESIGNATION AS A TOOL FOR MANAGEMENT DECISION MAKING IN THE CASE OF THE HAZARDOUS SUBSTANCES RELEASES INTO THE WATER ENVIRONMENT

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ABSTRACT

Accidental surface water pollution presents a serious threat to biota and water quality, especially for that water which is used for human consumption or irrigation in agriculture. In the case of such events it is important to determine the pollution plume shape - the affected area and determine the proper procedure for sampling the various aquatic compartments (water, sediment, biota) for subsequent evaluation of the extent of damage. According to the Article 4 of Directive 2008/105/EC, member states have the possibility to designate the mixing zones for substances of priority importance for the environmental protection. Czech Republic accepted the designation of mixing zones on its territory. For this purpose T.G. Masaryk Water Research Institute, p.r.i. developed methodological procedure and software tool for decision making by competent authorities. It is called „The Czech Pollution Test" (CPT). The model is able to depict spatio-temporal scale of the pollution plum, hazardous substances concentration at the longitudinal and transverse section of the river, respectively. Since the mixing zone length in the case of large rivers can be up to several tens kilometres, the CPT is a usable tool for emergency management regarding to these substances in the area from leakage to the point, when waste plume achieves the whole cross section of the river. That data from the CPT are usable for emergency planning as relevant data, when the crisis situation starts.

In emergency management it is necessary given the nature of spilled media in a short time to establish and to realize an appropriate monitoring procedure of the affected area. Only well-established monitoring procedure can then provide the corresponding results on the level of contamination. The CPT may become a useful tool for decision making in crisis situations. It is a tool through which the decision maker is able to determine the preliminary effects on surface water and thus react appropriately. If pollution levels at the end of the hydraulic mixing zone exceeds the legal environmental standards are needed for modelling the spread of further contamination plume using another suitable modelling tools. To find the space for the preventive measures to reduce pollution levels is needed, too. For decision making, it is important to know the substance leaked, its quantities and the hydrodynamic conditions data for the affected recipient. This information will contribute to more accurate estimates and enable to reduce environmental impacts.

Keywords: mixing zone, accident pollution, surface water, software tool, accident prevention

INTRODUCTION

Waste water discharge and accidental pollution incidents introduce a range of undesirable extraneous substances into surface water with the potential for serious harmful effects on the aquatic environment. Through the aquatic environment, they may have a negative impact on the human population. In the first place, the mixing process of polluted and surface water occurs in the immediate point of pollution loss or discharge. Such location is called the mixing zone. It is an area where the discharged/leaking pollution components are scattered in all directions and where steady concentrations in the recipient are desired to be achieved (Neely, 1982) [1].

Article 16 of Directive 2000/60/EC of the European Parliament and of the Council [2] sets out a strategy of limitation for water pollution by chemicals. As an initial step within this strategy, the list of priority substances has been accepted (under Directive 2008/105/EC [3]) identifying 33 substances of priority interest. Directive 2008/105/EC laid down environmental quality standards (EQS) for priority substances and certain other pollutants that should not be exceeded in surface water. EQS are expressed as annual average values (protection against chronic effects) and as maximum allowable concentrations (protection against acute effects on aquatic organisms). The priority substance list should be further extended in the EC in the near future.

Regarding the fact that EQS established by the Directive cannot be met downstream close to the point of discharge, there is an option to designate mixing zones – the areas where such standards will not be achieved. For the calculation of mixing zone extent, a special tool has been developed in the Czech Republic, called "The Czech Pollution Test" (CPT), which is able to perform modelling of both longitudinal and transverse directions of widespread pollution in a mixing zone of surface rivers, i.e. from the point of discharge to the area where the discharge plume is already homogenous. This tool might also be used to support accidental pollution management for not only an evaluation of accident effects through the selection of appropriate sampling programmes, but also for the creation of possible accidental release scenarios under various flow conditions. A mixing zone namely might have a length of up to some tenths of kilometres in wide rivers.

The CPT is intended primarily for modelling the above mentioned priority substances and generally all conservative dangerous substances having a 3D dispersion ability in an aquatic environment (it is not intended for e.g. oil product modelling). Another criterion for model usage is that the pollutant discharge/accidental leakage into a river should occur under constant conditions for a period of time equal to or higher than the residence time of receiving water in the reach of the river, where the mixing zone exists.

THE CZECH POLLUTION TEST

For the modelling of the mixing zone process, a CPT is being developed to allow for the Competent Authority to simulate the mixing zone process both in longitudinal and cross sections of the river. Regarding the fact that modelling of 3D dispersion is very complicated, the 2D solution is commonly used for its simplicity, and also additional simplifications are introduced (such as average river width and depth) [4]. The model reflects a steady status which is achieved under unvarying conditions and river parameters, whereas the concentration is only a function of space variables. For a naturally shaped river channel, the calculations are only approximately applicable. The model is divided into several logical steps.

As the key values, the CPT uses the inputs downstream from the outfall, with an affected flow-rate: "U" is river flow velocity, "B" is the average width of the river and "h" its average depth, "C_r" is background concentration in the river, "Q_e" is volume and "C_e" is a concentration of discharged polluted water. In a mixing zone area where total mixing is performed in the vertical direction, the following equation is used for the calculation of concentrations (1) (Fischer et al., 1979) [5]:

$$\frac{C-C_r}{C_0} = \frac{1}{\sqrt{4\pi x}} \sum_{n=-\infty}^{\infty} \left\{ e^{\left[-(y'-2n-y'_0)^2/4x'\right]} + e^{\left[-(y'-2n+y'_0)^2/4x'\right]} \right\} \qquad (1)$$

where: "x" is the longitudinal distance from the outfall, "y" is the transversal distance from any bank, "y_o" is the outfall transversal distance from the near bank and where:

$$C_o = (C_e - C_r)Q_e/U * B * h \qquad (2)$$

The calculation is limited with the length of mixing zone "L" which is defined by the equation (2) used by the US EPA:

$$L = 0.1U\left((2-2y'_o)B\right)^2/E_y \qquad (3)$$

where the horizontal diffusivity:

$$E_y = a_y * u * h \qquad (4)$$

and where $a_y = 0.5 \pm 50\%$ (Fisher et al., 1979) [5] and where "u" is friction velocity and "h" is river depth.

The Czech Pollution Test further allows selection of roughness coefficient and dispersion coefficient calculations. The longitudinal concentration progress is displayed from the source/leakage point to the point of the mixing zone (i.e. where the chemical substance concentration is steady throughout the whole cross section of the river), see Figure 1. The concentration progress can also be simulated and displayed in the cross section in any distance whatsoever from the pollution source up to the area of thoroughly completed mixing, see Figure 2. In the first step, the model creates concentration progress for an invariable substance. In the case of a non-conservative substance, constitutive changes of such substance can be simulated which might be temperature dependent or independent.

The Czech Pollution Test can be used in the preparation of emergency scenarios of potential losses or current accident management depending on the quantity of the lost substance (as a concentration) and on the hydrological conditions in a recipient.

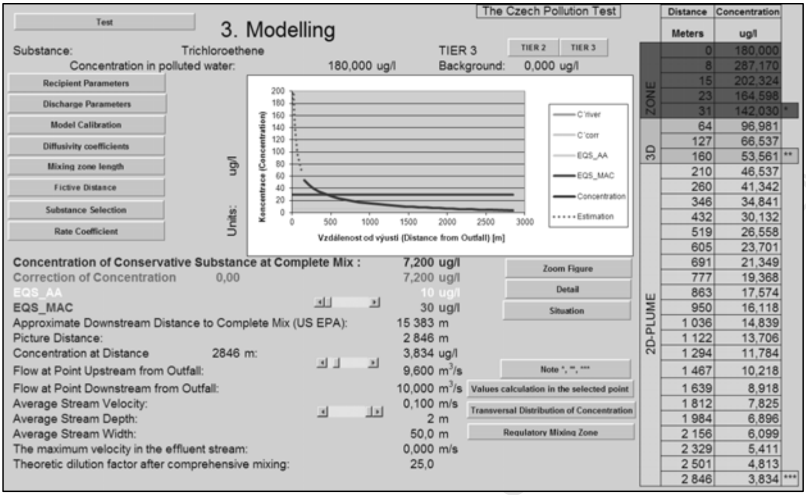

Figure 1. Main screen of the Czech Pollution Test

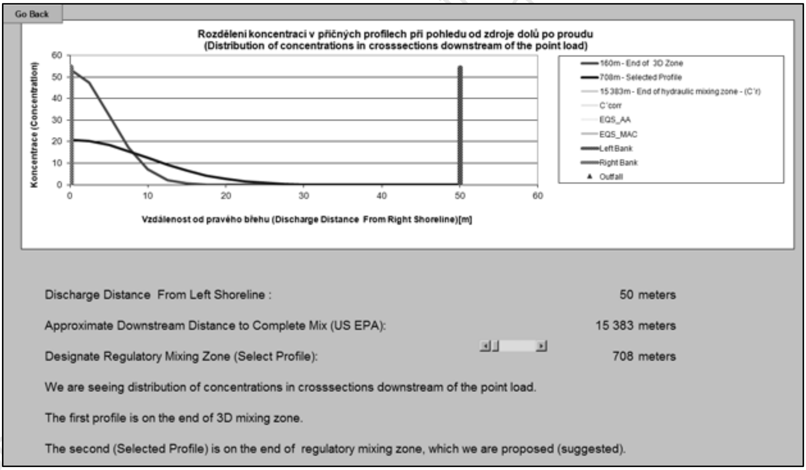

Figure 2. Screen of the transversal distribution of the pollutant (concentration) in the selected profile

ACCIDENT PREVENTION

According to Act No. 59/2006 Coll. (transposition of the SEVESO Directive [6]), two basic types of Emergency Plans are being prepared in the Czech Republic, reflecting the potential affection of surface water. This is particularly the Internal and External Emergency Plan. External Emergency Plans are prepared in each individual region by Fire Rescure Service of the Czech Republic. These plans are intended for the territory of an emergency planning area to secure the protection of the population, livestock, property and cultural assets, and environment.

Internal Emergency Plans are prepared by the operators of individual establishments classified into Group B according to Act No. 59/2006 Coll. These plans cover the procedures of emergency readiness inside the establishment and the nearest surroundings.

Pursuant to Water Act No. 254/2001 Coll., as amended, all appropriate precautions must be taken by anyone dealing with harmful substances (including those to whom the SEVESO Directive is applicable) to avoid their entry into surface water or groundwater, and to prevent them from becoming an environmental hazard. If large quantities of harmful substances are being used in any operation, or where the use of harmful substances represents an increased risk for surface water or groundwater, specific measures must be taken by each person responsible for handling the harmful substances in conformity with Article 39 of the above act.

THE CTP UTILISATION TO EVALUATE THE IMPACT OF ACCIDENTAL RELEASES

Notwithstanding any implemented precautions, accidental releases of hazardous substances from industrial facilities might be drained into the sewer system and consequently into surface water. In most cases when the pollutant leakage is not fast and proceeds constantly for a certain period of time, the quantity of the lost substance can be determined and its concentration can be estimated before it reaches any river. During such events and as prevention, an evaluation of the accident impact or the preparation of crisis scenarios might cover the CPT modelling of mixing zone shape and extent in an affected reach of river. It is especially important in such cases when there are protected areas downstream from the point of leakage (bathing areas, aquatic organism protection) or locations for surface water abstraction (for irrigation or drinking water treatment). The possibilities of CPT use are presented in the following examples (scenarios).

The mixing zone shape downstream close to the point of hazardous substance leakage into the river, see Figure 3 (Scenario No.1). The basic grid illustrates the river in its transverse and longitudinal distances which are shown in a different scale for better visual comfort. The solid line represents the limit of chronic effect toxic zone, which is the EQS-AA value according to Directive 2008/105/EC (for inland surface water, TCE = 10 μg/l), the dashed line is the limit of the acute effect toxic zone, which is EQS-MAC according to Directive 2008/105/EC (for inland surface water, TCE = 30 μg/l). For the given longitudinal downstream distance “x”, with the concentration EQS-AA and EQS-MAC, deduction from the CPT transverse distance “y” shall be converted to a % of river width and entered into the grid. The grid can be optionally extended on the “x” axis to display the whole mixing zone area.

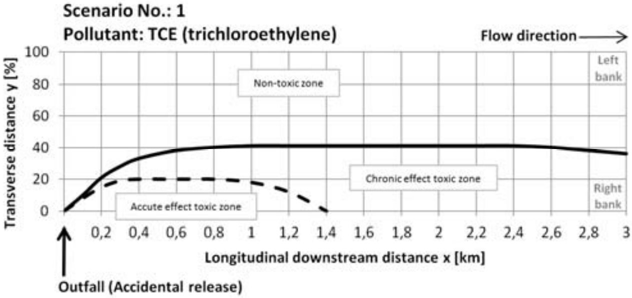

Figure 3. Accidental release modelling by the CPT. Input parameters: polluted water: Q = 110 l/s, C = 5,000 μg/l TCE; receiving water: Q_{330} = 36 m^3/s, C = 0 μg/l TCE.

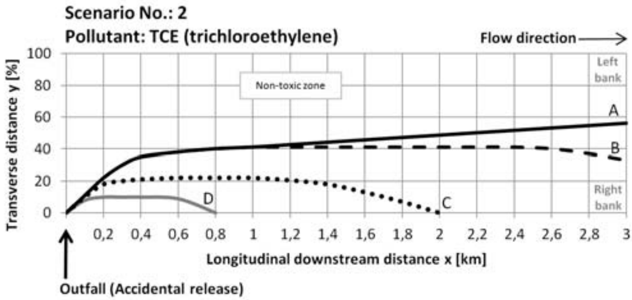

Figure 4. Accidental release modelling by the CPT. Input parameters: polluted water: Q = 110 l/s, C = 5,000 μg/l TCE; receiving water: C = 0 μg/l TCE, (A) Q_{355} = 10 m^3/s, (B) Q_{330} = 36 m^3/s, (C) $Q_{average}$ = 136 m^3/s, (D) Q1 = 227 m^3/s.

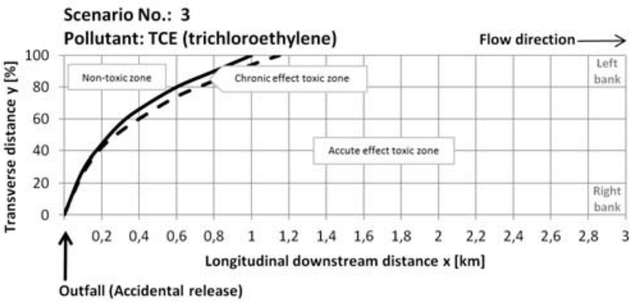

Figure 5. Accidental release modelling by the CPT. Input parameters: polluted water: Q = 110 l/s, C = 3,101,000 μg/l TCE; receiving water: Q_{330} = 36 m^3/s, C = 0 μg/l TCE.

For its modelling the CPT also requires basic hydrological characteristics of the channel to be entered. Figure 3 indicates that the substance leakage was not significant enough to cover the whole river width. Figure 4 (Scenario No.2) displays a simulation of the same leakage on the same river reach as above in Scenario No.1, but under different flow conditions, from the very low flow Q_{355} up to a flow achieved during a one-year flood Q_1 (only the extent of the chronic effect toxic zone is shown).

For an example of a more serious accident see Figure 5. High concentration of TCE contained in polluted water might be caused by the leakage of TCE from a storage tank in an amount of 10 m^3 within 12 hours, flowing into the sewer system and consequently into a river. The acute effect toxic zone has covered the whole river width (50 meters).

PROPOSAL FOR AMENDMENT OF SOME ASPECTS IN ACCIDENT PREVENTION

The modelling tool the CPT for mixing zone designation may become useful, as is showed above, for the needs of emergency management. This usage is considered especially in two aspects:

A) The analysis of existing emergency plans prepared within the OPTIZON Project [7] indicates that they only contain general instuctions: that there is a potential possibility for environment threats, determination of environmental part to be threated, without any appropriate data or particular informations. Completing the External Emergency Plan with selected hydrological characteristics suitable for designation of polluted reaches of the river (flow characteristics Q_r, Q_e, river width and depth in potential mixing zone extent) and, if needed, with possible scenarios (see Chapter 4) could optimise the solution of accident consequences on the rivers for selected pollutants.

B) Since only certain subjects are obliged to prepare emergency plans, we propose that the methodology procedures of rescue services intended for the protection of the population, property and environment during the management of accident consequences on rivers (FRS in the CR) be completed with the necessary data and tools required for mixing zone extent simulations.

The proposed actions above would reduce the impact on the environmental parts around a company handling dangerous substances. In this regard, it would be practical to have ready model scenarios for various flow and leakage conditions. With the predicted use of mixing zone shape (pollution plume), sampling point locations for the sample collection during an evaluation of accident consequences going downstream and the extent of possible acute and chronic damage in the aquatic environment could be optimised.

SUMMARY

The mixing zone designation tool developed in the Czech Republic can be potentially also used in the prediction of the extent of river accident caused by the leakage of selected dangerous substance or in the optimisation of sampling for individual aquatic environment parts to make an evaluation of accident impacts. The CPT can be used under the conditions that the assessed hazard substance has the ability of vertical and horizontal dispersion due to its water solubility or sorption into a fine fraction of suspended solids. The prediction of transversal and longitudinal concentrations of pollutant in the river uses steady hydrological and concentration conditions and an idealised river channel shape. Therefore, it is suitable for such types of accidents when the leakage persists for some time (some hours). If there are significant singularities within the river (such as meanders, weirs, bridge pillars), the mixing zone extent tends to reduce. That is why the CPT provides the possibility to calibrate the model for particular conditions in the field with an option to enter measured values and changes in dispersion coefficients. Other suitable modelling tools (such as ALAMO) shall be used for the modelling of widespread pollution in a river after mixing zone achievement.

REFERENCES

[1] Neely, W.B. The definition and use of mixing zones. Environ. Sci. echnol., Vol. 16, pp. 518A-521A, 1982.

[2] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

[3] Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council.

[4] Czernuszenko, W. & Rowinski, P. Water Quality Hazard and Dispersion of Pollutants. Springer Science + Bussines Media, Inc. USA, 250 pp. ISBN 978-1-4419-3606-6, 2010.

[5] Fischer, B. H. & List, E. J. & Koh, R. C. Y. & Brooks, N. H. Mixing in Inland and Coastal Waters. Academic Press, INC., London LTD, 483 pp. ISBN-13: 978-0-12-258150-2, 1979.

[6] Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances. Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003 amending Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances.

[7] Blažková, K. & Koťátko, A. Hodnocení úniků nebezpečných látek do životního prostředí pro účely stanovování zóny havarijního plánování. Mezinárodní konference mladých vědeckých pracovníků. Ostrava, Vysoká škola báňská - Technická univerzita Ostrava, pp. 30-38, ISBN 978-80-248-2486-4. 2011.

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OPPORTUNITIES FOR CAPITALIZATION OF LEATHER AND FOOTWEAR WASTE BY COMPOSTING

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ABSTRACT

The leather and footwear industries are the most representative industries that generated enormous amount of waste. The environmental aspects in this industry are generally ignored and huge amounts of solid leather wastes are discharged directly with the urban wastes. For a good management of the amount of waste the European Union Council emitted the 92/62/CE Directive, regarding packaging/package waste, that require to reduce the amount of packaging waste by prevention (reduction of the quantity and of their harmfulness), reuse and recycling by organic capitalization (composting and biodegradation) and energy recovery.(92/64/CE Directive). According to the European Directive the best solution for capitalization of the leather waste is recycling by composting or biodegradation by simple disposal. The composting process is an old and inexpensive method that converts organic waste into useful material (compost) that can be used as soil conditioner and organic fertilizer.

The aim of this paper was to study comparatively the composting of leather tanned with chromium and vegetal compounds respectively and the synthetic leather. The experimental process conditions were developed to sustain mesophilic and thermophilic microbial flora, responsible for degradation of the leather waste. The compost mixture content is: leather waste, sterile mature compost, corn cobs waste corn oil, sugar, sawdust and compost like inoculums. The size of leather waste pieces was about 2x2 cm. Moisture, temperature, pH values, total organic carbon, Kjeldahl nitrogen were monitored in composting systems and IR spectrum of leather waste were determined during one year period. The composting process represents a realistic way for capitalisation of leather waste.

Keywords: leather waste, composting, tanning, chromium salts, vegetal compounds, substitutes of leather

1. INTRODUCTION

The leather and footwear industries are the most representative industries that generated enormous amount of waste. The environmental aspects in this industry are generally ignored and huge amounts of solid leather wastes are discharged directly with the urban wastes [1]. For a good management of the amount of waste the European Union Council emitted the 92/62/CE Directive regarding packaging/package waste, that require to reduce the amount of packaging waste by prevention (reduction of the quantity and of their harmfulness), reuse and recycling by organic capitalization (composting and biodegradation) and energy recovery.(92/64/CE Directive). According to the European Directive the best solution for capitalization of the leather waste is recycling by composting or biodegradation by simple disposal. The composting process is an old and inexpensive method that converts organic waste into useful material (compost) that can be used as soil conditioner and organic fertilizer. [2]

During composting, the compounds that contained the carbon and nitrogen are transformed through the activities of successive microbial populations into more stable complex organic forms namely humus substances. [3] Metabolic activity evolution is affected by the chemical composition of starting material, moisture, temperature, pH, the turning frequency, the oxygen input and the particle size. [4]

The ratio of carbon to nitrogen, C/N of 25:1 to 35:1 are ideal for active composting, although initial ratios of 20:1 up to 40:1 consistently give good results. [5] Another parameter that influences the composting process is temperature. The composting process is based predominantly on microorganisms which grow in the temperature range from 25 to 60°C, mesophilic (< 45°C) and moderately thermophilic (40 to 60°C) organisms. Elevated temperatures (> 60°C) lead to inactivation of mesophilic microorganisms [6], destruction of pathogens, it reduces the level and activities of desired microorganisms that are important in the composting process. [7]

The preferred pH is in the range of 5.5 - 8.0. [8] The moisture content in range 45 -55 % is sufficient to allow optimum activity without releasing leachates [9], but can be in range 50 and 70 % by ensuring adequate oxygen supply (over 15 % O_2 concentration in the flue gas). [10, 11] The initial structure and the size of the composting mass to ensure an optimized aeration (passive or mechanical) required for an efficient aerobic degradation process. The particle size of mixture can be varied from 1.3 to 7.6 cm. [12] and a minimal free air space of 30% allowing the uniform air flow through.

The aim of this paper was to study comparatively the composting process of leather tanned with chromium and vegetal compounds respectively and the synthetic leather. The experimental process conditions were developed to sustain mesophilic and thermophilic microbial flora, responsible for degrading the leather waste. The compost mixture content was: leather waste, sterile mature compost, corn cobs waste, corn oil, sugar, sawdust and the compost like inoculums. The size of leather waste pieces was about 2x2 cm. Moisture, temperature, total organic carbon, Kjeldahl nitrogen, pH, conductivity, were monitored in aqueous system (aqueous extract) and IR spectra of leather wastes were determined during one year time period.

2. EXPERIMENTAL

In this study three leather samples have been used: one tanned with chromium salts (S_1), another tanned with vegetal compounds (S_2) and substitute of leather (S3) as synthetic leather. Each of samples was initially characterized by determining the content of humidity and volatile substances, ash, the extractible substance, free fat acids, total nitrogen, total organic carbon content (TOC), hazardous substances as heavy metal ions (Cr, Cd, Pb, Cu, Zn and Hg).

2.1 Initial characterization of wastes materials

For characterization of initial composition of leather and substitute of leather wastes were analyzed the ash content, humidity and volatile substance, extractible substance, total organic carbon, TOC, Kjeldhal nitrogen, free fat acids. To determine the toxicity of leather the content of heavy metals Cr, Cd, Pb, Cu, Zn and Hg has been also analyzed. The experimental results for initial characterization of samples are presented in Table 1. The content of heavy metals is presented in Table 2.

2.2 Characterization of composting systems

The initial organic mixtures for composting consist in sawdust (30%), sterile mature compost (30%), corn cobs oil (5%), corn cobs wastes (16 and 17.5% respectively), ureea (4 and 2.5 % respectively), and compost from leather wastes dump like inoculums of specific microorganisms (10%). In the composting systems were introduced the pices of wastes that have 2,5cm x 2,5 cm size, the ratio waste/compost in weight units was 1:100. The mixtures for composting were introduced in plastic recipients, 1L capacity, that present small holes for a good aeration of composting mixture. The composting mixtures were watered regularly to abide the moisture level between 55 - 70%. [8] The composting process takes place at ambient temperature (room temperature). It was worked at two carbon/nitrogen ratios: 25 and 35 respectively.

For characterization of composting systems the following parameters were analyzed:

- in composting systems: moisture, temperature, total organic carbon (TOC), Kjeldahl nitrogen;
- in aqueous extract: pH, conductivity, total organic carbon, Kjeldhal nitrogen. The aqueous extract was obtained by contacting 10g of compost with 100mL distill water and shaking (125 rot/min) for 2 h at room temperature. The suspension was filtered at vacuum system (vacuum shaft tube).
- evolution of wastes structure and biodegradation levels were characterized by IR spectra modifications in time.

2.3 Equipment and methods

The content of metal ions in initial wastes, such as Cd, Cr, Cu Zn and Pb was determined from ashes by means of a Contr AA 700 Analytik Jena – type Atomic Absorption Spectrometer with solids auto sampler. The Hg content was determined directly from solid samples by means of a Milestone DMA-80 model Hg analyzer.

The temperature of systems has been taken at 10 cm depth from free surface of composting mixture.

The organic carbon content was determined by combustion at 900ºC according to the standard RS 2505/2003 using a Liqui COT analyzer (the calibration was achieved using $CaCO_3$), and the Kjeldahl nitrogen method was determined according to RS 6417/1993, using a distillation unit, Velp Scientifica UDK 130D.

The pH was determined using a pH-meter Jenway 370 and the conductivity was determined using a conductometer, Jenway 470.

The samples have been taken weekly during first four months and monthly in next eight months.

The IR spectra for initial leather and substitute as well as for wastes samples on periods of experiments have been registered using a FT/IR-ATR spectrometer 4200 (Jasco, Japan) on the range 4000 – 400 cm^{-1}. The composting processes begined on first day of March and were finished at 31th day of February in next year.

3. RESULTS AND DISCUSSION

3.1. Initial characterization of leather and substitute of leather wastes

The initial characterization of samples of leather and substitute of leather wastes is presented in table 1.

The main compunds of leather wastes are dermic substances like colagene in value of 72,86 % for S1 and 60,89% for S2. Other important compounds in leather are fatty acids in concentration around 4%.

The initial content of toxic heavy metals, Cr, Cd, Pb, Hg, Cu and Zn present in leather and substitute of leather waste are summarized in table 2.

Table 1 Characterization of leather and substitute of leather wastes

Nr. Crt.	Parameter	Standard Method	Sample		
			S1	S2	S3
1	**Ash content, %**	STAS 7308-87	6.9	6.2	3.15
2	**Humidity and volatile substances 102°C, %**	SR EN ISO 4684 – 06	15.16	14.47	1.16%
3	**Extractible subst. %**	SR EN ISO 4048 – 08	4.77	7.48	0.12
4	**Total organic carbon, TOC, %**	SR EN 13137-05	64.8	66.4	75.12
5	**Kjeldhal nitrogen, %**	SR ISO 5397 – 96	12.96	10.84	5,61
6	**Free acids fat, %**	SR EN ISO 4048 – 08	4.14	3.97	-

Table 2. The initial content of toxic heavy metals in leather and substitute of leather waste

Sample / Metal	S1	S_2	S3	MAL, mg/Kg (SR EN 13432-02)
Cr, mg/Kg	136.7	35.59	9.73	50
Cd, mg/Kg	0.35	0.6	<0.57	0.5
Pb, mg/Kg	5.86	6.35	<0.43	50
Hg, mg/Kg	0.4	0.47	0.012	0.5
Cu, mg/Kg	11.49	12.99	1.86	50
Zn, mg/Kg	0.3	2.96	8.39	150
Sum	155.1	58.96	<20.99	101

The content in chromium for sample S_1 is far beyond the maximal admissible limit (MAL) - 136.7 mg/kg, as a result the toxicity of this leather is high. On the other hand, the chromium is a toxic element that inhibits the growth of microorganisms and influences the biodegradation of leather wastes. The content of heavy metals for S_2 and S3 is below the maximal admissible limits (MAL), according SR EN 13432/02, which shows that the leather tanning with vegetal compounds and substitute of leather could be biodegraded.

3.2. Composting systems evolution

The moisture content in composting systems must be abided in range 45-65%. It was worked at two C/N ratios. In figures 1 and 2 were showed, respectively, the evolution of C/N for two initial C/N ratios, R1=25 and R2=35, and for three samples of wastes: leather tanning with chromium salts (PCr), leather tanning with vegetal compounds (PTan), and substitute of leather (IP) in composting systems and aqueous extracts systems, respectively.

Initial C/N ratio influences the composting process. For systems where the initial C/N ratios are 25 and 35, the composting process has been finised after 180 days and 225 days, respectively, and is followed by maturation stage of processes. The wastes type also influences the rate of composting process and the quality of compost. The presence of leather tanning with chromium salts decreases the rate of composting and the quality of compost. The final ratios C/N are around 13 and 17 for initial ratios C/N 25 and 35, respectively. According to compost/ soil amendment classification of the EPA 40 CFR 503.13 the quality of compost is specific to Class II and Class III, that is to lower classes.

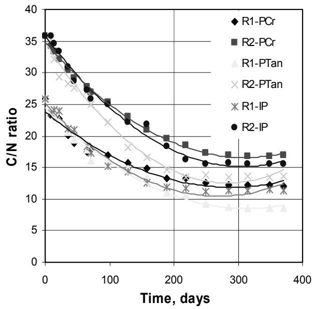

Fig. 1. The variation in time of C/N ratio in composting systems

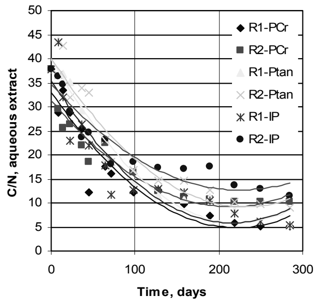

Fig. 2. The variation in time of C/N ratio in aqueous extract

The presence of leather tanned with vegetal compounds in composting systems increases the quality of compost, the final C/N ratio is around 8 and 13 for initial C/N ratio 25 and 35, respectively, the compost quality being characteristic to Class I and Class II, respectively.

The negative influence of substitute of leather on the composting systems is lower than that of leather tanned with chromium and higher than that of wastes tanned with vegetal compounds, the quality of compost being specific to Class II.

The variation of conductivity in time is presented in Figure 3. The conductivity in aqueous extract decreases for all systems from 0.4 mS at values in range 0.22-0.26 mS. According to compost/ soil amendment classification of the EPA 40 CFR 503.13 the quality of compost, regarding the conductivity parameter is specific to Class I.

In figure 4 is showed the variation of pH in aqueous systems. The pH values increase from values 6.5-6.7 at values in range 7.6-8.0. According to compost/ soil amendment classification of the EPA 40 CFR 503.13 the quality of compost regarding the pH parameter is specific to Class I.

Different communities of microorganisms predominate during various composting phases. Within the first phase, the initial 36 days for all the samples, the decomposition is carried out by mesophilic microorganisms, which rapidly break down the soluble, readily degradable compounds. The heat they produce causes the compost temperature to rise to 40-50ºC. Meanwhile, biodegradable substances are metabolized mostly by bacteria and fungi. During the second phase, which may occur over extended periods of time, temperature varied between 40°C and 52°C. Cellulose and other more difficult biodegradable substances are destroyed at that time. Lignin, the darker, woody components in plant tissues, break down even more slowly. During this high temperature phase, about 40°C, the mesophilic microorganisms become less competitive and are replaced by others that are thermophilic, or heat-loving. At temperatures of 55°C and above, many microorganisms that are human or plant pathogens are destroyed. During the thermophilic phase, the third stage, high temperatures accelerate the breakdown of proteins, fats, and complex carbohydrates like cellulose and hemicelluloses, the major structural molecules in plants. As the supply of these high-energy compounds becomes exhausted, the compost temperature gradually decreases and mesophilic micro-organisms once again take over for the final phase of "curing" or maturation of the remaining organic matter.

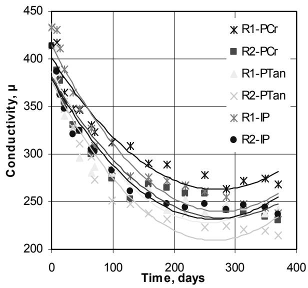

Fig. 3. Variation in time of conductivity in composting systems

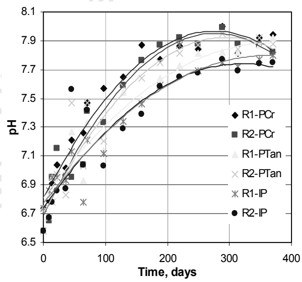

Fig. 4. Variation in time of pH in composting systems

In table 3 was showed the peaks and the functionalized group's characteristic for samples of leather wastes.

Table 3. IR spectrum for leather and substitute of leather, the peaks and the functionalized group's characteristic

Wave number, (ν), cm^{-1}	**Functional groups**
3450-3200	ν_{OH} **and** $\nu_{NH\ asociate}$
3050-3000	$\nu_{CH\ aromatic}$ **and** $\nu_{-CH=CH-}$
2950-2850	$\nu_{CH,}$ $\nu_{CH2\ aliphatic}$
1750-1700	$\nu_{C=O}$ **from oxigentes compounds**
1660-1630	$\nu_{C=O,}$ **from –CONH- (amide I)**
1550-1530	$\delta_{NH,}$ **from –CONH- (amide II)**
1430-1460	δ_{CH2}
1250-1230	$\nu_{C-N,}$ **(amide III)** δ_{NH}

1210-1180	**δ $_{C\text{-}O,}$ $_{from}$ $-COO^-$**
1080-1000	**$\nu_{C\text{-}C}$ and $\nu_{C\text{-}N}$ and $\nu_{C\text{-}O}$**
870-890	**$\nu_{C=C}$**
720-700	**$\delta_{NH,}$ (amide V)**
670-660	**δ_{CH2}**
620-600	**amide IV and amide VI**

The biodegradation of leather wastes tanned with chromium salts start after six and eight months respectively for ratio C/N 25 and 35 respectively (Figures 5 and 6) at begining of composting processes.

On the IR spectra the biodegradation processes have been identified by decreasing the high of peak and increasing the width of band in range 3450-3200 cm^{-1}, and modification of the high of peaks at 1660 cm^{-1} and 1550 cm^{-1} specific to hydrolysis processes.

The biodegradation process took place in mesophilic domain of temperature, during the maturation stage when the concentrations of nutrients decrease in composting systems and the microorganisms that were adapted with wastes using the specific enzymatic systems for biodegradation of the leather wastes.

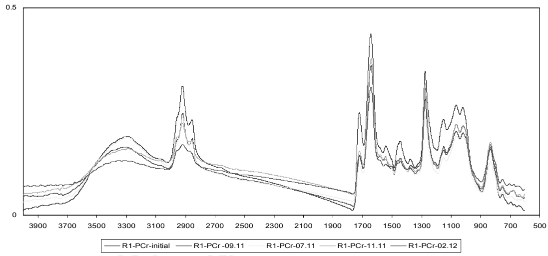

Fig. 5. Variation in time of IR spectra for sample of leather tanned with chromium salts for ratio C/N, R1 = 25

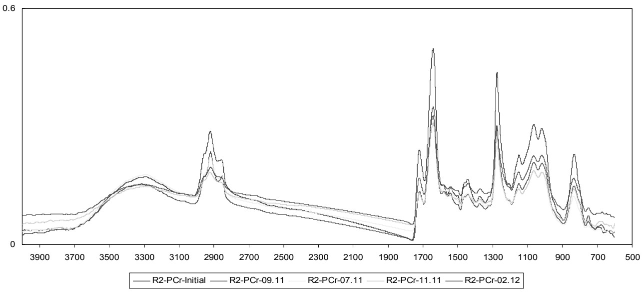

Fig. 6. Variation in time of IR spectra for sample of leather tanned with chromium salts for ratio C/N, R2 = 35

The biodegradation processes for leather wastes tanned with vegetals compounds were started after four months of composting processes for both ratios C/N. The intensity of processes increases in time. The biodegradation process took place in mezophilic temperature domain, during the final stage of composting and the start of the maturation stage, when the concentrations of nutrients decrease in composting systems and the microorganisms that were adapted at wastes using the specific enzymatic systems for biodegradation of the leather. The low toxicity of leather tanned with vegetal compounds determines the easy adaptation of microorganisms for biodegradation of leather.

The biodegradation processes of leather substitute start after four months of composting processes for both ratios C/N (Figure 10 and 11). The hydration degree of waste increases after eighth months, having a positive influence on the hydrolysis and oxidation processes of the main and lateral chains of polymer. The ratio C/N influences the rate of biodegradation, a high ratio C/N stimulates the leather substitute wastes biodegradation.

4. CONCLUSION

Initial C/N ratio influences the rate of composting process and the quality of compost. The waste type also influences the quality of compost, in presence of chromium tanned leather being obtained the compost of Class II and Class III, while in presence of the other samples were obtained the compost of Class I and Class II according compost/ soil amendment classification of the EPA 40 CFR 503.13 regarding final ratio C/N in compost.

The biodegradation of leather wastes tanned with chromium salts starts after six and eight months respectively for ratio C/N 25 and 35 respectively, and for leather wastes tanned with vegetals compounds started after four months from the beginning of composting processes for both C/N ratios. The intensity of processes increases in time. The biodegradation process took place in mezophilic domain of temperature during the final stage of composting and started the maturation stage when the concentrations of nutrients decrease in composting systems and the microorganisms are adapted with waste by using specific enzymatic systems for leather biodegradation. The lower toxicity of leather tanned with vegetal compounds determines the easy adaptation of microorganisms for biodegradation of leather.

REFERENCES

[1] Zerdani I. & Faid M. & Malki A. Digestion of Solid Tannery Wastes by Strains of *Bacillus Sp* Isolated From Compost in Morocco, International Journal of Agriculture & Biology, pp. 758-761. 2004.

[2] Chang J.I. & Tsai J.J. & Wu K.H., Waste Management Resources, 24, pp.354-362, 2006.

[3] Haynes RJ. The decomposition process: mineralization, immobilization, humus formation, and degradation. In: Haynes RJ (ed), Mineral nitrogen in the plant-soil systems. Academic Press, New York, pp. 52-126, 1986.

[4] Beffa T. & Staib F. & Lott Fischer J. & Lyon P.F. & Gumowski P. & Marfenina O. E. & Dunoyer-Geindre S. & Georgen F. & Roch-Susuki R. & Gallaz L. & Latgé J.P. Mycological control and surveillance of biological waste and compost. *Medical Mycology*, 36, pp. 137-145, 1998.

[5] Haug R. T. Compost Engineering Principles and Practices, Ann Arbor Science Publishers, First Edition, pp 23-48, 1994.

[6] Webley D. M. The microbiology of composting 1. The behavior of the aerobic mesophilic bacterial flora of composts and its relation to other changes taking place during composting. Proc. Soc. Appl. Bacteriol. 2, pp. 83-99, 1947.

[7] Kiyohiko N. & Shoda M. & Kubota H. Effect of temperature on composting of sewage sludge. Appl. Environ. Microbiol, 50, pp. 1526-1530, 1985.

[8] Zuccconi, F. & de. Bertoldi M. Compost specification for the production and characterization of compost from municipal solid waste, In: Compost production, quality and the use, (Eds.): M.De Bertoldi, M.P. Ferranti, P.L., Hermite and F. Zucconi, Elsevier Applied Science Publishing Co.,Inc., New York, pp. 37-59, 1987.

[9] Beffa T. & Lyon P. F. & Blanc M. & Lott Fischer J. & Aragno M. Influence of compost systems and management on the thermogenic biodegradation, maturation and hygienisation. In: *Recovery, Recycling and Re-integration*, (Eds: Barrage, A., and Edelman, X.). EMPA Dübendorf (Switzerland), vol 4, pp. 10-15, 1997.

[10] Bertoldi M. & Rutili A. & Citterio B. & Civilini M. Waste Manage Res, 6, pp. 239-259, 1988.

[11] Miller F.C. Science and Engineering of Composting: Design, Environmental, Microbiological and Utilization Aspects, in Hoitink, H. A. Keener H.M. (ed), Renaissance Publications, Worthington, OH, pp. 219-241, 1993.

[12] Gray, K.R., Sherman, K., and Biddlestone, Am.J. Proc Biochem, 6, 10, pp. 22-28, 1971.

OPTIMIZING THE TREATMENT OF WASTEWATER FROM A MINING UNIT USING A COMPLEX TREATMENT INSTALLATION

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ABSTRACT

For a higher efficiency of the waste water treatment process in the mining industry from Romania, this paper indicates a mixed treatment of industrial mining waste water with domestic waste water from the mining unit.

To perform this treatment process we used a complex treatment installation which meets in the same unit all the phases of municipal and industrial waste water treatment, namely: sewage clarification with the addition of reagents in vertical clearing tank; raw water treatment in a magnetic and electric field in order to potentiate the coagulation process; thickener drainage in screw filters; and clarified water passing through biological filters with added air for retaining organic matter, phosphates and nitrates.

To optimize the waste water treatment process we used Evolutional Exploitation Method with Self-regulation Simplex which is a version of evolutional exploitation to approach the optimal domain. Scheduling of tests and interpretation of obtained results are based on so-called "simplex projections".

To illustrate the principles of the method we consider y to represent the measured response and x_1, x_2 …x_n variables that influence the response. Research is made to observe how the modification of these variables affects the response y to find values for these variables closer to the optimal domain. The optimization of the process using this method was adopted in order to minimize the response function.

In order to apply this method to the complex treatment installation proposed by us we established that the technological parameters influencing the treatment process are: water flow, concentration of solid phase, concentration of ammonia nitrogen, organic matter content, air flow, exhaust thickeners flow.

Applying the calculation algorithm for the centre of the start simplex, the unitary changes and the changes for each parameter, steps taken towards the optimal point are found by calculi and verified by experiments, without the need for logical thinking of the events. But having the sequence of parameters for each test and the obtained results we demonstrated that the Evolutional Exploitation Method with Self-regulation Simplex surprises the synergistic effect of process parameters on the response function.

The complex treatment installation proposed by us can be used by any economic agent who has waste waters with similar characteristics.

Keywords: optimization, wastewater treatment, industrial wastewater, domestic wastewater

INTRODUCTION

Mining is a water intensive industry, contributing heavily to the pollution of recipient waters in the area. The composition of natural courses of water from water mining regions changes over time, depending on quantity and quality of incoming groundwater, storm water and waste water discharged into them.

The main sources of river water pollution in mining areas are waters resulting from extraction and processing of coal in preparation plants. The amount of water discharged from the underground, as a result of infiltration from surface mining network or technological water introduced in order to ensure the protection measures of people and deposit, directly discharged into the environment, ranging from 1.3 to 8 m^3/t, the main contaminants being the solid suspensions which are up to 8500 mg/l. [1]

Therefore, in order to achieve a higher efficiency of the waste water treatment process in the mining industry from Romania, this paper indicates a mixed treatment of industrial mining waste water with domestic waste water from the mining unit.

1. DESCRIPTION AND FUNCTIONING OF THE COMPLEX TREATMENT INSTALLATION

To perform this treatment process we used a complex treatment installation which meets in the same unit all the phases of municipal and industrial wastewater treatment. The aim is to destabilize the energy of the liquid to be purified, thus increase the purification and shorten the treatment time, purifying large amounts of water in a very small volume reactor. Decantation has a subordinate role of compaction, because the most part of the separation occurs under the effect of acceleration, forcibly superimposed to gravity, stacked in a closed hydraulic system.

The final treatment is done in the filtering columns through which the gas flows, which are part of the closed hydraulic system. [3]

The complex treatment installation is based on the synergistic effect of destabilizing colloidal systems with flocculating reagents added, clarifying the fluidized bed, denitrification, aerobic biodegradation of organic matter by passing the clarified water through a biofilter on the one hand, and draining it through the mud by pressing porous surfaces on the other hand.

The influent consisting of a mixture of mine water and wastewater is fed through the top of the strainer (1), together with chemical reagents. The conditioning chamber (2) is placed on a mechanical shaker (3) managing to mix reagents with the influent, in order to achieve the flocculation of solid suspensions.

Large floccules are captured in the funnel (5) and channeled into the mud cone (6).

Discrete particles and small floccules pass through the concentric space between the flocculator and the funnel (5) and leave the central tube through the space between the diffuser (7) and the deflector (8).

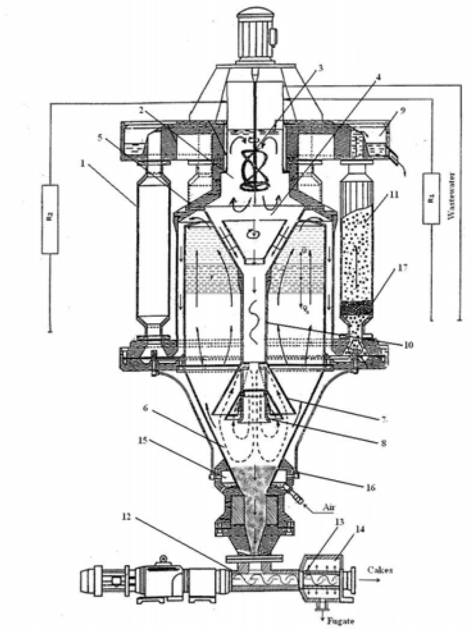

Figure 1. Complex treatment installation

1 –Decanter ; 2 – Conditioning chamber; 3 – Mechanical shaker; 4 – Flocculator; 5- Funnel, 6 - Cone of mud, 7 - Diffuser, 8 - Deflector, 9 - Overflow, 10 - Central tube, 11 - Filtering cylinders, 12 - Rotor worm pump 13 - Porous filter, 14 - Capture of fugate chamber, 15 - Chamber of equalization, 16 - Nozzles, 17 - Shaver foil, F- Filtering bed.

The system is open through the overflow(9) and communicates with the atmosphere creating an upward turbidity current, that carries along discrete particles and small floccules through the concentric space between the central tube(10) and the interior walls of the decanter. In these conditions, through an appropriate adjustment of the power flow there is formed a filtering bed (F), consisting mainly of particles with sedimentation rate, v_s, equal with the upward water speed, u. New water coming into the area, bearing suspension, will be required to pass through the bed (F) which retains solid fraction; above it there forms a layer of clear water that flows through the concentric space between the interior and the exterior walls of the decanter to the six filtering cylinders(11).

In order to use the complex treatment installation we inserted it into a technological flow, consisting in: mixing tank with stirring, mechanical stirrer, reagent metering pumps type Prominent, complex treatment installation, air compressor and power supply panel.

2. PRELIMINARY RESEARCH TO THE OPTIMIZATION METHOD

The description of the treatment plant showed us that the technological parameters influencing the treatment process are: water flow, concentration of solid phase, concentration of ammonia nitrogen, organic matter content, air flow, exhaust thickeners flow. To apply the optimization method to the complex treatment installation proposed by us we established some parameters to work with: water flow, air flow, exhaust thickeners flow materialized with the speed of the worm screw, concentration of solid phase, concentration of ammonia nitrogen, organic matter content, and to enhance clarification and denitrification processes we introduced two parameters namely flocculant reagent consumption and magnesium sulfate consumption.

Establishing these parameters was the first step in our research. In order to continue our study we had to make some preliminary research, namely: determination of the quantity of oxygen dissolved in water depending on the air flow of blast, the physico-chemical characteristics of raw water, clarification preliminary tests, setting the water flow and the specific consumption. Table 1 presents the values for raw water quality, and maximum concentrations allowed (MCA) to see where the limits are exceeded.

Tabel 1. The physico-chemical characteristics of raw water

	Parameters	UM	Determined value	MCA
1	pH	pH units	7,02	6,5 – 8,5
2	TDS	mg/l	505	2000
3	Conductivity	µS/cm	2380	-
4	Solid suspensions	mg/l	1576	60
5	NH_4^+	mg/l	2,95	3
6	CCO-Mn	mg O_2/l	41,08	125
7	SO_4^{2-}	mg/l	43,5	600
8	Dissolved Oxygen	mg/l	5,40	min 4

3. OPTIMIZING THE TREATMENT OF WASTEWATER USING EVOLUTIONAL EXPLOITATION WITH SELF-REGULATION SIMPLEX METHOD (EEOSAR)

To optimize the waste water treatment process we used EEOSAR method which is a version of evolutional exploitation to approach the optimal domain. Scheduling of tests and interpretation of obtained results are based on so-called "simplex projections".

To illustrate the principles of the method we consider y to represent the measured response and $x_1, x_2 \ldots x_n$ variables that influence the response. Research is made to observe how the modification of these variables affects the response y to find values for these variables closer to the optimal domain. The optimization of the process using this method was adopted in order to minimize the response function.

EEOSAR working technique is as follows:

1. there are made three initial trials, that form the start simplex and the *y* variable is measured in all the trials; if we have *n* variables we must have *n+1*trials;
2. in order to generate the forth trial there is built a symmetric of the point with the lowest response to the line that unites the points that represent the other two trials; this new trial and the other two left, form now the new simplex;

3. a new trial is made and then return to point 2, this procedure will lead to a region with a higher response.

The particularity of the simplex method is that coordinates' changes in relation to the focus are not equal and of opposite sign, but every attempt has one positive (negative) change for each of the *n* variables, that equals the sum of negative(positive) changes in absolute value. There are *n-i* trials in which the *i* variable stays the same.

In this paper the EEOSAR method is adopted to minimize the response function. The unknown response surface , for the solid concentration phase, with restriction regarding the ammonia, fixed residue and sulfate, will have the aspect of a "cauldron", not of a "hill". The optimal point will be situated at the bottom of the cauldron. (Figure 2).

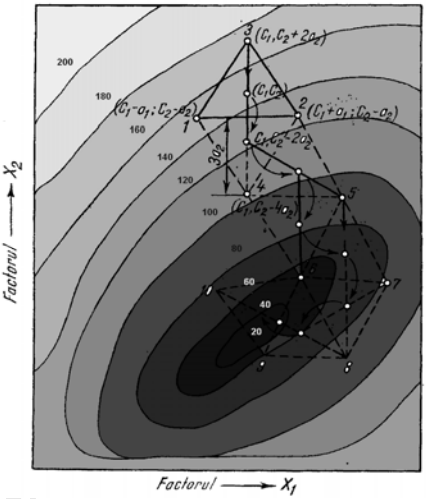

Figure.2. Geometric interpretation of simplex projection

Establishing the start simplex for five process variables

Once the complex technological treatment was done we started to check on the power flow, dosing of chemical reagents, sludge disposal and the time required for settling.

Therefore we have seen the influence of each process parameter on the response function, content of suspensions in the effluent, having as limitative parameters of water quality CCOMn, NH_4^{+}, SO_4^{2-}. Also based on these preliminary verifications and the matrix of coefficients we established the unitary changes for each parameter.

In order to apply the EEOSAR method to the complex treatment installation proposed by us we established that the technological parameters influencing the treatment process are:

x_1- water flow, l/min;

x_2 – flocculant reagent consumption , ml/l;

x_3 – $MgSO_4$ consumption, mg/l;

x_4 – air flow, l/min;

x_5 –worm screw speed, rot/min.

This optimization method is based on a form work presented in table 2.

Table 2. The form work for EEOSAR method

Specification		**Variables, x_i**								
		x_1	x_2	x_3	x_4	x_5	y mg/dm^3	CCO_{Mn} mg/dm^3	NH_4^+ mg/dm^3	SO_4^{2-} mg/dm^3
a) Basis level(centre of start simplex)		1,16	2	50	12,61	90	126	10.42	1,36	43,01
b) Unitary changes, S_i		1	3	63	6,83	70				
c) Modification, ai		0,5	0,86	12,85	1,08	9				
Trials in the start simplex	*1*	1,66	2,86	62,85	13,69	99	132,56	16,43	0,88	31,9
	2	0,66	2,86	62,85	13,69	99	79,47	12,64	1,00	36,15
	3	1,16	0,28	62,85	13,69	99	175,07	14,24	0,92	32,96
	4	1,16	2	11,44	13,69	99	167,28	13,62	2,07	38,55
	5	1,16	2	50	8,29	99	149,14	16,34	1,63	51,66
	6	1,16	2	50	12,61	45	186,53	12,58	1,88	59,58
Step 1 of improvement	*7*	1.16	2	49.996	12.61	153	94,87 / 96,02	12,18	1,02	32,32
Step 2 of improvement	*8*	1.16	4.408	32.	11.098	120	74,71 / 75,49	15,71	1,14	29,17
Step 3 of improvement	*9*	1.16	3.65	91.64	10.06	129	45,79 / 46,08	16,04	0,62	28,40
Step 4 of improvement	*10*	1.16	4.31	69.73	16.16	141	22.7/ 22,98	10,58	0,71	27,25

The fact that after only 4 steps of improvement the optimum is achieved in conditions in which the other control parameters are within the MCA is due to the coagulation capacity of the Mg^{2+} ion.

SO_4^{2-}ion found in the clarified water is excessive but not exceeding MAC, this is explained by the consumption of Mg^{2+} both as a coagulant and as a neutralizer of the ammoniacal nitrogen.

According to Henry's law and taking into account the ambient temperature and barometric pressure at the time of testing, as well as air insufflations' pressure in the system, based on correlation curves and tables of results, we could convert the content of the blast air flow into dissolved oxygen. The value of dissolved oxygen for the waters discharged into the environment is greater than 4 mg/dm^3. In the 10^{th} trial, which is optimal, the dissolved oxygen content is 12.19 mg/dm^3.[2]

CONCLUSIONS

Applying the calculation algorithm for the centre of the start simplex, the unitary changes and the changes for each parameter, steps taken towards the optimal point are found by calculi and verified by experiments, without the need for logical thinking of the events. But having the sequence of parameters for each test and the obtained results we demonstrated that the Evolutional Exploitation Method with Self-regulation Simplex surprises the synergistic effect of process parameters on the response function.

To characterize the operation of the installation in terms of effectiveness of treatment we calculated the efficiency for each parameter, with the equation:

$$E = \frac{a-b}{a} \times 100$$

Where: E- treatment efficiency;

a – pollutant in the influent;

b - pollutant in the effluent.[4]

The best efficiency was recorded for the solid phase concentration, which was the response function in the optimization method.

The complex treatment installation proposed by us can be used by any economic agent who has waste waters with similar characteristics.

REFERENCES

[1] Marchis D.M. Iclanzan R. Provenance of wastewater from E.M. Petrila and their influence on Eastern Jiu, National Student Symposium "Geoecologia", Petrosani, Romania, 2010;

[2] Marchiş D., Şipot C., Sârbu R. Experimental research on the treatment of wastewater from EM Petrila, National Student Symposium "Geoecologia", Petrosani, Romania, 2010;

[3] Nagy A., Process for purification of liquids and apparatus for performing this procedure Patent no. 42 25 967, declared on 06.06.1992, Munich, 1992;

[4] Sarbu R., Traista E., Badulescu C., Procedures and equipment for waste water treatment, lithography of University of Petrosani, Romania, 1994;

[5] Simionescu A., Nagy B., Optimizing the processes of preparation of useful mineral substances, Ed. Tehnică, Bucureşti, Romania, 1979.

PERMEABILITY FOR WILDLIFE MIGRATION IN THE BIOREGION PODBESKYDI

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ABSTRACT

In most cases, the problem of migration pathway for higher animals (as *Lynx lynx, Ursus actors, Canis lupus, Cervus elaphus, Alces alces*), is not actualization for USES, (Territorial System of Ecological Stability) for territorial planning. Ecological centres and ecological corridors are structural elements of USES, but not migration routes.

This term (migration route) is not protected by the Czech legislation. The theoretical part of this article, deals with the characteristics of the area designed and mapping (migration throughput of the landscape Podbeskydi) and the theoretical approaches to the examined issues.

There is also the brief methodology of creating ecological corridors and migration routes, because these terms are different. The practical section summarizes the current state of conservation of nature and landscape in the area, describes the methodology and field work are localized hot spots of migration route.

Summary of this work is to determine whether the line of migration route is properly conducted, and then there is a proposal a new line of migration route. All practical results are represented by maps, created by GIS software.

Requirement for the investigation of this migration route was placed by Agency for Nature Conservation and Landscape Protection of the Czech Republic, subdivision Ostrava.

Keywords: ecological corridors, migration routes, landscape Podbeskydi, USES, territorial planning, GIS software.

INTRODUCTION

The region of Podbeskydi is recreation zone of Ostrava inhabitants. This landscape isn´t impacted area by industry, that´s why, there is the typical landscape character – the foothills of Beskydy mountains. Attractiveness of the housing in this region increases, the typical dispersed developed area is changing the satellite housing, connected route network. These constructions have disruptive effect, or rule out the migration of animals.

Some of the mountains whole become the separate islands in landscape, the developed valleys become migration barriers for the keystone species, protected as *Lynx lynx, Ursus actors, Canis lupus, Cervus elaphus, Alces alces*).

Fragmentation of the landscape becomes substantial and very complicated problems of conservation of nature and landscape. In the future may result in catastrophic after effects for all ecosystems. In framework of construct Territorial System of Ecological Stability (USES), in the Czech Republic has legislative support, the base building elements are ecological corridors, but these haven´t identical lines with migration routes in landscape.

These problems solve in the Czech republic legislative support, as Act No. 114/92, of the Czech National Council, on nature and landscape protection, in the wording of the pursuant regulations. Here gives a definition USES, the base elements for mapping migration throughput of landscape. The next legislative support is Regulation No. 395/1992 of the Ministry of the Environment of the Czech Republic., implementing certain provisions of Act No. 114/1992. and Act No. 183/2006 on territorial planning and Building Code (the building act), in wording of the pursuant regulations. USES not discusses the problems of the migration throughput for all species animals. The design the migration corridors are simply the territorial analytical documentation, but legislative treatment is absent here. Present have a discussion about the possibility of the connection migration routes with existing system of USES, during his update. This solves a problem of legislative conservation measures of the actual and possible migration routes.

Materials and methods

Methods are in parts:

- ✓ **Define and specify the area and the choice of the map materials:**

Map materials for creation migration route, requirement for the investigation of this migration route was placed by the Agency for Nature Conservation and Landscape

Protection of the Czech Republic. It used software ArcMap (ArcGis Desktop 9.3). Used data - line stratum of migration, vector data of the database DMU25 (line stratum of roads, waters, orthophoto maps, obtained by the Agency Cenia (www.geoportal.cenia.cz).

Downstream processing were used map materials as maps of territorial planning of the municipality Kuncice p. Ondrejnikem and Frenstat pod Radhostem, administration centre of the interest group, map scale 1:5000, 1:10000, where are perceptible the future purpose of the settlement development. The mapping part of migration route was evaluated and diveded into two category. The first category is the territorial migration throughput (forest area) and the second category the territory difficultly throughput (with problematical, questionable points, areas). It was necessary to pay attention to problematical territory, with mapping of disturbing impacts, have an influence on permeability of landscape. The selected tracts, parts, according to map materials and then were consulted with civil servant of municipal office.

- ✓ **Field observation, fieldwork, and data collection:**

During terrain research were taken photos of problematical territory, these sectors were mapping by GPS instrument **(**Garmin eTrex Vista HCx) for making a new map of the migration throughput by technology GIS. It got in network of points, scanning GPS technology, for new migration route was suggested after evaluation of all problems sections on examined route. The area was studied from point of view the mapping forest area and treeless area.

- ✓ **Methods landscape design of migration routes and their parameters:**

The concept assessment of migration throughput stresses, natural and anthropogenic barriers in landscape run as the filter, which can get over only a part of individuals of species (NOSS, CSUTI, 1994)[3]. The function of migration route can meet without fence meadow. The ecological corridors for long distance migration of high mammals should have at least width: 500 m. The width of migration route should have: one hundred metres. In narrow neck, when the migration route have a conflict with barrier (as building), should have the width at least 50 m, very critical is width 10 m. (ANDEL, MINÁRIKOVÁ, ANDREAS, (eds.), 2010)[1].

- ✓ **Own methods assessment of migration route, problematic parts:** The own methods were used owing to deficiency in expert methods for mapping and evaluation the permeability of landscape. We have decided these parameters:

  Watercourse – the presence of course, his width, his depth, the inclination of river bank. Evaluation of adjustment of river valley. The evaluation if the river is migration barrier.

Transport Network – the presence of road and railroad transport, the number of streams, frequency of transport.

Vegetation – the presence of vegetation area, her cover, species composition.

Housing development – the presence of building area, the type of housing development (continuous and dispersed).

Territorial System of Ecological Stability – the presence of the ecological corridors, the ecological corridors as supporting elements.

Aforementioned standards of throughput migration route were lastly assessed, every problematical areas, points, considering migration requirement of animals on the basis of three grades:

Good – animals can easily get over barrier.

Suitable – animals get worse over barrier, only a part of individuals get over barrier.

Unsuitable - animals cannot get over barrier.

Results and Discussion

The animal migration in agricultural-forest landscape use fully hedgerow, scattered vegetation and terrain depression. In preference are used landscape components, outside building zone.

The results are in parts:

- the evaluation of problematic stretches
- the project of new migration line
- evaluation of new migration line according own methods
- the project arrangement for amelioration connection region landscape

Final product is complex long distance migration corridors, which can integrate into territorial planning as separate stratum of GIS. All practical results are represented by maps, created by GIS software, as Fig.1. We prepared very significant map documents for territorial planning.

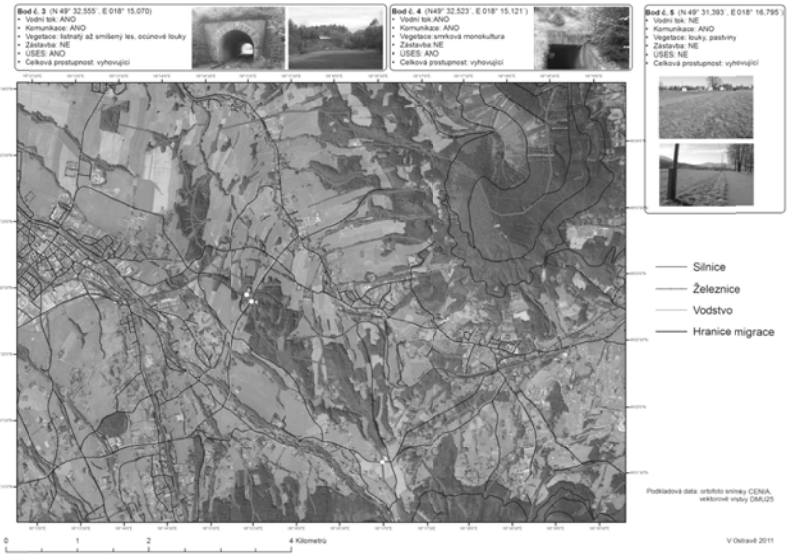

Fig. 1: Map of migration throughput of the landscape Podbeskydi

Legends: red line – migration routes, blue line – network of watercourse, black line – transport network.

Photos from fieldwork.

Conclusions

The project arrangement for amelioration connectivity landscape in region and migration significant area is based on providing for implementation elements USES in region Podbeskydi and care for present and future long distance migration corridors, their integration into territorial plan as individual element, which not be changed with elements of USES. The result of the isolation migration population can be reproduce excessively, the other way around, becoming extinct location population consequence the genetic degeneration by inbreeding (KRAJČA, KUTAL, 2010 a)[2].

REFERENCES

[1] ANDĚL, P.; MINÁRIKOVÁ, T.; ANDREAS, M (eds.): *Ochrana průchodnosti krajiny pro velké savce*. Liberec : Evernia, 2010. 137 pp. ISBN 978-80-903787-5-9.

[2] KRAJČA, T.; KUTAL, M. (a). *Migrace velkých savců v Jablunkovském průsmyku*. Olomouc : Hnutí DUHA Olomouc, 2010. 27 pp.

[3] NOSS, R.F.; CSUTI, B. *Habitat fragmentation*. Sunderland, Massachusetts, USA: Sinauer Associates, Inc. 1994. 264 pp.

PERSISTENT ORGANIC POLLUTANTS IN ROMANIA

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ABSTRACT

As a result of treating the soil casual indifference Romania today has many contaminated sites, some of them unidentified. As a part of Stockholm Convention, Romania started to apply the National Plan regarding the inventory and elimination of POPs. The main activity is the inventory of both, deposits and contaminated sites all over the country.

The paper present the situation of Polychlorinated Biphenyls - PCBs, quantities found out in Romania, the spreading on the territory and also the possibilities to apply some technologies in order to clean contaminated sites. The technologies proposed consist on two versions: 1) Excavation and disposal of soil ex-site and 2) Excavation and treatment by incineration. The analyses shows that the second technology is more effective and cheaper.

Keywords: Persistent Organic Pollutants, Stockholm Convention, cleaning technologies

INTRODUCTION

Persistent Organic Pollutants (POPs) are chemical substances that persist in the environment, bio-accumulate through the food web and pose a risk of causing adverse effects to human health and the environment. There is the evidence of long-range transport of these substances to regions where they have never been used or produced and the consequent threats they pose to the environment of the whole globe, the international community has now called for urgent global actions to reduce and eliminate releases of these chemicals.

Persistent Organic Pollutants are toxic synthetic organic chemicals that are used in industry and agriculture, as well as created unintentionally through chlorine combustion processes [1]. There are currently twelve of the most dangerous POPs under the scrutiny of the Stockholm Convention, a treaty signed by over one hundred countries and ratified by over fifty countries with the express purpose of eliminating these dangerous chemicals on a global scale. These twelve chemicals are aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex, toxaphene, polychlorinated biphenyls (PCBs), hexachlorbenzene, dioxins, and furans. POPs are particularly harmful because, by their nature, they are highly soluble in lipids, allowing them to accumulate in fatty tissues and thus biomagnify up the chain. This is why they are of particular threat to high level predators -including humans.

There are three major reasons for the production of Persistent Organic Pollutants: 1. Most are produced intentionally as commercial products, particularly pesticides. The most harmful pesticides include aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex, and toxaphene [1].

2. Persistent Organic Pollutants are also produced for use in industrial processes, such as coolants for electrical transformers. This group includes polychlorinated biphenyls (PCBs) and hexachlorobenzene-HCH [1].

3. The third category encompasses Persistent Organic Pollutants that are produced unintentionally in industrial processes, as the by-products of the manufacture, use, or combustion of chlorine and chlorine-containing materials. This group includes dioxins and furans [1].

THE OCCURRENCE OF PCBs AND THE DISTRIBUTION OF PCB USE

Polychlorinated biphenyls or PCBs are synthetic organic substances and belongs to the class of chlorinated hydrocarbons. This subset includes all compounds with a biphenyl structure that have been chlorinated to varying degree (Figure 1). Theoretically, a total of 209 possible PCB congeners exist, but only about 130 of these are likely to occur in commercial products [2]. Commercial PCBs are a mixture of 50 or more PCB congeners.

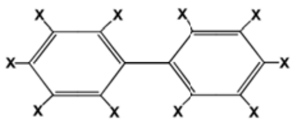

Figure 1 Molecular structure of PCBs

$C_{10}\,H(10\text{-}n)Cl_n$, X = H or Cl

PCBs have been produced on industrial scale for more than fifty years and have been exported as chemicals and in products to virtually every country in the world. Countries that have manufactured PCBs include Austria, China, Czechoslovakia, France, Germany, Italy, Japan, the Russian Federation, Spain, the United Kingdom, and the United States [3], [4]. PCBs were commonly used as dielectric fluids in transformers and capacitors, in heat transfer and hydraulic systems, and as ink solvents in carbonless copy paper. Other uses of PCBs included the formulation of lubricating and cutting oils, as plasticizers in paints, in adhesives, in sealants, as flame retardants, and in plastics.

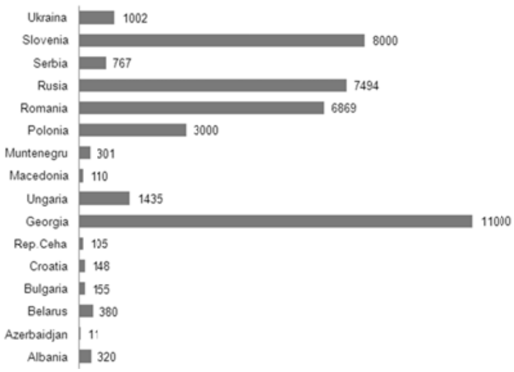

Figure 2 Quantities of PCBs demanding Environmental System Management in Central and Eastern European Countries [5]

These PCB fluids were sold to various manufacturers, and some of the products that contained PCBs were exported to developed and developing countries. In Germany and Japan, sale for use as dielectrics-mostly in transformers and capacitors- represented over half of all PCB-use [6], [2].

Most CEE countries currently hold PCB wastes in long-term storage. In general, adequate capacity for environmentally sound disposal of PCBs is still lacking in the CEE region and substantial amounts of wastes are transported to France, Germany, the Netherlands and Switzerland for destruction (Figure 2).

INVENTORY OF PCBs IN ROMANIA

Once the National Plan for Implementation of Stockholm Convention entered in force, in Romania started the actions for elimination of devices containing PCBs as dielectric fluid [9]. Since 2008 the inventory regarding the number of transformers and capacitors was updated. There where about 8000 of such devices and already 1200 tones of waste containing PCBs where destroyed.

In Romania, at the end of 2009, the emission of PCBs decreases from 223.6 kg in 2005 to 62.855 kg (Figure 3). The most important sources of emission are represented by industry of steel, lead and iron.

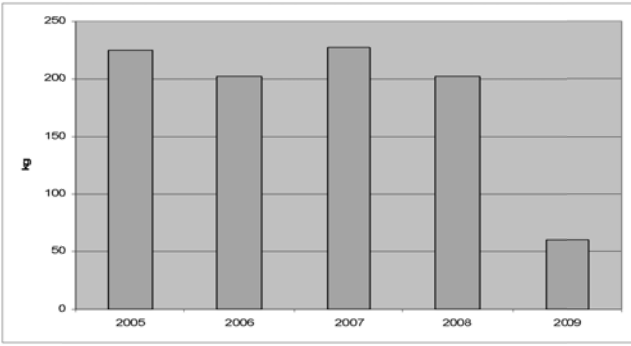

Figure 3 Total PCBs emmission in Romania

The actions of National Plan for Implementation 2011 have two directions:

- The elimination of PCBs from or together with the functional devices – no later than 2028;
- The elimination of PCBs contained in the waste-equipments;

Even if all the waste-equipments should be destroyed to the end of 2011, the data collected by Romanian Environmental Protection Agency shows a number of 7117 existed equipments.

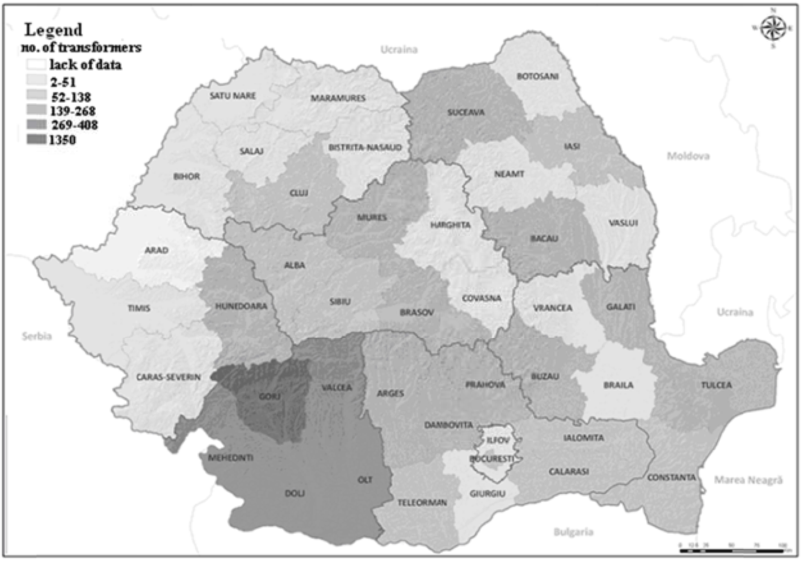

Figure 4 Allocation of transformers in Romanian county in 2009

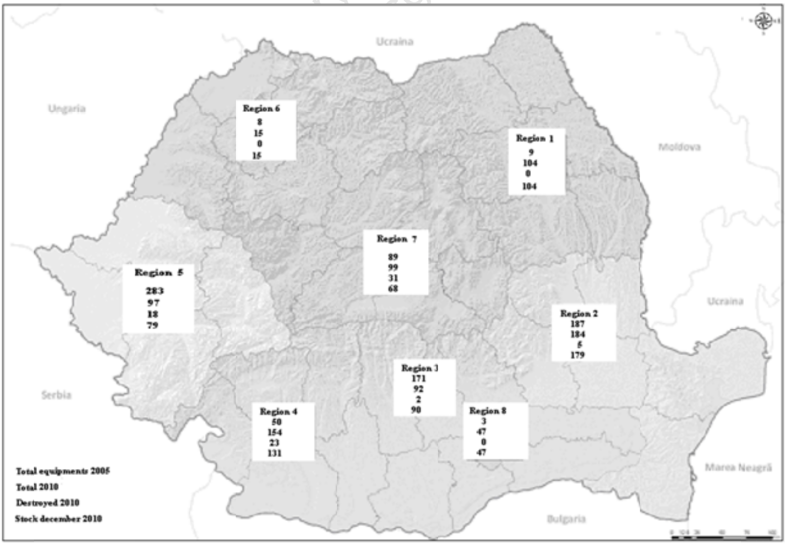

Figure 5. The stage of elimination for the transformers – number of pieces

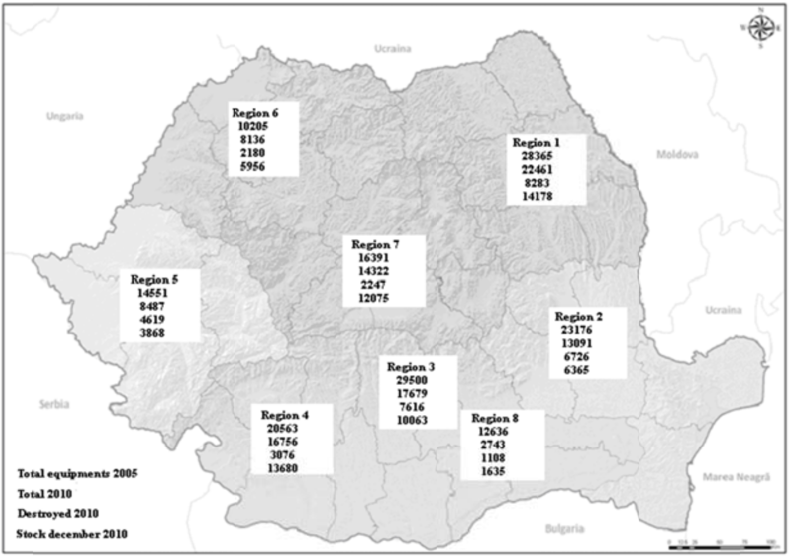

Figure 6. The stage of elimination for the transformers and capacitors – total number of pieces

PROPOSED TECHNOLOGIES TO REMOVE PCBs

The technologies proposed have the objective of land decontamination and corresponds to the provisions–elimination of PCB and pesticides being included in the first objectives out of 11 objectives from Romanian National Implementation Plan of Stockholm Convention [10].

The soil contaminated with PCB belonging to an industrial platform – 15 ha – a transformer and capacitor factory, in the west of Romania, total polluted surface area being 500 m^2, total volume of soil to be decontaminated - 500 m^3 (Figure 7). The cleanup plan has been drawn up based on two technical versions which were thought to be plausible:

- Excavation and disposal of soil ex-site
- Excavation and treatment by incineration

Excavation and disposal of soil ex-site - soil removal and dumping in an isolated controlled area. The contaminated soil is extracted from the delineated area at the transformer factory and transported to the approved new deposit. This deposit will be arranged in such a way that all risks would be eliminated, as much as possible (Figure 8). An insulated deposit consisting in two reinforced concrete basins – 4 m (width) x 20 m (length) x 3 m (effective depth) are provided. The contaminated soil is covered by clay (20 cm – thickness). Turf will be planting on the filling up soil.

The deposit will be covered and no leachate exists. The hazardous waste deposit will be watched by 4 persons during 30 years. Extension was provided. The necessary estimated area is 25 x 45 = 1,125 m^2. The hazardous waste deposit will be supervised - watched and monitorized - during 30 years time. All expenses during this time have been evaluated. All facilities, namely- electricity, water supply, etc. have been evaluated.

Figure 7 Layout plan of transformer factory

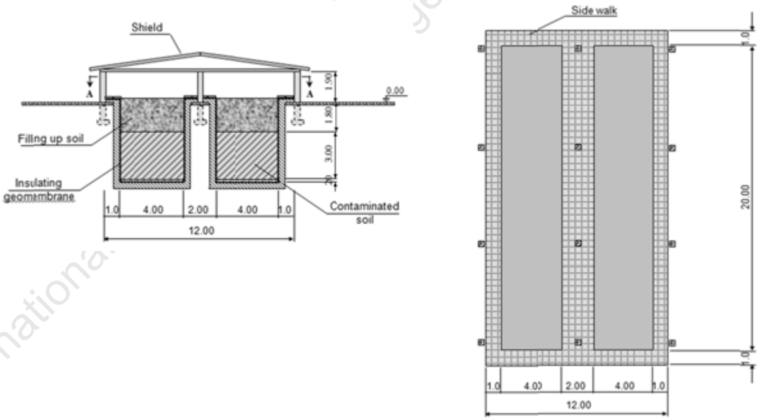

Figure 8. Deposit of contaminated soil at the transformer factory – Scheme of final disposal, 1 : 200

Excavation and treatment by incineration at on adequate plant - soil removal and transportation to the incineration plant which is especially designed for persistent organic pollutants incineration. The exportation line has been evaluated according to the preliminary offer value of the operators acting in Europe. The specific price offer is about 2 Euro per kg of PCB waste, including packaging, shipment.

The proposed technologies have both, advantages and disadvantages as following:

Excavation and disposal of soil ex-site:

- **Advantages**
  1. It is a cheaper method if a proper location will be found and properly arranged in order to avoid pollution of the surrounding area.
  2. The dumping site could be designed to receive contaminated soil from the other places in the country. That is more job opportunities and some more money could be earned with this service.

- **Disadvantages**
  1. The problem of existing deposit is transferred to the another controlled deposit.
  2. Storage is a necessary element of the management of PCB wastes, but is not a long-term option. PCB wastes and PCB contaminated equipment need to be stored under sound (and regulated) conditions before shipment and/or treatment/destruction. Areas storing drums and equipment containing PCBs should be bounded [7].

Excavation and treatment by incineration:

- **Advantages**
  1. It does not suppose any risk of environment pollution after incineration of PCB content. The most widely used and proven technology for destroying PCBs is high temperature incineration. Properly done, this has been shown to destroy PCBs at a destruction efficiency of 99.99 % [7].
  2. It does not need any aftercare measures of maintenance or operation because there will be no final disposal of resulted ashes on the territory of Romania-the contaminated soil will be exported to a specialized company.

- Disadvantages
  1. After incineration the treated soil can be used only as fill material[8]

Table 1. Rough costing of cleaning up the factory site (in USD)

No	Activity description	Excavation and disposal of soil ex-site	Excavation and treatment by incineration
1	***Expenses for land licensing and land arrangements***	**10,000**	**3,350**
2	***Expenses for designing and technical assistance***	**39,000**	**18,000**
3	***Expenses for basic investment***	**148,986**	**-**
4	***Expenses for work organizing and legal taxes***	**23,000**	**1,000**
5	***Training of operation, maintenance and public participation***	**7,000**	**5,000**
	TOTAL (1 + 2 + 3 + 4 + 5)	**229,000**	**27,350**

No	Measure	Activity description	Cost evaluation	
			Version 1	*Version 2*
6	Operation and	Monitoring, watching, sampling, interpretation of analysis made,	One person per shift of 8 hours per	-

	Maintenance Costs	reporting, maintenance of installations, administrator (heating, lighting, water consumption and discharge, solid waste disposal)	day + 1 person in reserve Monitoring is to be run during 30 years 42,880.000	
		Exporting the contaminated soil (waste) for elimination, including building demolition and decontamination	1,000000	2,394000 1,000000 – demolition and decontamination of building
		TOTAL COST for Elimination / Final disposal	**4,109.000**	**3,421.350**

CONCLUSION

Comparing the two studied technologies one can conclude that **Excavation and treatment by incineration** has been resulted to be cheaper and the PCB is definitely eliminated. In **Excavation and disposal of soil ex-site,** the problem of existing deposit is transferred to the another controlled deposit.

REFERENCES

[1] http://www.epa.gov/tri

[2] Neumeier, G. The technical life-cycle of PCBs. Subregional Awareness Raising Workshop on Persistent Organic Pollutants (POPs), Slovenia, May 1998;

[3] Fiedler, H. Polychlorinated Biphenyls (PCBs): Uses and Environmental Releases. Presented at the Subregional Awareness Raising Workshop on Persistent Organic Pollutants (POPs), , Thailand, 1997.

[4] Environment Canada. Meeting Background Report, Vol. IV. Prepared for International Experts Meeting on Persistent Organic Pollutants Towards Global Action, Vancouver, Canada, 1985.

[5] Jaromír Manhart, PEN magazine, PCBs elimination network-sharing information of PCBs, Inventories of PCBs. The place to start! UNEP, (www. pops.int/pen)

[6] Dobson, S.; van Esch, G.J. Environmental Health Criteria 140: Polychlorinated Biphenyls and Terphenyls, 2d ed.; World Health Organization, International Program on Chemical Safety (IPCS) Switzerland, 1993.

[7] UNEP Chemicals. Inventory of Worldwide PCB Destruction Capacity, September 2004, United Nations Environment Program, 2004, pp. 11, 31.

[8] Barnes D., Laderach Sh., Showers Ch., Treatment of Petroleum Contaminated Soils, Misoulla Techonologies and Development Center, USA, 2002, pp. 31-32

[9] The National Research and Development Institute for Environment Protection – "National Implementation Plan for Stockholm Convention, Romania, 2005".

[10] Ministry of Environment and Water Management – "Implementation Plans for EU Environmental Directives (eg Council Directive 96/59/EEC on the disposal of Polychlorinated Biphenyls and Polychlorinated Threephenyls, PCBs/PCTs).

PREVENTION OF ENVIRONMENTAL RISKS OF TAILINGS PONDS

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ABSTRACT

The authors present results of experiments in research and development of new remediation technologies unconventional pond dross ashes mixture by using structured layers stabilized, soil and land. Stabilisation material while the by-product of the desulfurization of power plant technology in combustion processes. The biologically reclaimed pond can grow different species of plants and use them as co-incineration of biomass with coal in the same technology. The solution thus achieves a synergistic environmental-economic-security effect.

Keywords: environmental risks, tailings ponds, dross ashes mixture, stabilization material,

INTRODUCTION

Effect of plants on the environment and is now a global problem. Fly ash and slag (dross ashes mixture) resulting from the combustion of coal is waste that burdens the environment in the wider vicinity of power plants and landfill sites are in terms of landscape stability and severe environmental-safety problems that must be effectively addressed.

Especially in the case of dumping large quantities of such wastes in an area of huge tailings ponds there is a real danger of breaking up the dam with serious Crisis consequences for the population, components of the environment and property in general. The tailings ponds are stored in very fine waste containing significant amounts of water, whose mobility if released from the pond is large, so they can migrate to long distances, particularly over the surface water flows, including transboundary impacts, impacts on the landscape areas and protected areas of European importance. [2]

It is therefore necessary to ensure adequate management of these wastes, to ensure long-term stability and security of tailing ponds after conclusion especially preventive environmentally sound technologies.

1 .TAILING PONDS IN SLOVAK REPUBLIC

In Slovakia, there is 53 different types of tailing ponds of material deposited in various stages of their life cycle, respectively existence. They are deposited mainly waste from power plants and heating plants (slag, ash), products of ore treatment (flotation sludge), coal gangue and the like. Ponds are generally large and environmentally dangerous objects, and therefore safe closure and rehabilitation potential to become the hot topic of environmental security. [1]

Types of impoundments:

25 with ash material,

20 with ore,

8 others.

The present Tailing ponds are still expensive and also environmentally dangerous objects. This is demonstrated by example. The accident in the Hungarian village of Ajka, where on 4th October 2010 the dam pond broke after heavy rains. Subsequently, more than 700,000 cubic meters of red sludge flooded the neighborhood and toxic mud struck seven villages and towns. They destroyed dozens of homes and the environmental disaster has claimed up to ten human victims and over 150 injured. The tab. 1 shows examples of other accidents at tailings ponds fatal and environmental devastation. For this reason, the discussion about closing these ponds is very actual. [4]

Tab.1 Examples of tailing ponds from the world of accidents resulting in death

Tailing Pond - dam break			
Town/Country	**Date**	**Number of death**	**Type of pond**
Zemianske Kostoľany (Slovakia)	26.5.1965	4	Ashes from heat power plant
Stava (Italy)	19.7.1985	268	Fluorite sludge
Harmony (South Africa Republic)	6.2.1994	10	cyanide pond
Placer (Philippines)	2.9.1995	12	sludge
Ajka (Hungary)	4.10.2010	10	Red sludge

The European Union currently allocates huge funds in development projects for member countries to prevent and remedy environmental damage, hence the restoration and rehabilitation of tailing ponds dross ashes biological mixtures. [6]

1.1 Tailing Pond of EVO Vojany

Vojany Power Plant is the biggest fossil fuel plants in Slovakia, where such fuel is used mainly semianthracite coal from Ukraine and Russia. Currently, the plant operates two facilities for disposal of waste products from coal combustion:

- ailing ponds with dross ashes mixture,
- dump with stabilisation material.

The pond with two cassettes of dross ash mixtures (cassette no. 1 is already closed) are stored as hydraulic transport of coal combustion products and the self-imposed dump with stabilisation material, which is a byproduct of the desulfurization of power plant technology, combustion processes. [5]

Fig. 1 Tailing ponds

Pond of EVO plant Vojany is water works and its operation and safety oversight within the relevant legislation. It was built in 1965 to store dross ash mixture. Located on the left bank of the river Laborec in the administrative area village Vojany and Drahňov, on the verge of PLA Latorica and is bounded on all sides by raising grass covered embankments. Pond consists of two separate approximately the same cassettes:

- Cassette No. 1 – 29 ha,
- Cassette No. 2 – 27 ha.

Cassettes are separated by dividing dam, which originally had the function of the peripheral dam cassette No. 1. This means that the area to be addressed after the final shutdown of the pond is about 56 ha. [3]

2 .LABORATORY EXPERIMENT

The authors present performance of the experiments in the research and development of new remediation technologies unconventional pond dross ashes mixture by using structured layers stabilized, soil and land, to replace previous legislative solution in the form of drainage system and the overlap hydro film material.

For verification of replacement waterproofing properties of stabilizer was based experiment simulating any large-scale use of this new non-traditional, uncertified practice anywhere technology. The purpose of verification or experiments was to assess the possibility of using stabilisation material due to its potential ability to prevent solidification of penetration of rain water into the lower layers of the pond, with the risk of a subsequent accident.

Covering the energy crop is a mixture of grass varieties that are resistant to typical and local conditions as to the future consideration of a pond grown plants used as biomass for co-incineration with coal in power plants. Experimentally it is verified and the cultivation of fast growing willow Swedish and with respect to its root system was therefore used in the experiment and subsoil thickness of 500 mm.

The laboratory experiment was set up with the following procedure:

- on the bottom of 2x11 container with size of 1000 mm x 1000 mm x 1000 mm was stratified the stabilisation material, with thickness of 0, 50, 100,150, ..., 450, 500 mm**,**
- this layer was then deposited in the soil subsoil thicknesses of 300 mm for grass, 500 mm for willow, which reflect the profile subsoil rehabilitated land,
- the last build up layer of topsoil with a thickness of 200 mm is uniformly for all variants, like the subsoil, even topsoil profile describe the reclaimed area,
- half of containers was located in areas with variable weather conditions and the other half for use in the local climate. [7]

Tab. 2 Requirements for growing

	subsoil	**topsoil**	**soil together**
grass	300 mm	200 mm	500 mm
willow	500 mm	200 mm	700 mm

In the following table is an analysis of slag and ash and the Fig. 2 shows the structured layers in individual containers used in the experiment. Used stabilisation material has pH 8,45 and conductivity 38,7.

Tab. 3 Analysis of slag and ash

	Slag	Ash
D10	0,085 mm	0,0095-0,024 mm
D_M	4,0 mm	0,015-0,032 mm
φ	40°	25°-30°
c	0	0,0-0,5 $t.m^{-2}$
γ	1,60-2,0 $t.m^{-3}$	0,9-1,43 $t.m^{-3}$
k	10^{-1}-10^{-2} $cm.s^{-1}$	$1,3.10^{-4}$ -3.10^{-4} $cm.s^{-1}$

where:

D10 - the average particle diameter,
D_M - maximum diameter of particles,
φ - angle of internal friction,
c - the value of cohesion,
γ - density,
k - coefficient of seepage.

The containers were filled with layers of stabilisation material, subsoil and topsoil layers according to their draft. The first container was filled without a layer of stabilizer, as a control container - do nothing. Individual layers after they were filled with compacted sufficiently to attempt what was closer to actual conditions. [7]

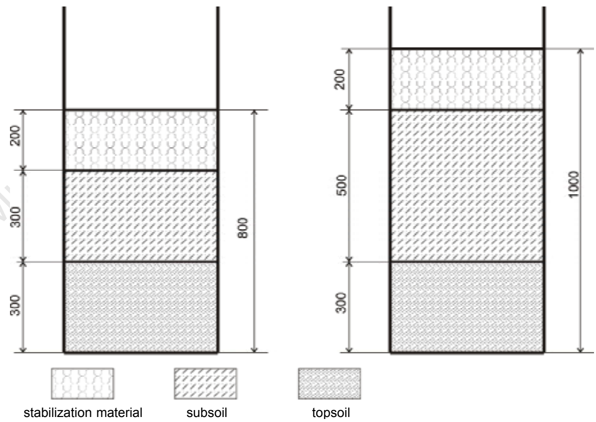

Fig. 2 Diagram of the experimental variations of the experiment at 300 mm stabilizer

The containers were located in areas where weather conditions are controllable and the same number of containers has been placed in areas where conditions are consistent with local climatic conditions.

Simulation of precipitation in real indoor and outdoor watering was applied to water, reflecting the maximum monthly average for last 50 years. Data on rainfall while the data drawn from the Slovak Hydrometeorological Institute, Regional Centre of Kosice from stations in Michalovce, in Milhostov, in Somotor and in Vysoká nad Uhom that are closest to the pond.

The long-term measurements of rainfall in the area show that the average monthly values range from 40-50 mm/month, except for the rainy year 2010, when the monthly average rose to 85 mm/month. [7]

Tab.4 The maximum rainfall of long-term measurements of nearby stations

Meteo-station	Year	Month	Rainfall [mm]
Michalovce	2010	May	174
Milhostov	2010	May	219
Somotor	2010	May	226
Vysoká nad Uhom	2010	May	197
Max. average rainfall			**204**

3 . RESULTS OF THE EXPERIMENT

The results of the experiment can be divided into 2 groups according to different climatic conditions:

1. containers under conditions consistent with local climate:

During the period November 2010 - November 2011 rainfall was observed in containers on average 43.5 mm/month, which represents 1.45 mm of rainfall per day. The natural rainfall of water do not get through the layers or in one container that stabilisation material, soil absorbed them.

2. containers in terms of controllable:

The containers with variable conditions were simulated extreme daily rainfall amounts of water, min. 50 mm/day that is to say more than 7 times more than the maximum daily average precipitation. Part of the precipitation absorbed by each layer in the container and seepage water is accumulated discharge outlet in the prepared containers and continuous metering.

In carrying out experiments in order to determine the waterproofing ability of the individual layers, the daily rainfall amounts of water in controlled conditions was specified to multiple of the maximum long-term nature of rainfall in the area of the pond.

In the following Fig. 3 and 4 are shown depending on the thickness stabilizer and the amount of water tightness of the subsoil thicknesses of 300 and 500 mm.

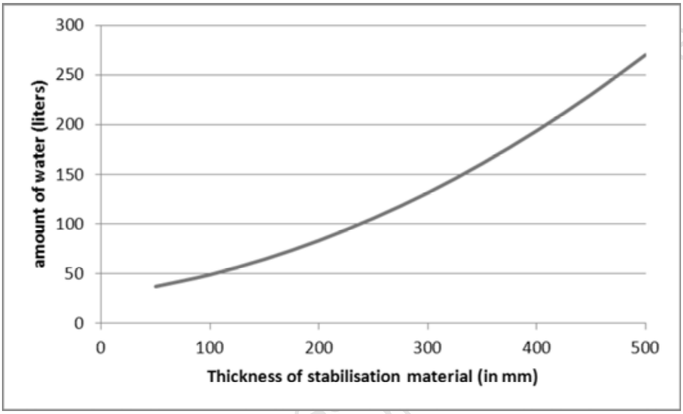

Fig. 3 Dependence of the thickness of stabilizer and the amount of water tightness in thickness of the subsoil 300 mm

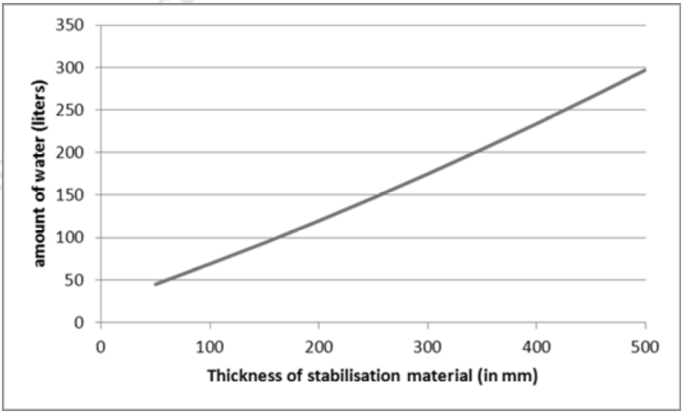

Fig. 4 Dependence of the thickness of stabilizer and the amount of water tightness in thickness of the subsoil 500 mm

Implementation of laboratory experiments conducted to establish the maximum daily amount of rain water at 100 mm (70-times the average daily value) are shown to be suitable alternatives to using 170 and 230 mm of stabilisation material depending on the thickness of subsoil differences for seed grass and willows. Saturated water in the subsoil and topsoil will be gradually pumped through the root system of plants planted on the surface.

CONCLUSION

The achieved results should be confirmed respectively. verified by real small plot experiments directly on the pond. Thus, during the growing season will test the proposed real alternatives to the coating of bio-remediation of the pond in terms of water permeability in natural conditions and atmosphere effects. It also verifies the best type of plants growing in the creation of sanitation, security conditions, with respect to the possibility of their further use as a co-incineration of biomass with coal in the same technology.

The uniqueness lies in the presented technology solutions, where a waste product of energy combustion processes will be used in another form defuse synergistic environmental-economic and security effects.

REFERENCES

[1] Andrejovský, P., Huttmanová, E., 2007, Decision solving problems old environmental loads in Slovakia, In: Riešenie regionálnych disparít a nerovnovážnych stavov v prírodnom a hospodárskom prostredí, Slovenská akadémia pôdohospodárskych vied, Nitra, s. 17-22, ISBN 978-80-89143-55-9

[2] Gajdoš, J., 2011. Kvalita života v mestách. In: Podniková revue, vol. X, No. 21. PHF EU Košice, s. 59-65, ISSN 1335-9746

[3] Hronec, O., Vilček, J., Majerník, M., Tkáč, M., 2009. Ekologická stabilizácia odkaliska trosko-popolovej zmesi, vodohospodárske dielo EVO Vojany – štúdia, EU PHF Košice, 106 p.

[4] Jánová, V., Panenka, P., 2010. Máme odkaliská pod kontrolou ? Enviromagazín, vol. 15, no 5, pp. 4-8

[5] Majerník, M., Húsková, V., Bosák, M., Chovancová, J., 2008. Metodika posudzovania vplyvov činností na životné prostredie, SjF TU Košice, 212 p.

[6] Spišáková, E., 2010, Inovačné aktivity podnikov, možnosti financovania inovácií a ich reálne využitie, Technická univerzita v Košiciach, Košice, 228 s., ISBN 978-80-553-0587-5

[7] Tkáč, M., Majerník, M., Hronec, O., Vilček, J., Bosák, M., 2011. Experimentálne overenie možností rekultivácie odkaliska TPZ v SE - EVO Vojany, EU PHF Košice, 53 p.

PROGNOSIS OF HIGH RAIN EROSIVITY PERIODS

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ABSTRACT

Erosion of agricultural soils due to water action represents an important factor which decisively contributes to diminishing crops, reducing soil general quality and diminishing landslides. In order to optimize the actions designed to prevent and reduce surface erosion effects on slope fields, having the prognosis of major rainfalls or knowing the years in which high erosivity rainfalls were present represent forefront useful factors. Rain erosivity, as a factor intervening in calculation of slope field rain erosion, can be estimated by measures of Fournier index, Fournier modified index, or through rain concentration index. The article presents results concerning the setting up of some prognoses on rainfalls high erosivity, starting from the experience of the previous monthly average rainfalls during 1936 – 2011. In order to obtain these predictions, the Fourier analysis of rainfalls history and Fournier index history, Fournier modified index and rain concentration index history, are used. Such a prognosis is aimed to evaluate soil losses and establish the optimum moments to intervene upon factors able to diminish the phenomenon. At the same time, because of the great period on which the calculus is made, significant in terms of climatology, certain conclusions constitute a base of discussions for observing the eventual climate changes. Therefore, personal observations on possible estimators of climate changes are formulated.

All the considerations have been made on the concrete case of rainfalls in Valea Călugărească vineyard, Prahova county, Romania.

Keywords: erosion, erosivity, prognosis, rain, soil

INTRODUCTION

According to [1], the frequency of precipitation is defined as the number of the precipitations, during a specified period of years, having a certain minimum intensity and watched by a surveying station. To determine soil losses by rainfall erosion on slopes is used USLE model, [2]. The USLE model is defined by the universal equation of soil loss, [2]. The factor that characterizes the rainfall aggressiveness is called the rain erosivity and is denoted R (MJ m ha^{-1} h^{-1}). Direct calculation of this factor is complicated because it requires detailed data about the precipitation. Without this information, many researchers have accepted the Fournier index, Fournier modified index and the rainfall concentration index as measures to characterize the rainfall erosivity. After calculating the index, if the rainfall erosion factor R is known for a small number of years (at least three), we can estimate the relation between R and each index.

In this paper, the term prognosis has the significance of the scientific prediction term according to [3], is a hypothesis about the development (in time) of the events, based on scientific data. The prognosis is a specific tool to approach the random nature phenomena, i.e. phenomena that are not deterministic. By deterministic phenomena one

understands the phenomena which are fully described in non-probabilistic mathematical frame. If the prediction of the non-probabilistic mathematical tools is verified (within the error of the measurement devices), it is said that the phenomenon is deterministic. Therefore, the development (generally in time) of the deterministic phenomenon is known exactly, repeatability is assured. If the phenomena are not deterministic, as defined above, then they say it has random character. Mathematical tools used to describe random phenomena are those of mathematical statistics and probability theory. The average annual amount of precipitation for a given geographic area, is a phenomenon whose time variation (history) has a non-deterministic character, according to human observations. But the fact that up to now, mankind could not describe exactly the phenomenon is not yet evidence that it is not deterministic, but randomly. Acceptance of randomness is a hypothesis based on human experience in describing and predicting weather. This framework subscribes the results presented in this article.
The phenomenon of time variation of the annual rainfall amount has oscillatory nature, and can be likened to random oscillation phenomena. Therefore, any suitable interpolation functions are not polynomial, but will be described by trigonometric series and other functions that have consisted of periodic functions. Thus, we have chosen the Fourier series to interpolation. There are many approaches to this problem by Fourier series method, [16], [17], [18], for example.

INVESTIGATIONS ON THE POSSIBILITY OF DEVELOPING A LONG-TERM PROGNOSIS OF RAINFALL REGIME

For the annual precipitation amount interpolation is used the Fourier series interpolation of data between the years 1936 and 2011. The annual amount of precipitation variation in the Valea Calugareasca between years 1936 – 2011, appears in figure 1. The measurement data are organized in the line $\{p_i\}_{1\le i\le N}$, where N=76, in this case. Let $\overline{p}$ be the average of the annual precipitation amounts string. Measured data show a higher monthly resolution, which allows calculation of the characteristic measures of rainfall erosivity. Also, in figure 1 appears linear qudratic and cubic interpolation of the same features. Note that, all interpolation curves indicate a slight increase starting from 1980 and appreciable in the range of extrapolation (after 2011). The statistic data calculation indicates the minimum value of 294.6 mm, the maximum value of 1079 mm, the mean value of 610.6 mm and the median 601.7 mm. Standard deviation is 150 mm.

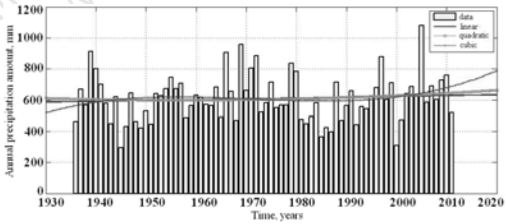

Fig. 1 Annual precipitation amount data, and linear, quadratic and cubic interpolation of it.

String power spectrum of the annual precipitation appears in figure 2 and highlights the main frequency identified, converted in periods: 2.8, 10.3, 18.0, 7.1, 4.8 years. Writing the Fourier series with coefficients calculated using the measured data, [4], and keeping 37 terms, is obtained the continuous function that approximates the experimental data.

In figure 3, this approximation is superposed over the measured data and extrapolated to the period from 2012 until 2050. For additional information was also analyzed the function:

$$\delta_i = p_i - \overline{p},\ i = 1, \ldots, N\ . \qquad (1)$$

The power spectrum of the sequence (1) reveals more clearly than the sequence of the annual precipitation amount the main frequencies, but these are the same. For storm erosion are important the years with large amounts of precipitation, as they result from the calculation of the correlation between the annual rainfall amounts strings and the Fournier index and rain concentration index. In order to predict the rain event with large amounts of water fallen, one can consider the function:

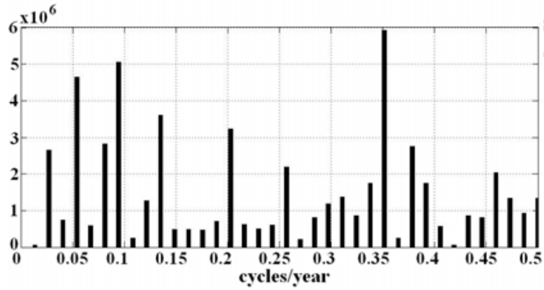

Fig. 2 String power spectrum of annual precipitation in Valea Calugareasca area, in the period 1936 – 2011.

$$p_{M\,i} = \begin{cases} p_i, \text{ if } p_i \geq 800 \\ 0, \text{ if } p_i < 800 \end{cases}, \qquad (2)$$

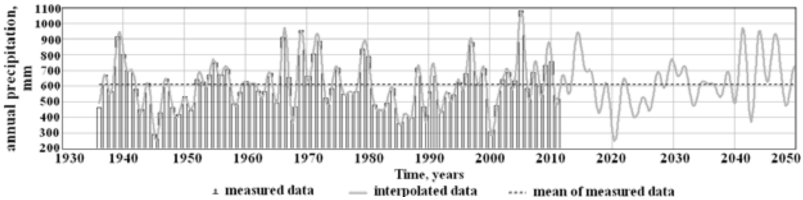

Fig. 3 The annual amount of precipitation: measured data, Fourier series interpolation and extrapolation.

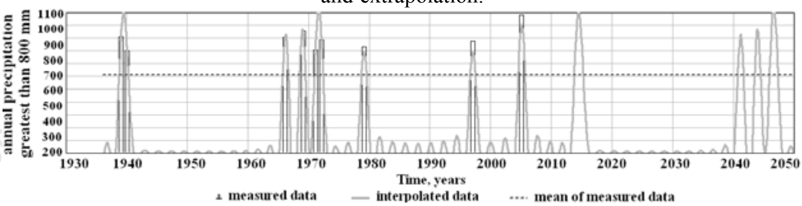

Fig. 4 The annual amount of precipitation greater than 800 mm: data measured, Fourier series interpolation and extrapolation.

Graphical representation, interpolation and extrapolation by Fourier series for function (2), appear in figure 4. One can see that the next period of significant rainfall is predicted for the middle of the decade 2010 – 2020.

A LONG-TERM PROGNOSIS OF MEASURES OF THE RAINFALL EROSIVITY

According to [5], if we denote by pl_i, i=1…12, the monthly amount of precipitation, then, Fournier index formula is written:

$$C_p = \left(\max\{pl_1,...,pl_{12}\}\right)^2 \cdot \left(\sum_{i=1}^{12} pl_i\right)^{-1} . \tag{3}$$

Modified Fournier index is defined, for example in [6] by the formula:

$$MFI = \left(\sum_{i=1}^{12} pl_i^2\right) \cdot \left(\sum_{i=1}^{12} pl_i\right)^{-1} , \tag{4}$$

In 1980, [7] or in 2011, [8], is proposed another estimator of rainfall erosivity, namely the precipitation concentration index, denoted *PCI* and defined by the formula:

$$PCI = 100 \cdot \left(\sum_{i=1}^{12} pl_i^2\right) \cdot \left(\sum_{i=1}^{12} pl_i\right)^{-2} , \tag{5}$$

According to [7], if $PCI \leq 10$, the rainfall distribution is uniform. If $11 < PCI \leq 15$, then the rainfall distribution is seasonal moderate , and if $16 < PCI \leq 20$, then the rainfall distribution is seasonal. If $PCI > 20$, then the distribution of rainfall is strongly seasonal. Time variation of the three measures of the rainfall erosivity (3), (4) and (5), for the period 1936-2011 are given in figure 5. Fourier approximations derived using data calculated by the formulas (3), (4), (5), are given also in the figure 5.

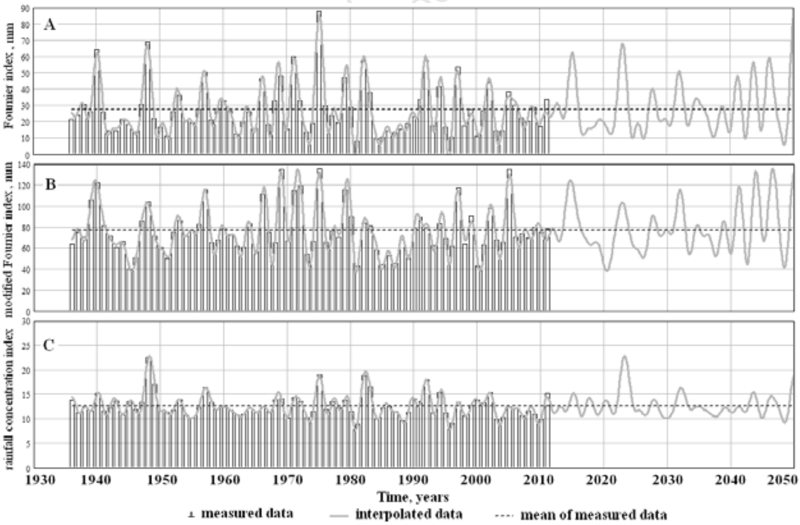

Fig. 5 The measured data, interpolated and extrapolated data, of Fournier (A), Fournier modified (B) and rainfall concentration (C) indexes.

Interpolation is the curve which overlaps the measured data and extrapolation, the rest of the approximated curve corresponds to the following years, for which there is not measured data. Fournier indexes (figure 5 A and B) predict a maximum of rainfall erosivity towards the middle of the decade from 2010 until 2020. Rainfall concentration index (figure 5, C) predicts a maximum of rainfall erosivity in the first half of the next decade (2020-2025). Correlation between the annual rainfall amount and each of the three indexes (3), (4), (5), has the next values, as succession: 0.397, 0.792, -0.112. Rainfall erosivity can be characterized by the indexes (3), (4), and (5), but also, in terms of statistics of their distribution, i.e. the probability that the indexes take certain values. The index (3) gives for the Valea Calugareasca geographical area the characterization from figure 6. The modified Fournier index and the rainfall concentration index, have characterized the same geographic area in figure 7 and 8. The average of the Fournier index is 27.524 (soil loss by erosion over 5 t/ha annually, which approaches the known data indicating 2.5 t/ha per year, [9]). Therefore, the erosion is very weak, 82.894 % of the studied period being in the range of low and very low erosion.

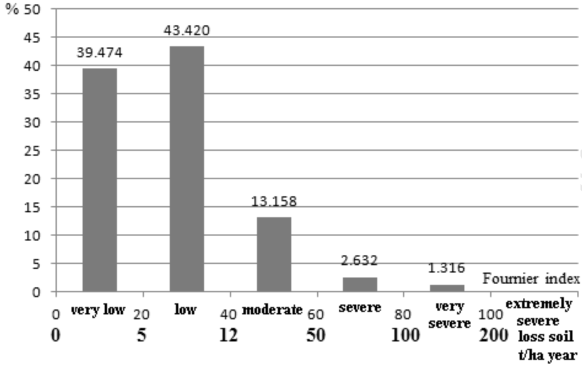

Fig. 6 Classification of erosion in Valea Calugareasca area between 1936 and 2011, according to Fournier index.

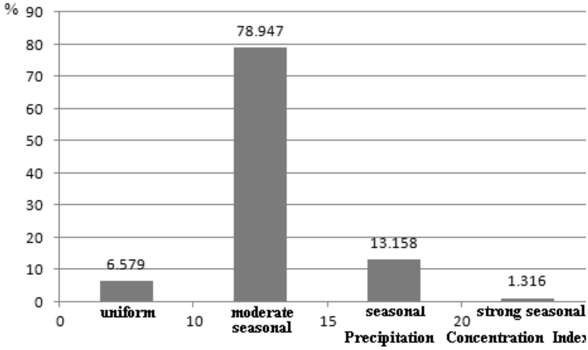

Fig. 7 Class of rainfall in the Valea Calugareasca area, between 1936 and 2011, according to precipitation concentration index.

The modified Fournier index mean during the period 1936-2011 is 76.82 %. Therefore, the erosion is weak (class 2 of erosion). This classification was found in [9] too, the modified Fournier index value being slightly higher (85.45 %) but within the same class of erosion. The analysis in [9] was made for the years 2002 -2007. The index of rainfall concentration classifies this

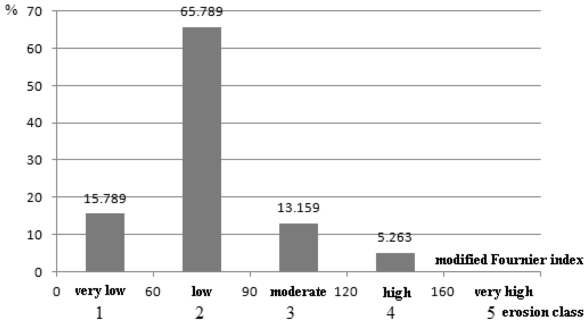

Fig. 8 Classification of erosion in the Valea Calugareasca area between 1936 and 2011, according to the modified Fournier index.

geographic area as moderate seasonal (figure 8), the average value during 1936-2011, being 12.671 %.

THE CALCULUS OF THE RAINFALL EROSION FACTOR

The measures (3), (4) and (5) of the rainfall erosivity, allow the calculation of the rain erosivity factor, *R*, which appear in the USLE formula, [13], if for some years (at lest three), are known the values of *R* calculated based on the definition formula ([10], [11], [12], [13], [14]. We used values of *R* calculated for the years 2002-2007 to determine a relationship linking the *R* factor and the measures of rainfall erosivity: Fourier index, modified Fourier index, rain concentration index, which are much easier to calculate. For the six years, the rainfall erosion factor, *R*, and the three measures of the rainfall erosivity, are given in table 1.

Table 1 Rainfall erosion factor values, R, and the values of the indexes C_p, *MFI* and*PCI* during the period 2002 – 2007.

anul	*R*, MJ cm/(ha h)	C_p, mm	*MFI*	*PCI*
2002	469.524	43.861	97.746	15.299
2003	407.947	14.656	67.759	9.872
2004	426.861	14.579	65.66	10.322
2005	999.515	38.222	134.65	12.477
2006	435.942	30.189	70.621	12.107
2007	535.625	22.084	73.383	10.66

The correlation between *R* and *MFI* has value 0.913 (higher than the correlations of *R* with C_p, 0.481 and with *PCI*, 0.203), so the two variables are highly correlated. Linear relationship between *R* and *MFI* is obtained by the method of least squares:

$$R = 7.672 \cdot MFI - 105.966 , \qquad (7)$$

Regression coefficient r=0.834, is satisfactory. Other formulas have been proposed for example in [13] and [15]. It can also give a formula of exponential type:

$$R = 4.935 \cdot MFI^{1.056}\ . \qquad (8)$$

The formula (8) is weaker than (7), with regression coefficient 0.732. În the formula (8) *MFI* exponent is dimensionless, and the factor 4.935 has the rainfall erosivity dimension. In the equation (7) and (8) *R* is obtained in MJ cm/(ha h), *MFI* is dimensionless.

CONCLUSIONS

The results show that it is possible long-term prognosis of the rainfall erosivity (a decade), with the recommendation of recalculation after each year. It is also possible to predict the rainfall factor of erosivity, *R*. Among the rainfall erosivity measures, the modified Fournier index is the most appropriate for rainfall erosivity and for the calculus of the rainfall erosivity factor, *R*. For identification of possible climate changes can also be used the heavy concentration index, but only measured data and not the interpolation.

In terms of long-term behavior, it is useful to study the variation of the average on periods of at least 30 years. For achieving the results we have studied the behavior of the average values of rainfall, the standard deviation and entropy for periods of 30 years between 1936 and 2011. It has been found a slight decrease in mean value, an increase of the standard deviation and a decrease for the entropy. Although, these studies are only in their early stages, we can say that it is possible to move towards a droughty regime and more intense storm events, so less water and violently managed hence higher storage losses and possible increase in the erosive intensity.

Fourier analysis of the sequence analyzed data show that an accurate prediction can not be based on the periods provided by their power spectrum. Time variation of the characteristics studied has random characteristics, therefore the Fourier predictions have probabilistic nature.

REFERENCES

[1] McGraw-Hill Dictionary of Scientific & Technical Terms, 6E, The McGraw-Hill Companies, Inc., 2003.

[2] WISCHMEIER, W. H., SMITH, D.D., Predicting rainfall erosion losses. A guide to conservation planning, Agriculture Handbook No. **537**, USDA-SEA, US. Govt. Printing Office, Washington, DC. **58** pp, 1978.

[3] http://dexonline.ro

[4] Tolstov P. Georgi, Fourier Series, Dover Publications, pp. 80 -81, 1976 .

[5] Aslan Z. (2003), Modelling of Environmental and Climatic Problems: Wind and Water Erosion, Lecture given at theCollege on Soil Physics Trieste, 3-21 March 2003.

[6] Lujan D., L., Gabriels D (2005), Assessing the rain erosivity and rain distribution in different agro-climatological zones in Venezuela, Sociedade & Natureza, Uberlândia, Special Issue, 16-29, May, 2005.

[7] Oliver, J., E. ( ), Monthly precipitation distribution: a comparative index, Professional Geographer, 32, pp. 300 – 309, 1980.

[8] Luis de, M., Gonzales-Hidalgo J., C., Brunetti M., Longares L., A. (2011), Precipitations concentrations changes in Spain 1946 – 2005, Nat. Hazards Earth Syst. Sci., 11, 1259-1265, 2011.

[9] Sfiru R., Cardei P., Herea V., Ertekin C., Calculation of rainfall intensity (rainfall erosivity) in Valea Calugareasca wine growing area, INMATEH-Agricultural Engineering, vol. 34, no. 2/2011.

[10] C.V. Patriche, V. Căpăţână, D.L. Stoica, Aspects Regarding soil erosion spatial modeling using the USLE / RUSLE within GIS, Geographia Tehnica, Nr. 2, Cluj University Press, pp. 67-77,2006;

[11] Matjaz Mikos, Darja Jost, Gregor Petkovsek, Rainfall and runoff erosivity in the alpine climate of north Slovenia: a comparison of different estimation methods, Hydrologic Science journal, 51 (1), pp. 115-126, 2006.

[12] Brown, L.C., and G.R. Foster, Storm erosivity using idealized intensity distributions. Trans. ASAE 30:379-386, 1987.

[13] Angulo-Martinez M., Begueria S., Estimating rainfall erosivity from daily precipitation records: a comparison among methods using data from the Ebro Basin (NE Spain), Journal of Hydrology, Vol. 379, Issues 1-2, pp. 111-121, 2009.

[14] Shamshad A., Azhari M. N., Isa M. H., Wan Hussin W.M.A., Parida B.P., Development of an appropriate procedure for estimation of RUSLE EI_{30} index and preparation of erosivity maps for Pulau Penang in Peninsular Malaysia, Catena 72 pp. 423-432, 2008.

[15] Yu B., Rosewell, A Robust Estimator of the R-Factor for the Universa Soil Loss Equation, Transaction of the ASAE, Vol. 39(2):559-561, 1996.

[16] Laguardia G., Representing the precipitation regime by means of Fourier series, International Journal of Climatology, Volume 31, Issue 9, pp. 1398-1407, July 2011.

[17] Hastenrath S., L., Fourier analysis of Central American rainfall, Theoreticall and Applied Climatology, Volume 16, Number 1, pp. 81-94, 2005.

[18] Woolhiser D., A., Pegram G., G., S., Maximum Likelihood of Fourier Coefficients to Describe Seasonal Variations of Parameters in Stochastics Daily Precipitation Models, Journal of Applied Meteorology and Climatology, Vol. 18, pp. 34-42, 1979.

PROPOSAL OF METHODS FOR MEASUREMENT OF AIRCRAFT NOISE ON SMALL SPORT AIRPORTS IN SLOVAKIAROMAN

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ABSTRACT

Noise from the air traffic affects the environment and life not only in major international airports, military airports and helikoports but also near small sport airports. This paper deals with a proposed and revised methodology for measuring and evaluating noise near of small sport airports. The proposed methodology includes all the necessary methodology elements for the assessment of the noise near airports. It was actively used to assess of the noise situation at the small sport airport in the Kamenica nad Cirochou village. It is necessary to noted, that noise from air traffic burden the environment and is necessary watch the noise not only near major international airports with dense traffic but also near small sport airports where have the traffic mostly shock character.

Keywords: noise, noise maps, methodology

INTRODUCTION

This algorithms and methodology will try to work comprehensively mapping all the essential elements that affect the calculation of the level of aircraft noise contours and noising from air traffic and noise from airports. Requirements for the calculation of aircraft noise and noise from airports can vary greatly depending on the nature of the airport and around the airport, weather conditions, airport-type and other factors. Three separate parts of assessing aircraft noise process are shown in Fig. 1. [6]

The proposed methodology implements all the necessary tools and calculations to calculate the noise level on the airport and near airports, which is emitted into the environment in the vicinity of airports. [5]

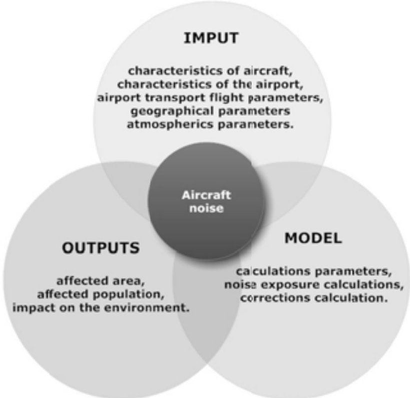

Fig. 1 Three parts of the assessment of aircraft noise

DESCRIPTION OF AIR TRACK

Location of aircraft around an airport and near the airports is exactly defined fixed network coordination system. X and Y coordinates are designated as ground coordination system of coordinates and altitude as coordinate the opening climb of the aircraft, after reaching the point of M_c, as shown in Fig. 2. [5]

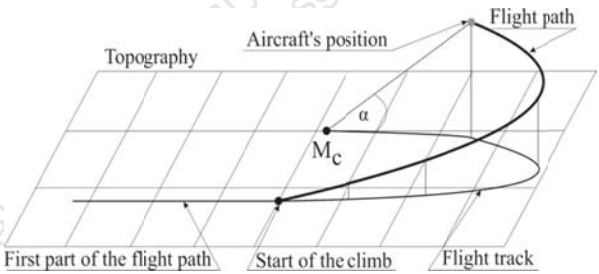

Fig. 2 Generalized location of measuring point

Coordinate system starting position is always at the measurement point Mc, where is starting the climb of the airplanes. The measurement point witches are very important for the measuring is all shown in Fig. 3. [1]

N-distance on the take-off runway of the aircraft's position will vary depending on the speed of the aircraft. The size of the grid and the network of the airplane itself are determined individually, always in direct contact with the aircraft type, aircraft speed and the individual needs of the observer. According to the results obtained, which are measured from the observation point is calculated in the simulation time during the stress level while passing aircraft.

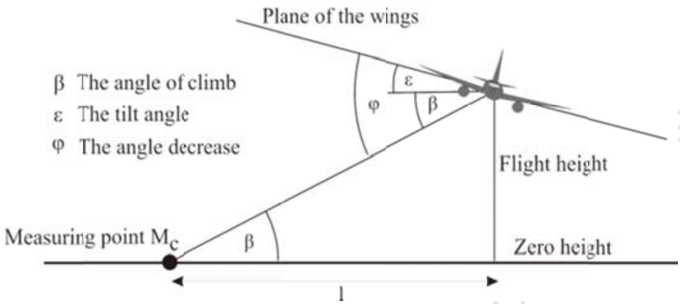

Fig. 3 Generalized location of measuring point

PRACTICAL APPLICATION

The small sport airport, where the measurements were carried out, is located east of the city Humenné. It is a civilian small sport airport, which is incorporated into the network Aeroclub Slovakia airports. The small sport airport is located in greenfield areas north of the small village of Kamenica nad Cirochou. [2]

Near the small sports airport Kamenica nad Cirochou is the first class road I/74. Near the small sports airport Kamenica nad Cirochou is not necessary to calculate with noise from railway and road traffic, because the traffic wasn't frequented and during the measuring was not moving on railway road and the move on road was minimum.

On the small sport airport Kamenica nad Cirochou was during the measuring recorded only move of small sports airplanes. The total number and character of the aircraft was:

1. Arrivals: 5 times Cessna,
2. Departures: 5 times Cessna,
   1 time ZLIN.

The airport has two runways no. 07 take-off. and no. 25, which is shown on Fig. 4.. These are located north of the buildings around the hangar. 150 m. Runways are located in flat areas with no more inclination surface of the track itself. [1] [4]

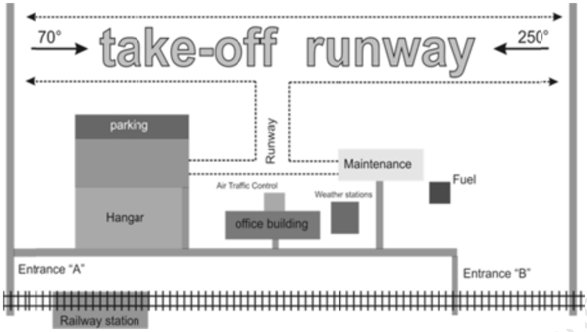

Fig. 4 Location of airport in Kamenica nad Cirochou

For need of calibration of a mathematical model created for informational and acoustic assessment of the current situation in the area of interest measurements were carried out in two hours four measurement points, one measurement at each measuring point.

MEASUREMENT RESULTS

In different parts of the table you can see the values for the correction, if it was necessary to modify the resulting data on the speed and tilt correction aircraft Table I.

The noise descriptors measured in the individual measuring points, which were placed in the take-off runway is stated the following conclusions:

- measurement of aircraft noise around the Aeroclub of Kamenica nad Cirochou at the measuring points 1 to 4 is shown that there are not exceeded immission values for determining values of environmental noise at all measuring points in a set time interval,

Tab. 1 Summary results plus of the corrections

Measuring point	Measurement time [h]	$L_{ASmax, 2h}$ [dB]	$L_{Aeq, 2h}$ [dB]	ΔV [dB]	ΔI(ε) [dB]	L_{korr} [dB]	$L_{Aeq, 2h, korr}$ [dB]
1	9:00 – 11:00	97,6	67,4	-	-	-	67,4
2	9:00 – 11:00	88,2	59,3	-	-	-	59,3
3	9:00 – 11:00	91,5	65,6	-	-	-	65,6
4	9:00 – 11:00	88,3	59,3	-	-	-	59,3

- it is not necessary to determine the correction for the acceleration of aircraft on take-off runway, because it did not reach maximum speed defined for this type of aircraft,

- the need to establish correct tilt of the aircraft because the aircraft has located the propulsion unit in front and not on the wings,
- noise, which was due to the surrounding environment, is the noise from the remote village of Kamenica Cirochou. Noise from the building reconstruction and traffic is negligible and has no impact on the measured values of air traffic at the airport Aeroclub Kamenica nad Cirochou,
- there is no need to introduce any measures to reduce noise emitted from traffic at the airport Aeroclub Kamenica nad Cirochou.

We can assume that if the future does not change the flight schedule, it stops at the Airport aircraft at a higher power has taken place or reconstruction of the runway take-off from turf to asphalt, we can assume that the noise will increase the burden of air transport and the airport itself. We assume that the noise emissions from aircraft, which are emitted into the environment, will increase the airport. The type of aircrafts, which operated at the airport, it is a ZLIN and Cessna engine, which rank among the older types of single aircraft. For these aircraft we assume that the future will improve their motor units, and in conjunction with the team likely will sound and the noise emitted to the environment around the airport over Aeroclub Kamenica nad Cirochou. This paper was created under the project KEGA no. 049TUKE-4/2012.

REFERENCES

[1] Badida, M.; Majerník, M.; Šebo, M.: Strojárska výroba a životné prostredie. Vienala, Košice, 1998. ISBN 80-7099-335-9

[2] Badida, M.; Lumnitzer, E.: Experimental measurements with acoustic camera. In: Annals of MTeM for 2009 and proceedings of the 9th international conference Modern Technologies in Manufacturing. - Cluj-Napoca : MTeM, 2009 P. 321-324. - ISBN 97379370704

[3] Herczner, P. a kol.: Aplikácia metodiky pre šírenie hluku v procese posudzovania akustrickej situácie v okolí železničných tratí. In: Mechanical Engineering 2007 : proceedings of abstracts : Bratislava, November 2007, Bratislava : STU, 2007. ISBN 978-80-227-2768-6

[4] Lumnitzer, E.; Badida, M.: The usage of dynamic visualisation by industrial noise source analysis. In: Acta Mechanica Slovaca. Roč. 13, č. 1 (2009), s. 20-24. - ISSN 1335-2393

[5] ŽIARAN, S.: Zniţovanie hluku a kmitania, Slovenská technická univerzita v Bratislave, 2006, ISBN 80-227-1009-1

[6] Herczner, P.; Románová, M.; Lumnitzer, E.: Analýza metodiky NMBP Route 96 a jej aplikácia pri rekonštrukcii križovatky ciest 1. Triedy. In: 9. Banskoštiavnické dni 2007 - Zvolen TU, 2007. ISBN 978-80-228-1786-8

PROTECTION AGAINST VIBRATIONS, A DESIDERATUM OF THE SUSTAINABLE DEVELOPMENT

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ABSTRACT

The importance of viaduct as vital structure from structure of terrestrial means of communication imposes a reduction in their exposure to shocks and disasters from natural (earthquakes) and human (heavy road traffic) causes. In order to diminish or even abolish effects of vibration from heavy road traffic or seismic activities, innovative modular systems for shock and vibration insulation must be introduced in their structure, capable to disperse the energy accumulated in the system. In order to define these systems as accurately as possible from the functional parameters perspective, a unitary analysis methodology for dynamic characteristics and behavior means will be created, following the intense and varied dynamic demands coming from road traffic and seismic activities.

Keywords: vibration, earthquake, viaduct, protection, methodology

1. INTRODUCTION

These systems have a high bearing capacity and can also take movement in all directions. In other words, such a system is characterized by six degrees of freedom. However, these rubber- based systems have a limited life cycle, on the one hand due to high dynamic loads that are subject to and, on the other, due to effects of atmospheric factors on the material: heat, cold, moisture and ozone. These factors adversely affect the dynamic characteristics and thus on the behavior of these systems to pulse excitation. Thus, in the event of seismic activity, the dynamic response of a mechanical system (viaduct) whose dynamic isolation devices are compromised, in terms of viscoelastic links, can degenerate into a chaotic motion with negative effects on construction safety.

2. METHODOLOGY

In this paper will be grounded in theoretical methodology for malfunctions diagnosing of rubber-based viscoelastic insulation systems used in viaducts structure. The methodology is based on the fact that abnormal function of rubber isolators meets their nonlinear behavior, when subjected to dynamic loads. In other words, identifying a nonlinear behavior of rubber insulators, accompanied by qualitative and quantitative changes of kinematic and energetic parameters of the dynamic vibration response, demonstrates a nonlinear behavior of the system. Identification methodology of rubber-based insulators nonlinear behavior is based on the following steps: a. Identification and quantification of control parameters able to characterize the system vibration; b. Qualitative and quantitative characterization of the control parameters putting into dynamic insulators under certain conditions of dynamic loading; c. Periodic determination of control parameters under the same conditions of dynamic loading; d. Comparative analysis of control parameters and results interpretation; e. Take corrective measures in order to avoid partial or total destruction when a high degree of nonlinearity is revealed. In the following, this methodology will be theoretically demonstrated.

3. OBJECTIVE DESCRIPTION

Even if the study is a theoretical one, physical model that will develop the mathematical one has as point of departure is the Transylvania highway viaduct, at Savadisla, in between Targu Mures and Cluj, [2]. Bearing structure supports, on each direction of travel, a roadway width of 12.00 m which includes two lanes each 3.75 m width, a parking strip of 3.50 m width and two safety belts of 0.50 m width each. Overall width of the superstructure is 13,60 m and consists of roadway width plus two spaces 0.80 m for very hard deformable safety bulwarks disposition of, one on each side. In the transverse direction, for both directions of traffic, the path has unique cross slope of 2.5%. Viaduct infrastructure consists in 2 abutments and 4 beam for each traffic direction. In the transverse direction, viaduct superstructure consists in 4 U precast beams placed at distance of 3.32 m spacing, and beams are poured over a plate of 25cm thick reinforced-concrete plate cast, fig. 1. The beams are made of prestressed C35/45 class concrete and Slab finishing plate is of C25/30 class concrete. Viaduct has five equal spans of 40m. Superstructure propping on infrastructure elements, abutments and piles, was achieved by Freyssinet type neoprene bearings, 81mm of height, [2].

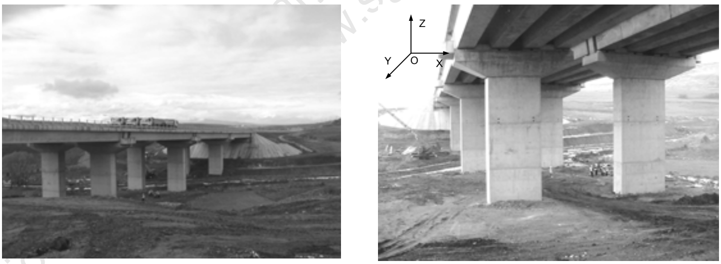


Fig. 1 The bridge deck

4. DETERMINING THE DYNAMIC RESPONSE OF A VIADUCT SECTION

4.1 DEVELOPING PHYSICAL AND MATHEMATICAL MODEL

In this work, a physical and mathematical theoretical model able to accurately indicate the optimal timing of dynamics insulation systems replacement, by periodic monitoring of some functional parameters has been developed. Thus a section of bridge deck can be considered a rigid solid with viscoelastic type triortogonal links, [3].

Matrix equations that characterize the system oscillatory motion can be written as:

$$\underline{\underline{I\ddot{q}}} + \underline{\underline{C\dot{q}}} + \underline{\underline{Kq}} = \underline{\underline{f}} \qquad (1)$$

where: $\underline{\underline{q}}$ - generalized coordinates vector; $\underline{\underline{\dot{q}}}$ - generalized velocity vector; $\underline{\underline{\ddot{q}}}$ - generalized accelerations vector; f - generalized forces vector; $\underline{I}$ - inertia matrix; $\underline{C}$ - damping matrix; $\underline{K}$ - stiffness matrix;

Main elastic axes of the elastic bearings are parallel to the reference axes. In this case, movements represented by coordinate's variation, corresponding to the six freedom degrees, may be released as follows:

- coupled translational movement along the X axis and rotation around the Y axis - (X, φ_y);
- coupled translational movement along the Y axis and rotation around the X axis - (Y, φ_x);
- translational movement along the Z axis, independent of other modes;
- rotation movement around the Z axis (φ_z) independent of other ways.

In this case the system of differential equations can be structured as follows:

Coupled mode (X, φ_y)

$$\begin{cases} m\ddot{X} + \dot{X}\sum_{1}^{16} c_{ix} + \dot{\phi}_y \sum_{1}^{16} z_i c_{ix} + X\sum_{1}^{16} k_{ix} + \phi_y \sum_{1}^{16} z_i k_{ix} = 0 \\ J_y\ddot{\phi}_y + \dot{X}\sum_{1}^{16} z_i c_{ix} + \dot{\phi}_y \sum_{1}^{16}\left(c_{iz}x_i^2 + c_{ix}z_i^2\right) + X\sum_{1}^{16} z_i k_{ix} + \phi_y \sum_{1}^{16}\left(k_z x_i^2 + k_x z_i^2\right) = e_x F_z \end{cases} \qquad (2)$$

Coupled mode (X, φ_x)

$$\begin{cases} m\ddot{Y} + \dot{Y}\sum_{1}^{16} c_{iy} - \dot{\phi}_x \sum_{1}^{16} c_{iy} z_i + Y\sum_{1}^{16} k_{iy} - \phi_x \sum_{1}^{16} k_{iy} z_i = 0 \\ J_x\ddot{\phi}_x - \dot{Y}\sum_{1}^{16} z_i c_{iy} + \dot{\phi}_x \sum_{1}^{16}\left(c_{iy}z_i^2 + c_{iz}y_i^2\right) - Y\sum_{1}^{16} z_i k_{iy} + \phi_x \sum_{1}^{16}\left(k_{iy} z_i^2 + k_{iz} y_i^2\right) = -e_y F \end{cases} \qquad (3)$$

Translation on OZ axis

$$m\ddot{Z} + \dot{Z}\sum_{1}^{16} c_{iz} + Z\sum_{1}^{16} k_{iz} = -F_z \qquad (4)$$

Rotation around OZ axis

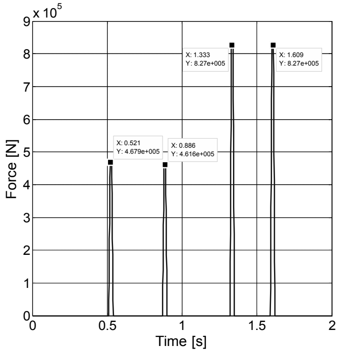
$$J_z\ddot{\phi}_z + \dot{\phi}_z \sum_{1}^{16}\left(c_{ix}y_i^2 + 2c_{iy}x_i^2\right) + \phi_z \sum_{1}^{16}\left(k_{ix}y_i^2 + 2k_{iy}x_i^2\right) = 0 \qquad (5)$$

Since vertical vibrations are most intense, in this paper only dynamic system response to dynamic excitations on this direction has been studied. Each deck of a viaduct section is leaning on each end to eight molding rubber-based dynamic insulation systems. Deck stress was obtained by passing a truck weighing 41 tons over an obstacle with a height of 40 mm at a speed of 20 km/h, in accordance with STAS 12504-86. Truck weight distribution on the four axes is as follows: m_1 = 7440 kg, m_2 = 7339 kg, m_3= 13149 kg and m_4 = 13149 kg.

Driving forces are calculated using the following mathematical expression, [1]:

$$F_z = \frac{mv}{3\Delta t}\frac{h}{R}\left(3 - 2\frac{h}{R}\right)\sqrt{2\frac{R}{h} - 1} \tag{6}$$

where h = 0.04 m, R = 1.2 m - wheel diameter, Δt = 0.03s - wheel passing time for obstacle crossing, m - mass distributed on the axle, v_0 = 20 km / h - the speed of the vehicle for obstacle crossing. Based on this expression, we obtain application forces values on the bridge deck, according to the figure 2 in which it was considered that arousal has a trapezoidal shape.



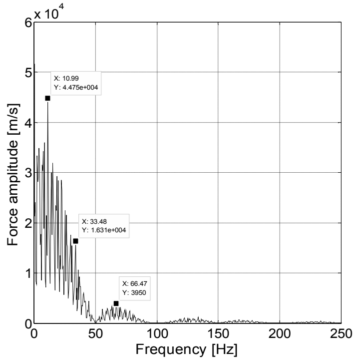


Fig. 2 Four trapezoidal pulse train Fig. 3 Spectral representation of the excitation

Representation in the frequency of system excitation, fig. 3, which actually consists in four pulses train, reveals significant spectral components between 0 and 33 Hz.

4.2 Identification and interpretation of kinematic and energetic parameters

In order to characterize the kinematic and energetic parameters, assuming two types of elastic forces in dynamic insulation systems, linear and nonlinear one, [4] the dynamic response of bridge deck requesting impulsive stress produced by a 41 tons truck passing over an obstacle of 40 mm height, was analyzed.

a. Linear elastic forces case

In this case the motion equation is:

$$m\ddot{Z} + \dot{Z}\sum_{1}^{16} c_{iz} + Z\sum_{1}^{16} k_{iz} = -F_z \tag{7}$$

where: m – deck mass; Z - vertical movement; c_{iz} – vertical bearing damping coefficient, k_{iz} - elasticity coefficient; F_z - vertical applied force;

b. Nonlinear elastic forces case

In this case the motion equation is:

$$m\ddot{Z} + \dot{Z}\sum_{1}^{16} c_{iz} + Z\sum_{1}^{16} k_{iz}(1 + \beta Z^2) = -F_z \tag{8}$$

Based on differential equations of motion (4), the characteristics parameters of the vibration deck resting on viscoelastic systems were plotted and analyzed: 1. time response of vibration kinematic parameters; 2. frequency response of vibration kinematic parameters; 3. dissipated energy by viscous friction; 4. movement trajectory; 5. power spectral density. Mathematical model solving was made through the MATLAB program version R2008a, [5] assuming the following numerical values of motion equation coefficients: k_{iz}=650·10^{6} N/m; c_{iz}=4·10^{7} Ns/m; m=992·10^{3} kg; β_1=5·105 m^{-2}; β_2=5·105 m^{-2}; F_1= 4.6793·10^{5} N; F_2= 4.6157·10^{5} N; F_3= F_4= 8.2699·10^{5} N.

Next will be presented against parameters that characterize the dynamic response of bridge deck section for the two cases previously considered: linear and nonlinear elastic forces. Representation of system displacement on the vertical direction in time, figs. 4 and 5 reveals a value of 1.5·10^{-5} m for nonlinear case against 9.25·10^{-5} m in the other case.

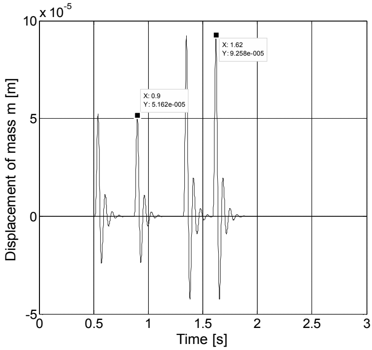


Fig. 4 Displacement: linear case

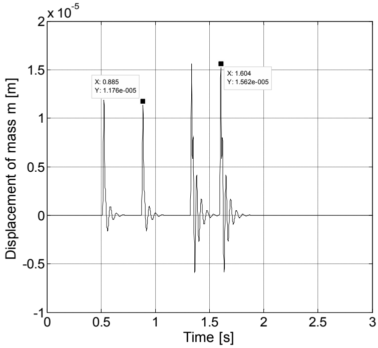


Fig. 5 Displacement: nonlinear case

Same values represented in the frequency domain, highlights for nonlinear case an increase of the dominant spectral components range to 44 Hz compared to the value of 22 Hz in the linear case, figs. 6 and 7.

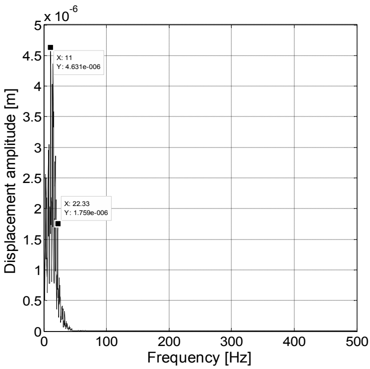


Fig. 6 Spectral representation: linear case

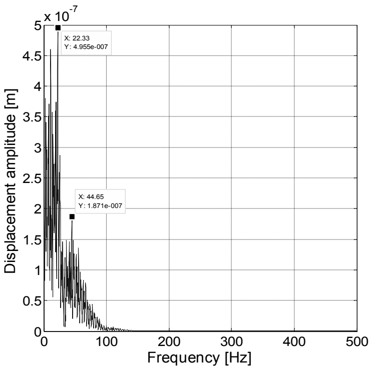


Fig. 7 Spectral representation: nonlinear case

System acceleration representation in time reveals significant differences of amplitudes parameter for the two cases, fig. 8 and 9. Thus, acceleration amplitude value increases to 13.31 m/s^2 for nonlinear case against to 1.03 m/s^2 registered in the linear case.

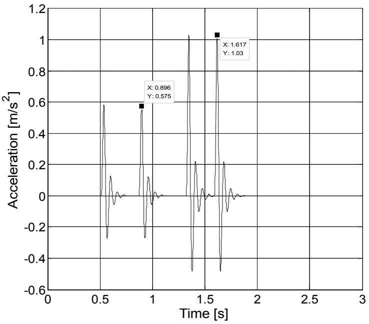


Fig. 8 Acceleration: linear case

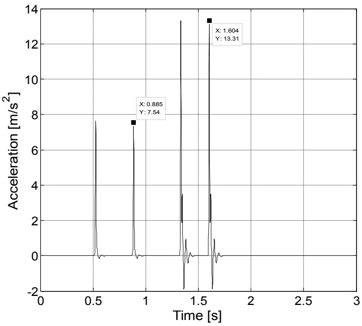


Fig. 9 Acceleration: nonlinear case

Acceleration representation in frequency domain, figs. 10 and 11 show for nonlinear case the appearance of supra-harmonic components, extending in this way the dominant frequency range from 0 - 22 Hz in the linear case to 0 - 88Hz. Supra-harmonic spectral components appearance is a phenomenon that can lead to unwanted resonance phenomenon in systems that normally would not be affected by this.

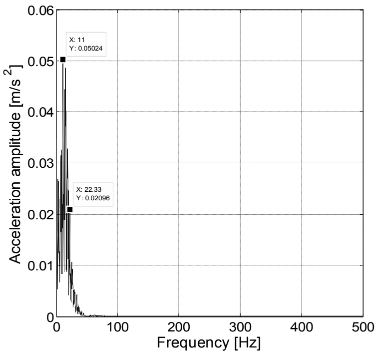


Fig. 10 Spectral representation: linear case

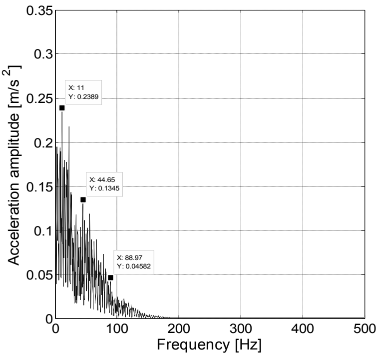


Fig. 11 Spectral representation: nonlinear case

Graphical representation of the hysteresis loop provides information both over the amount of dissipated energy and dynamic stiffness form of systems isolation, figs. 12 and 13. Very low amount of dissipated energy for nonlinear case corresponds to an extreme type of rubber stiffening in bearing systems. Median curve of hysteresis loop coincides with the graphical representation of the bearing systems elastic coefficient.

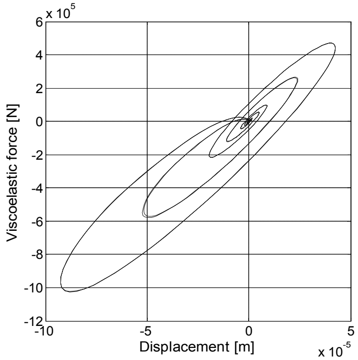


Fig. 12 Hysteretic loop: linear case,E=135 J

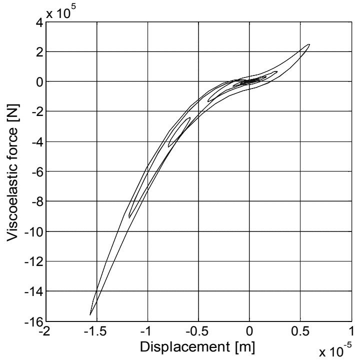


Fig. 13 Hysteretic loop: nonlinear case, E=7J

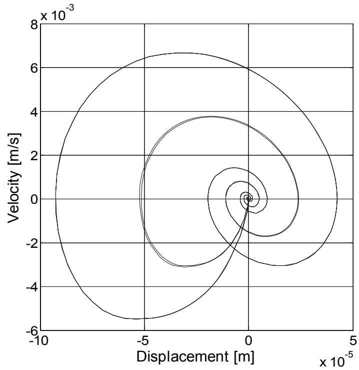


Fig. 14 Phase plane representation: linear case

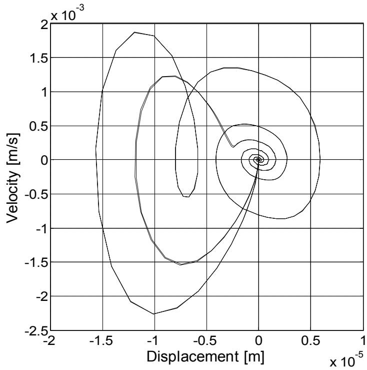


Fig. 15 Phase plane representation: nonlinear case

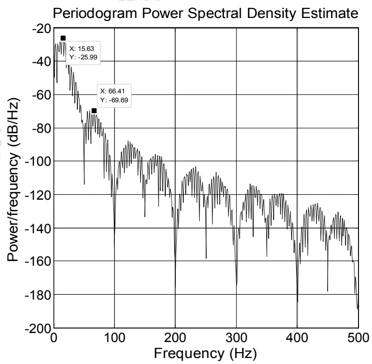


Fig. 16 Periodogram: linear case

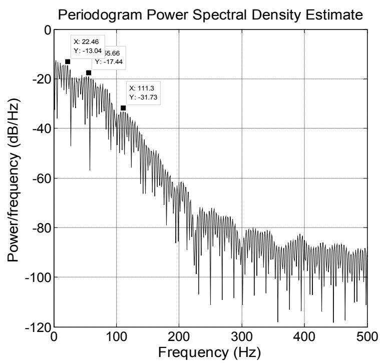


Fig. 17 Periodogram: nonlinear case

Representation in the phase plane shows the system stability for this type of stress, but for nonlinear case a strange attractor point has been observed, which is specific for such systems, figs. 14 and 15. From graphs of power spectral density for the two analyzed cases, figs. 16 and 17 it appears that in nonlinear case significant part of signal average power is carried by the spectral components corresponding to frequency in the range of (0 ÷ 55) Hz, while for linear case this range is of (0 ÷ 22) Hz.

5. CONCLUSIONS

This work is the theoretical development of experimental approaches for the nonlinearity degree investigation in the case of dynamic insulation viscoelastic systems. From theoretical point of view, the result on nonlinearity degree assessing provides useful information on the structural integrity of insulation systems. Among the analyzed parameters, it was observed that acceleration is the most sensitive parameter for nonlinear behavior of rubber-based viscoelastic systems, its representation in time and frequency domains showing the most significant changes. Displacement representation in time is not an eloquent criterion in nonlinear behavior identifying, because even if the difference between displacement amplitudes in the two cases is 7 times, the size of this parameter is 10^{-5}m. Another important clue to identify nonlinear behavior is the strange attractor point emphasized in phase plane representation. However, for scientific rigor, theory must be validated experimentally. Experimental nonlinearity degree monitoring in time, by periodic characterization of analyzed parameters, is a useful tool in diagnosing the state of normality in the functioning of dynamic insulation systems.

ACKNOWLEDGMENTS

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REFERENCES

[1] Dragan, N., Analiza experimentală a dinamicii podurilor din beton armat supuse acţiunilor din trafic, SINUC, Bucuresti, 2010.

[2] Final report on testing for Transylvania highway viaduct, ICECON SA, 2009.

[3] Leopa, A., Debeleac, C., The evaluation of the behavior to dynamic loads from traffic of seismic enegy disipation devices to the viscous effect, The 10th International Conference on Vibration Control, Praga, Cehia, 2011.

[4] Leopa, A., Nastac, S., Dragan, N., Debeleac, C., "Considerations on the influence of viscoelastic behavior of nonlinear systems bearing on the dynamic constructions response", International Conference on Structural Engineering Dynamics, Tavira, Portugalia, 2011.

[5] MATLAB, "High-Performance Numeric Computation and Visualisation Software. Reference Guide", The MATWORKS Inc., Natick, Massachusetts, 1992.

PSYCHOACOUSTIC ANALYSIS OF TRAFFIC NOISE

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ABSTRACT

Traffic noise is the most frequently occurring type of noise that is encountered by all. Its effects on humans, we can find mainly in annoyance and other nonspecific effects. These effects depend on gender, age, momentary disposition and other factors. The article deals with psychoacoustic noise analysis of the specific vehicles and its subjective evaluation. Similar analyzes are the basis for further development of the cars in their acoustic parameters.

Keywords: traffic noise, psychoacoustics, psychoacoustic analysis.

INTRODUCTION

The sound quality has become a very important activity in the design and development of all products that emit noise such as cars. This article aims to assess the suitability of vehicles sound, in this case, three cars of different brands (Renault Thalia, Skoda Fabia, Ford Escort) from different perspectives such as the passage of cars from the pedestrians point of view in terms of assessment in terms of passenger. Passing and driving were assessed with and without sensory sensory stimuli. It has been the subject of research assessing differences in perceptions, with passages of cars, which were between transit, videos, sounds altered. Based on these facts has set a target:

- Determine prejudice the visual impact of noise on the respondents (the same sound with different visual perceptions).
- Find basic psychoacoustic perceptions of target groups of respondents.

THE RESEARCH

The subject of the recording were three cars of different brands and the Renault Thalia 1.4, year of manufacture 2009, Skoda Fabia Combi 1.2, year of manufacture 2000, Ford Escort 1.4, year of manufacture 1992 in all cases the gasoline engine. In all cases, the recordings made under identical conditions, namely at a speed of 50 km / h at 2,500 rpm. Recordings have been made using a digital camera. The recordings were taken from a pedestrian perspective view of the passenger. These recordings were presented to respondents through questionnaires. The categories in the survey respondent had the opportunity to indicate their feelings on using predefined scales, four options "*non-distruptive*", "*less distruptive*", "*distruptive*" and "*very distruptive*". Questionnaires were filled out while watching movies and sounds. [1]

Evaluation

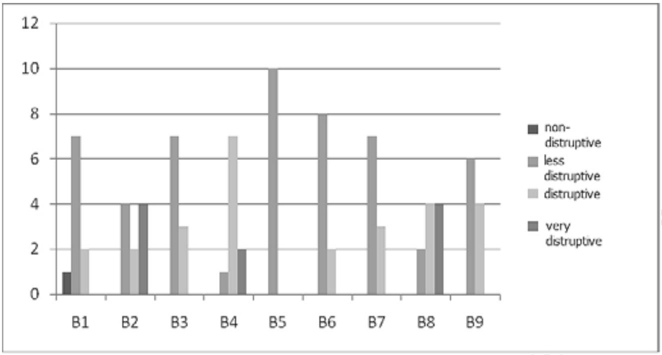

Fig. 1 Graphical representation, women from 21 to 30 years old

In Fig. 1 is an example of how comparisons were affected by the sound of the respondents to the original recording video and sound and video in modified cars and passing the assessment from the perspective of a pedestrian. B1-B9 are detailed in Table. 1. [2] [3]

Tab. 1 Description of category

	Simultaneously presented		
	Category	**Video**	**Audio**
Assessment from the perspective of pedestrian	**B1**	Skoda Fabia	Skoda Fabia
	B2	Ford Escort	Ford Escort
	B3	Renault Thalia	Renault Thalia
	B4	Skoda Fabia	Ford Escort
	B5	Renault Thalia	Skoda Fabia
	B6	Ford Escort	Skoda Fabia
	B7	Skoda Fabia	Renault Thalia
	B8	Renault Thalia	Ford Escort
	B9	Ford Escort	Renault Thalia

EVALUATION OF AVERAGE VALUES ACCORDING THE REFERRAL SCALES

The assessment scale, we chose to design the questionnaire were assigned values (see Table 2) for better implementation of the evaluation process.

Tab. 2 Assigned values of assessment scales

The referral scale sound			
non-distruptive	less distruptive	distruptive	very distruptive
1	2	3	4

In assessing the perceptions of the relationship was used:

$$V = \frac{\Sigma(PŠ \times n)}{m} \tag{1}$$

Where: V – final perception
PŠ – Assessment scale
n – number of judgments
m – number of respondents

EVALUATION OF AVERAGE PERCEPTIONS FROM THE PEDESTRIANS POINT OF VIEW

The conducted survey were statistically evaluated the results. A summary of the individual perception scales of all respondents to the passage of cars, so from the perspective of pedestrian, are listed in Table. 3. [3]

Tab. 3 The average assessment of perceptions in the passages that is, from the perspective of pedestrian

The combination of sounds and visual prejudices	Renault Thalia	Skoda Fabia	Ford Escort
Identical recordings of passages (B3, B1, B2)	2,3	1,9	3
audio Renault Thalia - video Skoda Fabia (B7)	2,4	-	-
audio Renault Thalia - video Ford Escort (B9)	2,6	-	-
audio Skoda Fabia - video Renault Thalia (B5)	-	1,95	-
audio Skoda Fabia - video Ford Escort (B6)	-	2,1	-
audio Ford Escort - video Renault Thalia (B8)	-	-	2,95
audio Ford Escort - video Skoda Fabia (B4)	-	-	2,65

The table shows that the resulting feelings of acoustic perception in combination with visual perceptions differ on average by 0.1 -0.4 points. According to the least intrusive sound was the sound of the engine Skoda Fabia, regardless of visual perception. [1]

Renault Thalia is in the range of scales less intrusive and disturbing. It is interesting that the same sound but changing the image values rising New to Old car. We can conclude that in this case, the respondents inclined to sensory perception assessment.

In the case of Ford, the most inclined to assess disruptive, but, in changing its image and maintaining sound, we can see moderate fall, in favor of less annoyance. So I can assume that to some extent as well as the appearance. [1] [4]

EVALUATION OF AVERAGE VALUES FROM THE PASSENGER POINT OF VIEW

The survey was conducted for different age groups and for men and women separately. As an example results of the survey are shown in the figure for the category of women from 21 to 30 years of age (Fig. 2). [2]

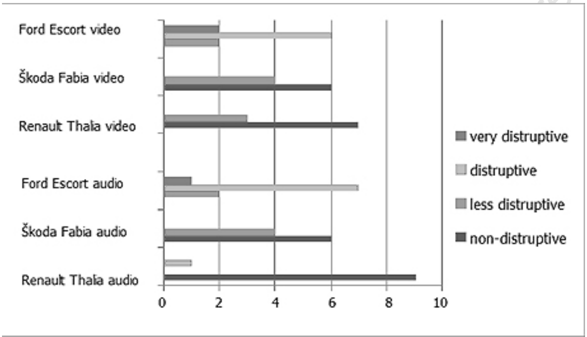

Fig. 1 Graphical representation, women from 21 to 30 years old

Visual prejudices have shown more significantly, it is clear that they significantly influenced subjective feelings, especially in a case of Renault Thalia. Results of mens' reactions in age group from 31 to 40 years are shown in figure 3. [2]

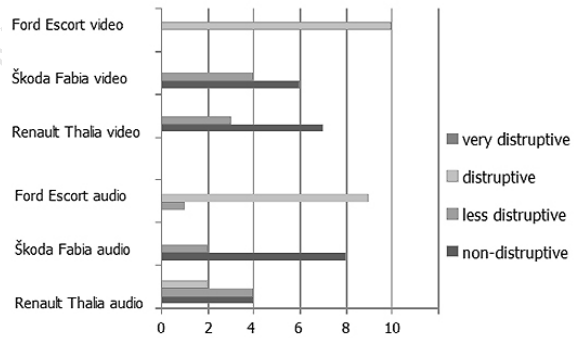

Fig. 3 Graphical representation, men from 31 to 40 years old

The chart shows that the respondents found the noise without the visual information less disruptive.

CONCLUSION

From these values, we can assess that in all cases these are similar results in terms of a mathematical difference between the judgments. In the case of Skoda Fabia and Ford Escort, the respondents seemed noise, without video, less disturbing than with video, while in the case Renault Thalia is the opposite.

The Renault respondents considered more intrusive than the perception and Skoda Fabia is more intrusive audio without video. As for Ford, respondents are more inclined to judgment intrusive, although as in Škoda also had seemed audio perception without disturbing of video.

In these cases, could be said that audio of Renault is more intrusive than the Fabia but due to the video of the Renault stable with fewer shocks and this might influence the attitude of the respondents. In case of Ford is the first obvious phenomenon for the same reason as this is already the older type of vehicle.

The survey broke within the project VEGA 1/1216/12: Research and development application procedures for solving sound engineering design of products.

REFERENCES

[1] Lumnitzer, Ervin. & Polačeková, Jana. Možnosti aplikácie psychoakustiky v pracovnom prostredí, In: Fyzikálne faktory prostredia, Slovakia, vol.1, pp 38-44, 2011.

[2] Polačeková, Jana. & Lumnitzer, Ervin. Vplyv hluku na orhanizmus človeka z pohľadu psychoakustiky, In: Fyzikálne faktory prostredia, Slovakia, vol. 1, pp 231-237, 2011.

[3] Biľová, Monika. & Lumnitzer, Ervin. & Farkašovská, Zuzana. & Polačeková, Jana Evaluation of acustical insulating material properties, In: International Joint Conference on Environmental and Light Industry Technologiesv, Budapest, Hungary. - Budapest : Óbuda University, pp 29 - 33, 2010.

[4] Decký, Martin & Gavulová, Andrea. & Putirka, Dušan. & Pitoňák, Martin & Vangel, Jozef. & Zgútová, Katarína. Navrhovanie a rozpočtovanie asfaltových vozoviek, In: Žilina, 2010

QUANTIFICATION OF CELLS CAPABLE OF GROWTH AND MULTIPLICATION USING DIRECT VIABLE COUNT METHOD ON FILAMENTOUS AND UNICELLULAR CYANOBACTERIA

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ABSTRACT

This paper presents the results concerning the quantification of cyanobacterial cells capable of cellular growth and multiplication using the direct viable count method (DVC). During incubation of cyanobacterial samples in the presence of nalidixic acid as inhibitor of DNA replication , all other metabolic properties remain active. Viable cells may continue to metabolize nutrients and grow but will not be able to divide, thus becoming more elongated after incubation whereas inactive cells do not elongate during the incubation period. Measurements of cells size were performed using two automatic software Image J to measure cell length and CellC software for cell quantification in light microscopy, compared with manual counting and measuring. The results show that the medium cell size increases from 1.81 μm to 3.35 μm in 84 hours of light incubation with nalidixic acid . Up to our knowledge this is the first report on DVC applied to filamentous cyanobacteria. The method was also used on the unicellular cyanobacterium *Synechocystis* PCC 6803 where the results were compared with growth rate calculated taking into account the increase in optical density.

Keywords: direct viable count, unicellular cyanobacteria, filamentous heterocystous cyanobacteria, digital image analysis.

INTRODUCTION

Direct viable count method for the quantification of living cells (DVC) was initially developed to distinguish viable heterotrophic bacterial cells (Kogure et al.,1979; Kogure et al.,1984) from cells unable to grow and multiplication in natural samples; in more than 30 years this method was copiously used in microbial ecology (Daley, 1979; Caron, 1983; Clarke & Joint, 1986; Epstein & Shiaris, 1992; Coallier et al., 1994; Barcina et al.,1995; Joux & LeBaron, 1997; Guyard et al., 1999; Joux & LeBaron, 2000; Berrnann et al., 2001; Ghiţă et al., 2010a; Ghiţă et al., 2010b). When it comes to autotrophic growing cyanobacteria there is only one report on the use of this method (e.g. Lucilla et al., 1996).

In this study we report our results concerning the use of direct viable count (Kogure et al., 1979) for quantification the number of viable cells in cultures of filamentous cyanobacteria isolated from the sulphurous mesothermal spring Obanul Mare (Romania) and in cultures of unicellular cyanobacteria, our isolate IS-7 and *Synechocystis* strain PCC 6803. Up to our knowledge this is the first report on DVC method applied to filamentous cyanobacteria.

MATERIALS AND METHODS

Study area and sampling. Samples were collected from sulphurous mesothermal spring Obanul Mare (43˚49'53.6''N; 28˚34'05.3''E) and used to isolate in axenic culture filamenous heterocystous cyanobacteria by inoculation into conical flasks with nitrate-free medium BG_0, either in BG_{11} medium to isolate filamentous nonheterocystous cyanobacteria. Natural samples inoculated in either BG_{11} or BG_0 media, either solid or liquid, were incubated in culture room at 25 ± 1º C and illuminated with fluorescent tubes having the photon rate of 50 µmol $m^{-2}s^{-1}$ at surface of the culture vessels (Sarchizian and Ardelean, 2010). Cell length measurement was performed using a microscope eyepiece and preparations were viewed in bright field by heat fixation and staining with 0.02% crystal violet for 5 minutes. The measurements were performed automatically on a number of 100 - 200 cells for each sample. Standard error of the mean for each set of measurements was usually less than 5% of average.

Direct viable count method applied to filamentous heterocystous cyanobacteria IS-H. For direct determination of viable cells in culture of filamentous cyanobacteria we performed the following experiment: we prepared stock- solution of nalidixic acid (100 mg nalidixic acid in 1 mL distilled water) following this protocol: antibiotic solution was centrifuged 4 minutes at 21°C and 650g, filtered (Millipore filters- 0.22 µm) and added into the culture IS-H to a final concentration of 100 µg/mL. The cultures of cyanobacteria were incubated with nalidixic acid in continuous light at 30°C for 5 days and to achieve microscopic preparations were harvested 12 hours; each 900 µL suspension of cyanobacteria were fixed immediately with 100 µL formaldehyde. The preparations for microscopic analysis were stained with 0.02% crystal violet for 3 minutes and viewed in bright field; for automatic measurement of the cyanobacterial cells within filaments ImageJ software was used in connection with a calibrated ocular grid (10 µm = 156 pixel).

Direct viable count method applied to *Syneccocystis* PCC 6803 and our unicellular cyanobacteria strain called IS-7. In a sterile tube was added 20 µL of nalidixic acid solutionto in 10 mL of culture suspension of *Syneccocystis* PCC 6803, by adding additional 10 mL of culture medium BG_{11}. The suspension was cultivated at continuous light at 35°C, the samples were collected at 24 hours (T0 - the initial time; T1 - after 24 hours of incubation on light, T2 after 48 hours, T3 - after 60 hours). Fixing samples was performed with 900 µL suspension of cyanobacterial culture and 100 µL formaldehyde. The same method was performed with our unicellular cyanobacteria called IS-7 incubated with nalidixic acid for 72 hours, and samples were collected at 12 hours.

Direct viable count method applied to population of cyanobacteria from sulphurous spring was done as shown above. One of the main limitation of this method when applied to complex communities of microorganisms is that the resistance of each population to this antibiotic can be very different, so this approach is only preliminary. In all experiments were analyzed a total of 985 microscope images using ImageJ software, 40-50 measurements were performed for each sample. The flexibility of the ImageJ software allowed us to obtain accurate experimental data (Abramoff et al., 2004; Almesjo, 2007; Burger & Burge, 2007; Ishii et al., 1987). Acquisition of high quality digital images and automatically analyze them are critical steps in obtaining results, facilitating thus a large set of data processing in a relatively short time especially for unicellular and filamentous cyanobacteria (Ishikawa et al., 2004).

RESULTS AND DISSCUTION

Direct viable count method applied to filamentous heterocystous cyanobacteria IS-H . Figure 1 presents the evolution of the mean and the maximum size of cyanobacterial cells at initial time, after 24, 48,72 and 84 hours of incubation in the presence of nalidixic acid. These values show a strong increase in average cell length from 1.819 µm at the starts of the experiment to 3.354 µm after 84 hours of incubation, while the maximum cell size increases from 3.469 µm (at time zero)to 8.133 µm at the end of experiment.

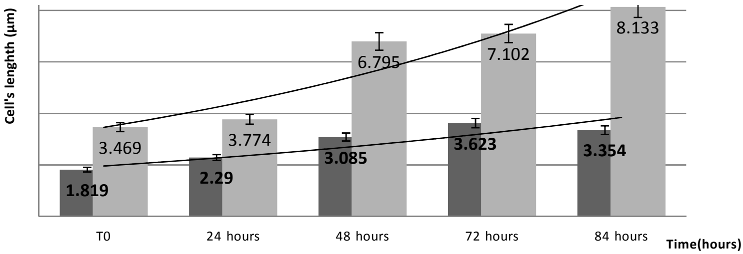

Fig.1. The evolution of the mean and maximum size of cyanobacterial cells during incubation in the presence of nalidixic acid.

The DVC method used for quantification the number of cell capable of growth and multiplication from cyanobacterial filaments allowed us to obtain these original data; thus, up to our best knowledge this is the first report concerning DVC method applied to filamentous cyanobacteria (isolated from sulphurous mesothermal spring). These experiments aimed to determine the proportion of viable cells (DVC^+), compared with the total number of individual biological cells, in this case represented by cyanobacterial filament. DVC^+ cell percentage was calculated as the ratio of DVC^+ cells to total cells counted (100 cells per time).

In table 1 one can see the dynamics of cell size distribution within filaments of cyanobacteria, during incubation with nalidixic acid. According to these experimental data, 64% of cells are able to grow and divide; 7% of cells from the first size class and 57% (89%-32%) from the second size class can be found at the end of experiment in the following size classes: 3 - 6 µm (67% - 4%= 63%) and 6-9 µm (1%).

Table 1. Cell size distribution of cyanobacterial filaments during incubation time with nalidixic acid.

Time	Cell size distribution (%)			
	< 1 µm	1-3 µm	3-6 µm	6-9 µm
T0	7%	89%	4%	0%
12 hours	0%	94%	6%	0%
24 hours	0%	90%	10%	0%
36 hours	0%	92%	8%	0%
48 hours	0%	52%	46%	2%
60 hours	0%	80%	19%	1%
72 hours	0%	19%	79%	2%
84 hours	0%	32%	67%	1%

Direct viable count method applied to *Syneccocystis* PCC 6803. In Figure 2 is presented the cells' shape and size in cultures of *Syneccocystis* PCC 6803 after criystal violet 0,02% staining, obtained automatically with ImageJ software. Digital image analysis allowed us to corectelly identify the sizes of cells. Every digital image was analyed with ImageJ in bright field microscopy and then we utilised the graticula attached to the microscope to measure the size of cells.

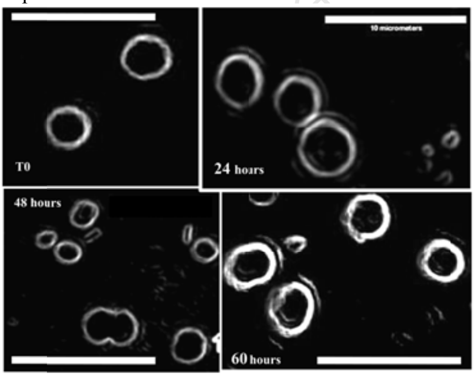

Fig.2. Cell's shape of *Syneccocystis* PCC 6803 after criystal violet 0,02% staining obtained with ImageJ software (scale bar=10 µm).

Table 2 presents the numerical data obtained during the experiment in presence of nalidixic acid to be able to quantify the cells capable of growth and multiplication.

Table 2. Cell's size class distribution after *Syneccocystis* PCC 6803 incubation with nalidixic acid (100 cells counted per sample).

Time (hours)	Cell's size class distribution			
	0.1-1 µm	1 - 2 µm	2 - 3 µm	3- 4 µm
T0	71	21	8	0
24 hours	37	45	18	0
48 hours	0	24	73	3
60 hours	0	47	49	4

Data analysis and cell's size class distribution after incubation with nalidixic acid in continuous light showed that the number of cells ranging in size from 0.1 to 1 μm is 71 at the beginning of the experiment, reducing at half after 24 hours of incubation, and at the end of 60 hours of incubation there are no cell size included in this class. In Table 3 is briefly detailed the percentage distribution of cell's size class after incubation with nalidixic acid.

Table 3. The percentage distribution of cell's class sizes during incubation with nalidixic acid.

Time (hours)	**The percentage distribution of cell's size class**			
	0.1-1 μm	**1 - 2 μm**	**2 - 3 μm**	**3- 4 μm**
T0	71%	21%	8%	0%
24 hours	37%	45%	18%	0%
48 hours	0 %	24%	73%	3%
60 hours	0 %	47%	49%	4%

According to the calculation presented above 71% of the cells are able to grow and multiply; 71% of the cells from the first size class increase their size, thus increasing the percentage of cells in larges size classes : 26% increases in class 1-2 μm, 41% increase in class 2-3 μm and 4 % increase in class 3-4 μm.

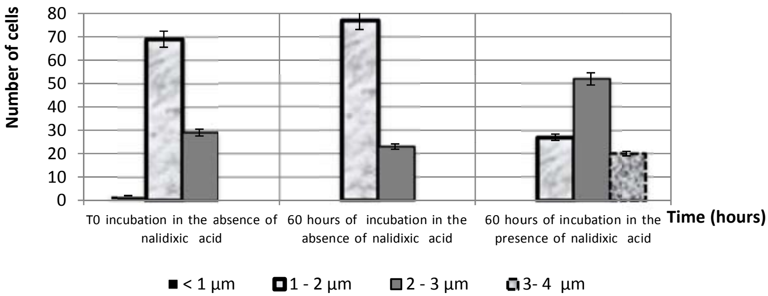

Fig.3. Size distribution in *Syneccocystis* PCC 6803 cells grown in the absence of nalidixic acid or in its presence, at the beginning of the experiment (T0 - 0 hours) and at its end (60 hours).

As one can see in figure 3, there is a clear difference in size distribution of cells grown in the absence of nalidixic acid or in its presence. Whereas, at different times (T0- 0 hours and T3-60 hours) the distribution is practically the same in populations growing in the absence of nalidixic acid, there is a clear shift towards larger cells in populations grown in the presence of nalidixic acid (Table 3 and Figure 4). The monitoring of cell size distribution in populations without nalidixic acid is needed for accurate quantification of cells capable of growth and division by DVC method (Kogure et al., 1979). In our experiments, practically the same size distribution at different times (e.g. 0 hours and 60 hours) in populations growing in the absence of nalidixic acid is determined by the fact that the work is done on a pure strain during asincron cultivation, the increase in length being undoubtedly continue throughout the cell cycle (Sargent, 1975). The increase in optical density of cultures is practically the same in the absence and in the presence of nalidixic acid (figure 4).

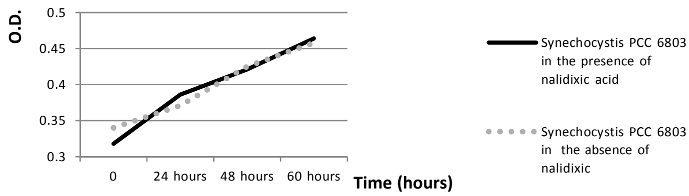

Fig.4. Time evolution of optical densities in cultures of *Synechocystis* PCC 6803 grown in the absence or in the presence of nalidixic acid.

Direct viable count method applied to IS-7. In Table 4 is presented the numerical data obtained during the experiment to determine the cells capable of growth and multiplication in the presence of nalidixic acid.

Table 4. Distribution by size class of IS-7 cells after incubation with nalidixic acid

Time (hours)	**Cell's size class distribution**			
	0.1-1 µm	**1 - 2 µm**	**2 - 3 µm**	**3- 4 µm**
T0	82	15	3	0
12 hours	57	35	8	0
24 hours	0	58	40	2
36 hours	0	44	49	7
48 hours	0	38	51	11
60 hours	0	23	68	9
72 hours	0	27	63	10

Direct viable count method was used on natural mixed population of cyanobacteria from sulphurous sping and the preliminary results are presented in figure 5.

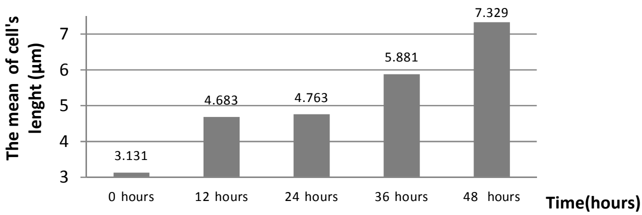

Fig.5. The increase in the mean of cell's length in mixed natural populations of cyanobacteria.

These preliminary results argue that DVC method could be used, after appropriate treatment of experimental data (e.g. quantification of cell size distributions patterns dynamics) for quantification of cells able to capable of growth and multiplication in mixed populations of cyanobacteria.

CONCLUSIONS

Up to our best knowledge this is the first report on DVC method applied to filamentous cyanobacteria and for the first time when automated image analysis is used together with direct viable count method. This method can be used for quantification of cells able to grow and divide in pure cultures of filamentous cyanobacteria and unicellular cyanobacteria, where 64% and 71% of cells are capable of growth and division. DVC method could be used for quantification of cells able to grow and divide in natural samples containing filamentous cyanobacteria, including the cells within the level of individual filaments, to differentiate between filaments that are in growth (containing at least one cell able to grow and multiply) and resting filaments (that do not contain any such cell).

REFERENCES

[1] Abramoff M.D. & Magelhaes P.J., Ram S. J. Image processing with Image J. Biophotonics International, vol.11, pp. 36-42, 2004.

[2] Almesjo L. & Rolff C. Automated measurements of filamentous cyanobacteria by digital image analysis. Limnol. Oceanogr. Methods, vol. 5, pp. 217-224, 2007.

[3] Barcina I. & Arana I., Santoram P., Iriberri J., Egca L. Direct viable count of gram positive and gram negative bacteria using ciproflocacin as inhibitor of cellular division. J. Microbiol. Methods, vol. 22, pp. 139-150, 1995.

[4] Berrnann T.& Kaplan B., Chava S., Viner Y., Sherr B.F., Sherr LB., Metabolically active bacteria in Lake Kinneret. Aquat. Microb. Ecol., vol. 23, pp. 213-224, 2001.

[5] Biggerstaff I.P. & Le Pull M., Weidow B.L., Prater J., Glass K., Radosevicli M., White D.C. New methodology for viability testing in environmental samples. Mol. Cell Probes, vol. 20,pp. 141-146, 2006.

[6] Burger W. & Burge M.J., Digital Image Processing - An algorithmic introduction using Java. Springer-Verlag New York. ISBN 978-1-84628 379-6, 2007.

[7] Caron D.A. Technique for enumeration of heterotrophic and phototrophic nanoplankton, using epifluorescence microcopy and comparison with other procedures. Appl. Environ. Microbiol., vol. 46, pp. 491-498, 1983.

[8] Clarke K. R & Joint L. R. Methodology for estimating numbers of free-living and attached bacteria in estuarine water. Appl. Environ. Microbiol., vol. 51, pp. 1110 - 1120, 1986.

[9] Coallier J. & Prevost M., Rompre A. The optimization and application of two direct viable count method for bacteria in distributed drinking water. Can. J. Microbiol., vol. 40, pp. 830- 836, 1994.

[10] Daley R.J. Direct epifluorescence enumeration of native aquatic bacteria: used, limitations and comparative accuracy. In: Native Aquatic Bacteria: Enumeration, Activity and Ecology (Costerton J.W. and Colwell R.R, Eds) ASTM Philadelphia,pp. 29-45, 1979.

[11] Embleton K.V. & Gibson C.E., Heaney S.I. Automated counting of phytoplankton by pattern recognition: a comparison with a manual counting method. J. Plankt. Res., vol. 25, pp. 669-681, 2003.

[12] Epstein S.S. & Shiaris M.P. Size-Selective Grazing of Coastal Bacterioplankton by Natural Assemblages of Pigmented Flagellates, Colorless Flagellates, and Ciliate. Microb. Ecol., vol. 23, pp. 211-225, 1992.

[13] Ghiţă S. & Sarchizian I., Ardelean I.I. Utilization of epifluorescence microscopy and digital image analysis to study some morphological and functional aspects of prokaryotes. Ovidius University Annals - Biology-Ecology Series, ISSN- 1453-1267, vol. 14, pp.127-137, 2010a.

[14] Ghiţă S. & Sarchizian I., Ţuţuianu A., Ghiţă D., Abdulcherim E, Ardelean I.I. Quantification of actively growing hydrocarbon-oxydizing /tolerant bacteria in marine microcosms supplemented with gasoline. 3rd. International Symposium of Biotechnology „SimpBTH 2010" serie F, ISSN 1224-7774, pp: 204-212, 2010b.

[15] Guyard S. & Mary P., Defives C., Hornez J.P. Enumeration and characterization of bacteria in mineral water by improved direct viable count method. J. Appl. Microbiol., vol. 86, pp. 841-850, 1999.

[16] Ishii T. & Adachi R., Omori M., Shimizu U., Irie H. The identification, counting, and measurement of phytoplankton by an image-processing system. J. Cons. Ciem., vol. 43, pp. 253-260, 1987.

[17] Ishikawa K. & Walker R.F., Tsujimura S., Nakahara H., Kumagai M. Estimation of *Microcystis* colony size in developing water blooms via image analysis. J. Japan Society on Water Environ., vol. 27, pp. 69-72, 2004.

[18] Joux F. & LeBaron P. Ecological implications of an improved direct viable count method for aquatic bacteria. Appl. Environ. Microbiol., vol. 63,pp. 3643-3647, 1997.

[19] Joux F. & LeBaron P. Use of fluorescent probes to assess physiological functions of bacteria at single-cell level. Microbes Infect., vol. 2, pp. 1523-1535, 2000.

[20] Kogure K. & Simidu U., Taga N. A tentative direct microscopic method for counting living marine bacteria. Can. J. Microbiol., vol. 25, pp. 415-420, 1979.

[21] Kogure K. & Simidu U., Taga N. An improved direct viable count method for aquatic bacteria. Arch. Hydrobiol, vol. 102, pp. 117-122, 1984.

[22] Lucila M. & Acosta Pomar C., Giuffre G. Pico- nano- and microplankton in hydrothermal environments of the Eolian Islands in the Mediterranean Sea. J. Plankton Res.,vol. 18, pp.715–730, 1996.

[23] Sarchizian I. & Ardelean I.I. Axenic culture of a diazotrophic filamentous cyanobacterium Isolated from mesothermal sulphurous springs (Obanul Mare - Mangalia), Rom. J.Biol- Plant Biol., vol. 55, No.1, pp. 47-53, 2010.

RECEPTOR MODELING AS A TOOL FOR AIR POLLUTION SOURCE DETECTION AND APPORTIONMENT

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ABSTRACT

The usual way for air quality assessment and pollution source apportionment estimation is usually based on air pollution dispersion modeling. This approach has some serious drawbacks. The most serious drawback is that only known and documented pollution sources can be took into the consideration. Receptor modeling in the other hand is based only on statistical analyses of air pollution measurements and can provide information about decisive air pollution sources and their chemical profiles at the measuring site. This article is based on pollution data at Ostrava-Bartovice and Ostrava-Mariánské hory air pollution monitoring sites which were analyzed using PMF receptor model.

Keywords: receptor modeling, air quality, pollution sources

INTRODUCTION

Within a research which was done in Department of Environmental Protection in Industry was testing of receptor modeling on two industrial air quality monitoring stations in Ostrava - Ostrava – Bartovice and Ostrava – Mariánské Hory.

Receptor models methods are commonly used to source apportionment in foreign countries. Methods PCA (Principal Component Analysis) and PMF (Positive Matrix Factorization) were selected to be used for pollution source apportionment. [1],[2],[3],[4] These two methods were used for receptor modeling on the air quality monitoring stations above.

METHODS APPLICATION

Data from the years 2005 – 2009 were analyzed.

To find out numbers of sources which affect concentration in air pollution stations was used PCA method. The Statgraphics software was used for calculation.

Secondly we used PMF method to find out characteristic ration of substances in each source (factor). For this calculation we used the Matlab software.

RESULTS AND DISCUSSION

On the air pollution monitoring station in Ostrava - Bartovice were identified 5 factors – 5 statistically significant air pollution sources. The results are summarized in the table below.

Table 1 Results of PMF, Ostrava - Bartovice

	PM_{10} [$\mu g.m^{-3}$]	NO_2 [$\mu g.m^{-3}$]	O_3 [$\mu g.m^{-3}$]	SO_2 [$\mu g.m^{-3}$]	As [$ng.m^{-3}$]	Cd [$ng.m^{-3}$]	Pb [$ng.m^{-3}$]	benzen [$ng.m^{-3}$]	fenantren [$ng.m^{-3}$]	B(a)P [$ng.m^{-3}$]
Factor 1	12.77	2.15	0	0.41	1.19	0	4.43	0.22	3.05	7.36
Factor 2	2.98	6.28	0	2.77	0.14	0.44	4.45	2.50	24.17	0
Factor 3	1.60	3.16	0	3.53	0.95	1.02	5.00	0	34.46	0
Factor 4	13.24	3.82	12.51	1.74	1.40	0	8.49	0.28	0	0.29
Factor 5	16.59	7.48	29.46	7.12	1.01	2.39	2.66	0	11.45	0
Sum	47.18	22.90	41.97	15.56	4.70	3.84	25.03	3.00	73.12	7.65
Average	55.00	23.88	43.83	18.65	9.50	5.04	76.93	3.63	100.26	9.70
Remain	7.83	0.98	1.86	3.09	4.80	1.20	51.90	0.63	27.14	2.05

Factor 1 was identified due to high concentration of PM10 and benzo(a)pyren as a coke plant of the ArcelorMittal company.

Factor 2 was identified as a source pollution from automotive transport. There are represented some PAU, nitrogen dioxide and PM10.

Factor 3 was identified as secondary pollution from automotive transport. Between factor 2 and 3 we can observe correlation. Both of these sources have a similar time running and concentrations of pollutants. It could be caused by a resuspension dust after passing car because there was almost no pollution from this source during rainy days.

Factor 4 was identified as a steelworks. This source represented particular matter PM10 and higher concentrations of heavy metals.

Factor 5 was identified as a primary metallurgy (sintering plant + blast furnaces). During the ore processing before their using in blast furnace there are emissions of PM10 and heavy metals. Emissions of PAU probably come from stoppers of blast furnace, which are made from alkyd.

Beside this factors remain the pollution without time running and characteristic chemical composition. This pollution is named remain. It is an unsolved part of receptor model.

Although the air pollution monitoring station in Ostrava – Bartovice is situated in residential district there were not identified local heating sources. This kind of sources is probably hidden in the remain and cannot be determined by PCA-PMF method combination.

On the air pollution monitoring station in Ostrava – Mariánské Hory were identified 4 factors - 4 significant air pollution sources. The results are represented in table below.

Table 2 Results of PMF, Ostrava – Mariánské Hory

	PM_{10} [$\mu g.m^{-3}$]	NO_2 [$\mu g.m^{-3}$]	O_3 [$\mu g.m^{-3}$]	Ni [$ng.m^{-3}$]	As [$ng.m^{-3}$]	Cd [$ng.m^{-3}$]	Pb [$ng.m^{-3}$]	benzen [$ng.m^{-3}$]	fenantren [$ng.m^{-3}$]	B(a)P [$ng.m^{-3}$]
Factor 1	16.54	5.86	21.06	1.14	2.83	0.27	10.00	0.09	0	0.21
Factor 2	10.76	4.39	0	1.36	1.42	1.14	4.19	0	19.73	0.00
Factor 3	2.37	3.14	0	0	0	0	2.04	0.74	2.48	2.97
Factor 4	10.24	8.83	20.61	2.40	0.31	2.10	4.29	1.71	14.04	0.01
Sum	39.92	22.21	41.67	4.89	4.55	3.51	20.52	2.53	36.25	3.19
Average	47.60	22.75	52.81	6.41	9.42	5.13	84.99	3.58	46.91	3.78
Remain	7.68	0.54	11.14	1.51	4.87	1.62	64.47	1.05	10.66	0.59

Factor 1 was identified as a steelworks due to higher concentrations of heavy metals and PM10. This factor has a similar chemical composition as steelworks in Ostrava – Bartovice.

Factor 2 was identified as probably industrial source, which wasn´t specified. Neither time running nor ratios of chemical compounds in did help.

Factor 3 was identified as a local heating. Nitrogen dioxides, PM10, and higher concentrations of PAU are typical for burning process in local heating. We can´t explain absence of heavy metals. It is possible, that this source could be a heating plant or other seasonal energy source.

Factor 4 was identified as pollution from automotive transport. There are represented by nitrogen dioxides, fenanthren and others PAU, but also by PM10 and 03.

According to assumption impact of industrial sources, local heating and road traffic were proved in this air pollution monitoring station.

REFERENCES

[1] Karman, D. Source Oriented vs. Receptor Oriented Models. Carleton University, Ottawa, Canada [online]. [2011-01-14]. On WWW: <http://http.server.carleton.ca/

~dkarman/81403/receptor_modelling.ppt>.

[2] CHRISTENSEN, William F.; SCHAUER, James J.; LINGWALL, Jeff W.. Iterated confirmatory factor analysis for pollution source apportionment. Environmetrics. 2006, 17, s. 663-681.

[3] TAULER, R., et al. Identification, Resolution and Apportionment of Contamination Sources. Environmental Modelling, Software and Decision Support. 2009, 17, s. 269-284.

[4] ALLEMAN, Laurent Y., et al. PM10 metal concentrations and source identification using positive matrix factorization and wind sectoring in a French industrial zone. Atmospheric Research. 2010, 96, s. 612-625.

REGIONAL RELATIVE RISK RANKING OF DIFFUSE POLLUTION SOURCES IN AN URBAN ENVIRONMENT, GOTHENBURG (SWEDEN)

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ABSTRACT

Complex urban environments are not easily described in terms of ecological risks. Relative regional risk ranking (developed by W.G. Landis) summarizes the impact of multiple parameters within a region considering their source and distribution. As part of the EU Interreg project (DiPol; homepage http://www.tu-harburg.de/iue/dipol.html), the regional relative risk ranking analysis in Gothenburg evaluates several diffuse pollution sources including agriculture, industry, forestry, recreation, surface water runoff, waste water treatment plants, and maritime shipping in the area in regards to geographical distribution and perceived risk and impact. The model combines sources, stressors, habitats, and indicators and allows the user to rank the relationships between these. The model output can help determine the highest at-risk regions within an area as well as the significant sources of diffuse pollution in order to prioritize remediation or mitigation measures. Our analysis focuses on the rivers and streams in Gothenburg, specifically looking at the Göta älv River, and the tributary streams Säve ån, Mölndals ån, Kvillebäcken, as well as the estuary at the mouth of Göta älv River. The highest risk to the indicators (bathing water quality, environmental water quality, and sediment quality) is suggested to be largely dependent on which region one looked at, but the highest relative risk is associated with surface water runoff, industry, and agriculture. However, the estuary is more highly affected by discharges from the city waste water treatment plant.

As a decision-making tool, these results need to be evaluated with cost benefit and stakeholder concerns. In this project, a system analysis ("Sensitivity model") was carried out to make these connections and to highlight the possible mitigation alternatives. In addition, GIS models for contaminant fluxes and site-specific loading along the urban waterways are used to complement the conclusions from relative risk ranking to balance, for instance, the use of local infiltration, treatment and direct discharge of surface runoff, one of the main sources of diffuse pollution. These models and quantitative assessments illustrate an integration of scientific and end-user perspectives, especially important for complex urban systems.

Keywords: urban pollution, risk ranking, waterways, Sweden, modeling

INTRODUCTION

Cost-effective planning and remediation decisions are ideally based on both the priorities of stakeholders and the factual information of impact that alterative measure can have. However, the complexity of urban and natural ecological systems does not allow most of the variables to be determined with purely empirical data. Instead, conceptual models of the components, sources of stressors, processes involved and probable impact can often be based on experience, theory and available observations. The formulation of such models is best done with multi-disciplinary and trans-professional groups, where the individual subjective evaluation will be to some degree balanced by other perspectives.

SIMACLIM is a tool developed within the EU Interreg project DiPol, a consortium developed to analyze the impact of diffuse pollution and climate change on the quality of urban and coastal waters. This tool is composed of two programs, the "Sensitivity Model" [7] for system structure analysis and the regional relative risk ranking model (4RM) that is primarily dealt with here. The 4RM model uses Excel-based macros for applying the principles of the regional relative risk ranking model, allowing the evaluation to be visualized with graphs. SIMACLIM has been applied in Hamburg, Germany, Oslo, Norway, and Amsterdam, Netherlands in addition to Gothenburg.

The first part of the SIMACLIM modeling, a system structure analysis, was carried out in two workshops in 2011 with the Göta älv River Water Council, which is the main stakeholder group within the county administration office. The SIMACLIM modeling facilitated a broad perspective and initially included 27 variables that interact with each other and impact on the water quality. The system was identified as relatively stable. Many of the variables acted as "buffers", and were not greatly changed in response to changes in the variables. This may allow for planners to recognize consistent, predictable conditions, but it also limits the choices they have for inducing changes when these are needed, for instance to improve water quality in certain areas. The system is also interpreted to respond comparatively slowly to changes, so that decision makers must realize that both positive and negative effects will often be evident only with considerable time. Risk modeling becomes important in this connection because it can stress the long-term importance of alternative actions.

RELATIVE REGIONAL RISK RANKING

Relative risk modeling (RRM) is an integrated assessment method [4]. First, the study area is divided into regions; within these regions, sources of stressors and habitats are ranked and given weighting factors. By evaluating the relationships between sources, habitats, end-points, the relative risk to each region can be calculated and visualized. This risk assessment method is intended to better demonstrate the complex ecological connections while providing a way of comparing the relative risk between regions of a study area and identify high risk areas [3]. The Relative Regional Risk Ranking modeling (4RM) was applied to Gothenburg.

The main urban waterway in Gothenburg is Göta älv River, which is approximately 93 km long and drains from Vänern Lake into the Kattegat. Approximately 20 km north of Gothenburg, at Kungälv, the river divides into the Nordre älv River and southern Göta älv River, which continues to its mouth at Gothenburg. As shown in

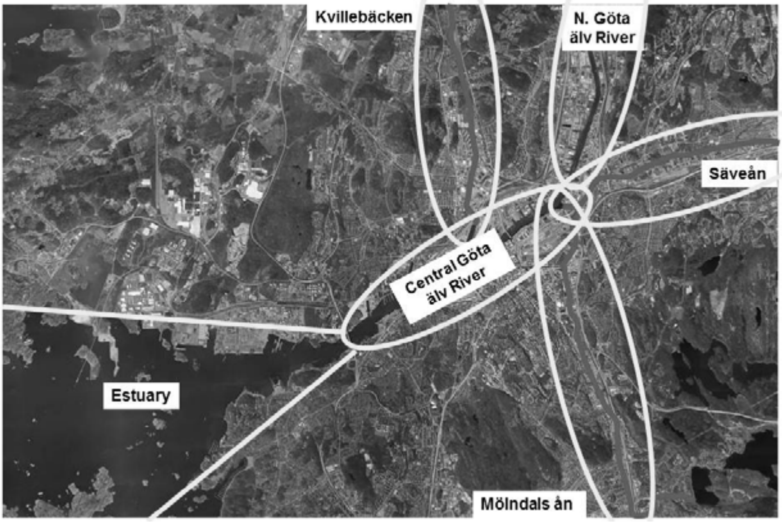
Figure 1, there are three main tributary streams to Göta älv River within Gothenburg city limits: Säve ån, Mölndals ån, and Kvillebäck, each with a significantly different discharge and watershed area, shown in Table 1. Göta älv River discharges into an estuary that is part of the coastal archipelago outside of Gothenburg

Table 1: Göta älv River and Tributaries in Gothenburg Characteristics (Source: Göta älvs vattenvårdsförbund, 2005, Ekfeldt, 2007.)

	Watershed (km^2)	Discharge (m^3/s)	Impermeable Surface (km^2)
Göta älv (total)	50 233	180	--
Säve ån	1 475	23	5.02
Mölndals ån	268	3.4	3.49
Kvillebäck	26	0.2	1.45

Figure 1: Map of Gothenburg, showing the regions for risk ranging. Since the water discharge and settings are quite different, each region also represents a separate habitat.

Gothenburg has an area of 450 km^2 and the population is approximately 525 000. It is the second largest city in Sweden, and has Sweden's largest harbor and seaport. Göta



älv River is used for both drinking water and as a receiving medium for wastewater. The area has a mix of residential, industrial, and agricultural zoning (Table 2).

Table 2: Land Use in Gothenburg (Göta älvs Vattenvårdsförbund, 2006, Statistics Sweden, 2008)

	Agriculture (%)	Forestry (%)	Industry/Urban (%)	Other (%)
Gothenburg	9	20	43	28
Säve ån	15	59	15	11
Mölndals ån	3	62	26	9

The study area is split into risk regions according to the tributary streams, Säve ån, Kvillebäck, Mölndals ån, in addition to Northern Göta älv (meaning the area north of Gothenburg) (NGA), Central Göta älv (the portion of Göta älv which is within Gothenburg city limits) (CGA), and the estuary. Due to the large difference in discharges and stream types, these regions are essentially equivalent to separate habitats. The habitats are further divided into sediment and water media.

The sources of stressors used for this assessment are industry, agriculture, forestry, waste water treatment plants (WWTP), surface water runoff (SWRO), recreation, and shipping. Stressors included in the assessment are dissolved metals, sorbed metals, pesticides, organic compounds (e.g., polycyclic aromatic hydrocarbons), pathogens, and temperature. Sediment quality (SQ), bathing water quality (BWQ), and ecological water quality (EWQ) are selected as end point indicators.

Relationships between indicators, stressors, sources, and risk regions are evaluated and weighted on a scale of 0-6 or 0-1. Examples of these relationships are presented in Table 3, 4 and 5. The values and weighting are based on empirical data and perceived risk and knowledge about the area. For example, regions with a high percentage of industrial land use are given a "6" for industry, whereas regions with limited industrial land use are given a lower value. The risk factor for a region is obtained by multiplying the relative ranks of sources and habitats (if these are separated) and stressors of a region and their weighting factors (which is related to their supply from the sources).

Table 3: Sources vs Risk Regions

	Risk Regions					
	Northern Gota älv	Central Göta älv	Säve ån	Estuary	Kvillebäck	Mölndals ån
Sources						
Agriculture	6	2	2	0	2	2
Industry	4	6	6	2	6	4
Forestry	6	4	4	0	4	6
Recreation	2	4	4	6	0	1
SWRO	3	6	6	2	2	6

	Risk Regions					
	Northern Gota älv	Central Göta älv	Säve ån	Estuary	Kvillebäck	Mölndals ån
WWTP	4	4	0	6	0	0
Shipping	4	6	0	6	0	0

Table 4: Stressors vs. Sources

	Sources						
	Agricu-lture	Industry	Forestry	Recrea-tion	SWRO	WWTP	Shipping
Stressors							
Dissolved Metals	2	6	2	2	4	2	4
Sorbed Metals	2	6	2	2	4	2	4
Pesticides	6	2	4	2	2	4	4
Organic Compounds	4	4	4	0	2	6	0
Pathogens	2	6	2	2	0	2	2
Temp	0	4	0	0	0	6	2

RESULTS

According to the 4RM model, the water and sediment quality in Göta älv River in Gothenburg is primarily affected by industry. As shown in Figure 2, surface water runoff, waste water treatment plants, and shipping also have an impact, but not to as high an extent. Agriculture, forestry, and recreation are minimal sources of risk to this risk region. Due to the large diversity of sources, all stressors were evaluated to present a relatively high risk to the water and sediment quality; however, the highest relative risk is attributed to pesticides and sorbed metals (Figure 3).

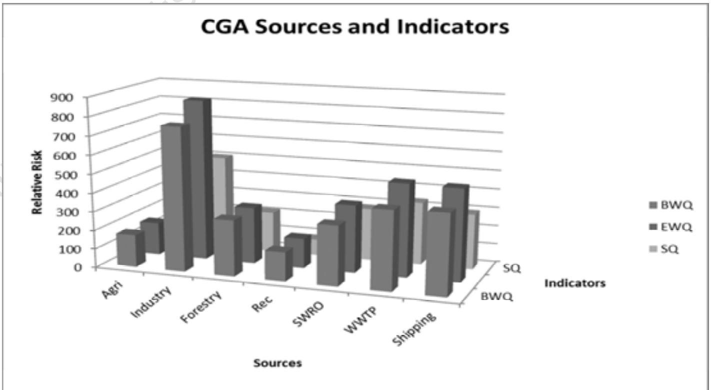


Figure 2: Relative Risk Evaluation – CGA Source and Indicators

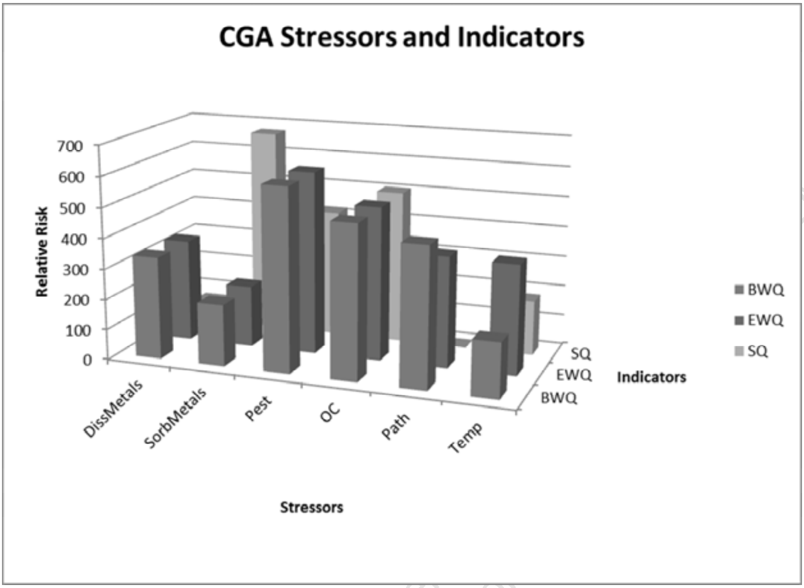


Figure 3: Risk Evaluation – CGA Stressors and Indicators

Säve ån does not receive discharge from a waste water treatment plant and is not a route used for shipping. The largest source of risk for this region is industry, followed distantly by surface water runoff. Agriculture, forestry, and recreation all contribute a slight amount of risk to bathing water, ecological water, and sediment quality, mostly due to pesticides, organic compounds, and pathogens.

The results indicate that water quality and sediment quality in Mölndals ån Stream has a high risk of being affected by industry, forestry, and surface water runoff. There are no waste water treatment plants connected to this stream and thus discharge does not contribute to risk. There is no ship traffic in this stream. Agriculture and recreation contribute a limited relative risk to this region. Due to the large amount of industry, forestry, and impermeable surfaces, however, sorbed metals, pesticides, organic compounds and, to a lesser extent, pathogens can all potentially harm water and sediment quality.

The sediment and water quality in the stream Kvillebäck are greatest affected by industry. Agriculture, forestry, and surface water runoff have low relative risk values. Recreation, waste water treatment plants, and shipping are not sources of risk for this region. Similar to Mölndals ån, metals, pesticides, organic compounds, and pathogens dominate the risk to water and sediment quality in this region.

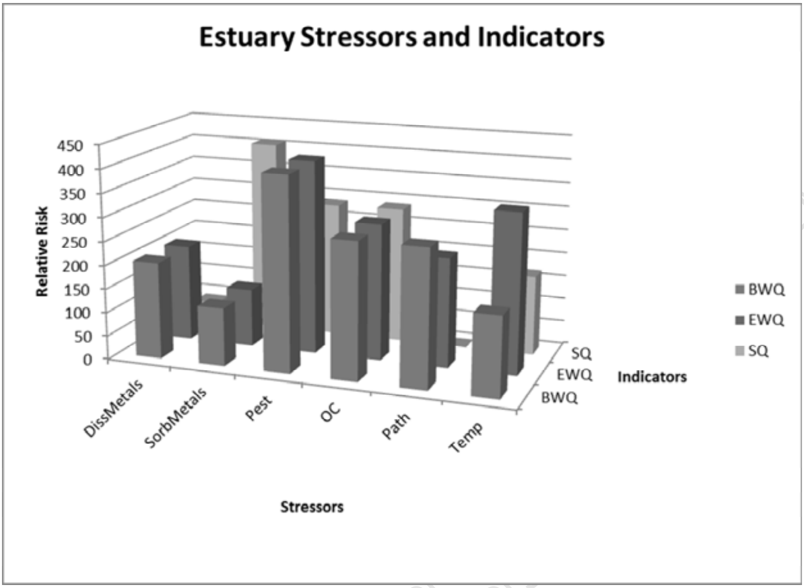


Figure 4: Risk Evaluation - Estuary Stressors and Indicators

The largest sources of risk for the estuary are the waste water treatment plant, which pumps effluent directly into the estuary during large storm events due to system overflow. Shipping is also a major source of risk to water and sediment quality. Industry, recreation, and surface water runoff minimally affect the estuary, and agriculture and forestry are not sources of risk. As shown on Figure 4, the relative risk to indicators is mostly due to sorbed metals (in sediment) and pesticides (water and sediment).

Due to the size and nature of Göta älv River north of Gothenburg, agriculture, industry, forestry, and waste water treatment plants have almost identical risk values. Shipping is also a significant source of risk. Recreation and surface water runoff have a much smaller impact. As a result of large areas of agriculture, pesticides and organic compounds are associated with the highest risk to indicators.

DISCUSSION

The 4RM results suggest that, although the Göta älv River water quality is strongly influenced by upstream sources, the urban sources within Gothenburg have a significant impact. This is even more obvious if the main tributary streams are considered as sub-areas and habitat environment, since their flow conditions vary from ca. 0.24 m^3/sec to 20 m^3/sec, whereas the Göta älv River has about 180 m^3/sec. The industrial sources and stormwater runoff are the two main urban sources for environmental stressors.

Pesticides and organic compounds are the dominant risk drivers, followed by metals (both dissolved and sorbed) and pathogens. Temperature mainly affects environmental water quality.

Based on this model, a combination of surface water runoff management and industry mitigation measures will be the most effective in reducing risk to environmental and human health. Pesticide usage (both for marine and agricultural use) should be monitored closely and managed properly as well.

The model does not account for storm surges and seasonal variations. It is likely that the wetter periods of the year will contribute greater risk to contamination to Göta älv River via the tributary streams as well as to the estuary. The model is also subject to a large amount of generalizations and estimations in order to account for the many variations on a regional scale.

The results of this regional risk ranking analysis combined with the sensitivity model mentioned in the introduction can help the city of Gothenburg best prevent contamination as well determine the most cost-effective methods in prevention of pollution in addition to remediation of existing problems. Other cities may find this tool useful in addressing long term management and prevention of diffuse pollution.

ACKNOWLEDGMENTS

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REFERENCES

[1] Ekfeldt, Frida. Göteborgs Blå Struktur – med studie av osbäcken. Dept. Landscape Architecture, Swedish Agricultural University, Thesis. 2007.

[2] Göta älvs vattenvårdsförbund. Fakta om Göta älv: en beskrivning av Göta älv och dess omgivning 2005. 2006.

[3] Landis, Wayne G. Regional-Scale Ecological Risk Assessment. CRC Press LLC, New York. 2005.

[4] Landis, W.G.; Wiegers, J.K.. Design considerations and a suggested approach for regional and comparative ecological risk assessment. Human and Ecological Risk Assessment. 3: 287-297. 1997.

[5] Vester, F. The Art of Interconnected Thinking. MCB Verlag GmbH, München. 365 pp. 2007.

[6] Statistics Sweden. Land Use in Sweden, fifth edition. SCB-tryck, örebro. 2008.

REABILITATION METHOD OF THE AREAS WHICH ARE NATURALLY CONTAMINATED WITH HEAVY ELEMENTS IN METALIFEROUS DISTRICT OF BĂLAN (ROMANIA, HARGHITA, EASTERN CARPATHIANS) – IMMOBILIZATION WITH APATITE

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ABSTRACT

The present researches in Romania regarding decontamination of the mining areas refer almost exclusively to the spoil-banks, settling lagoons and other areas influenced by the mining activity. In the present paper we wish to analyse the decontamination in the naturally contaminated areas which are not influenced by the mining activities, these areas are called by us naturally contaminated areas. In 2008 we have undertaken a biogeochemical research on *Vaccinium myrtillus* in the naturally contaminated metaliferous (pyrites-red copper) district of Bălan (Eastern Carpathians) respectively a pedogeochemical research, thus we determined increasing values above the threshold for the heavy elements such Cu, Ni, Pb, Zn, and a statistically significant corelation for all the analysed elements. We determined the pedogeochemical respectively biogeochemical secondary dispersion halos and we established the intensity and intensity contrast of these and the correlation coeficients for soil-plants.

In order to reduce the values of intensities and of intensity contrasts, of the fund values and biogeochemical threshold, we used the amelioration method through powdery apatite immobilization. We have chosen apatite because is a relatively cheap material which can be easily procured.

Keywords: Naturally contaminated areas, secondary pedogeochemical and the biogeochemical halos of dispersion, soil-plants correlation, amended biogeochemical intensity halos.

INTRODUCTION

The metaliferous district of Bălan is delimited by the Olt river in East and South. The Western border follows the way of Voroc stream (right branch of Olt river), traverses the Fagul Înalt stream in North in the upper site of Voroc stream and follows straight into North the Western branch of this stream, traverses the stream close to the spring, then goes straight into North till the valley of Şipoş stream, immediately in lower site with its right side branch the Jindieşul de Jos stream. The Northern border of the site is marked by the valley of Şipoş stream (fig 1).

Figure 1

Analysing the spontaneous vegetation in the contaminated/polluted areas (spoil-banks and settling lagoons) and the vegetation from the known mineralised areas which are not influenced tehnogenetically, we observed some similarities regarding the physiological changes and also the clorosions and necrosions of some plant species (Fig. 2 –a, plants from the contamined areas, b – plants of the not contamined areas).

Therefore we decided to study the contamination respectively the naturally pollution of the district through the determination of fund values respectively biogeochemical threshold and to test a method of immobilization of the heavy metals from the soil.

Figure 2/a Necrosis sample Figure 2/b Myrtillus outside the metaliferous area - sample 10

Material and Methods

The biogeochemical research was undertaken with two sample examinations on *Vaccinium myrtillus*with a collection surface of3,0 * 3,0 $m^2$and the second sample was collected after one year following the apatite ammendment. The determinations were done by atomic absorbtion spectrophotometric analysis and the results were processed in order to determine the content variation before and after the ammendment.

In the premise of apatite utilisation we were based on the fact that phosphates of the various heavy metals are not easily solvables (for example $Pb_5(PO_4)_3OH$ has lgKs = -76,5 and $Cd_3(PO_4)_3$has lgKs = -32,6) and its utilisation may represent an efficient method for the heavy elements immobilization, because many phosphatic materials can immobilize through absorbtion or coprecipitation the heavy metals [2].

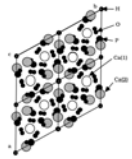

Figure 3 The apatite structure [5]

The metals remain inside the apatite structure for undefined period *(fig.3),* andpresent a reduced desorbtion capacity, levigation or changes, even significant changes of the pH[6] [7].

The utilised apatite was obtained from the chemical fertilizer plant of Tg Mureș – Azomureș SA, where is used to obtain granulár superphospate with apatite basis.

The apatite dose was 25 g/kg, and it was added in August 2010.The necessity of sample taking in August was indicated because Myrtillus is a fruit in ripen process and then absorbtion is more intensive. The apatite was added on the sample surfaces following the collection of fitogeochemical samples.

For the determination of the fund values respectively biogeochemical threshold, of intensity values and intensity contrast we utilised the Hawkes method, respectively Chauvenet test according to the established conventions in order to determine the anomalous values:

$$\left| X_i - X_m \right| > Z * \sigma \ (1)$$

Where $X_m$and σ represent the arithmetic value, respectively the standard variation of the experimental values, and Z represents the tabled value. In our case for n = 16, Z = 2.14.

The anomalous contents are those values for which is not verified the above mentioned condition (1).

The first sample for which is verified the above condition (1) represents the value of the biochemical threshold established with Chauvenet method. The fund value is determined by the average value of the experiments exclisively the anomalous values.

The intensity indicator is showed by anomalous values situated between pedogeochemical threshold and maximal concentration, while the contrast represents the relation between the intensity of the halos and fund concentration [4]or biogeochemical threshold[1].

Results and discussion

Following apatite ammendment*(tab. 1),*we succeed to obtain significant decreases versus the not ammended tests regarding the content of analysed heavy metals for myrtillus.

Table 1 Variation of the element content in plants before and after amendment (ppm)

No crit.	Cu	Cu amended	Cu %	Ni	Ni amended	Ni %	Pb	Pb amended	Pb %	Zn	Zn amended	Zn %
1	109	105	- 3.7	5	9	+80.0	4	2	- 50.0	95	62	-34.7
2	225	197	- 12.4	7	8	+14.3	32	20	- 37.5	110	49	-55. 5
3	330	327	- 1.0	12	26	+116. 7	45	29	- 35. 6	73	52	-28. 7
4	96	84	- 12.6	4	2	-50.0	3	5	+ 66. 7	63	34	-46.0
5	96	103	+7.3	9	16	+77. 8	10	12	+ 20.0	90	73	-18. 9
6	21	26	+ 23.8	4	2	-50.0	8	4	- 50.0	65	69	+6.2
7	21	19	-9.5	2	2	0.0	6	2	- 66. 7	74	72	-2.7
8	240	203	-15.4	4	6	+50.0	29	14	- 51.7	75	53	-29.3
9	24	32	+33.3	10	6	-40.0	15	6	- 60.0	54	28	-48.1
10	15	8	-46.7	5	2	-60.0	3	3	0.0	65	39	-40.0
11	6	2	-66. 7	9	2	-77. 8	5	6	+20.0	98	90	-8.2
12	335	297	-11.3	13	17	+30.8	38	19	- 50.0	90	49	-45. 6
13	102	86	-15.7	8	4	-50.0	26	17	- 34.6	68	28	-58.8
14	9	4	-55.6	6	4	-33.3	2	7	+250.0	55	41	-25. 5
15	8	2	-75.0	10	3	-70.0	8	2	- 75.0	60	48	-20.0
16	2	8	+ 300.0	14	35	+150.0	12	4	- 66. 7	75	67	-10. 7

The elements concentration decreased in those cases where concentrations are relatively high and in many cases where contents show some parts per million it can be observed an increase of bioabsorbtion. In table 2 wecalculated the anomalous samples following apatite treatment in order to establish the fund value, biochemical threshold respectively anomalous samples.

Table 2 Determination of anomalous values following apatite treatment 25g/kg

Elem.	Element value/anomalous (Va) – normal value (Vn)													
Cu	327	Va	297	Va	203	Va	197	Va	105	Vn				
Ni	35	Va	26	Va	17	Va	16	Va	9	Va	8	Va	6	Vn
Pb	29	Va	20	Va	19	Va	17	Va	14	Va	12	Va	7	Vn
Zn	90	Va	73	Vn										

Analysing the variation of the biogeochemical fund and threshold we can observe the decrease of the values for all analysed elements except nickel. (tab. 3).

Table 3 variation of the biogeochemical fund respectively threshold before and after amendment

Element	Zn	Ni	Pb	Cu
Chauvenet biogeochemical fund - Amended	50,933	9	4,100	39,917
Chauvenet biogeochemical fund	69,769	8,250	4,875	42,417
Chauvenet biogeochemical threshold - Amended	73	20,6	7	105
Chauvenet biogeochemical threshold	75	14	8	109

The immobilization method may be successfully used because the nickel limits are not situated in alarm limits.

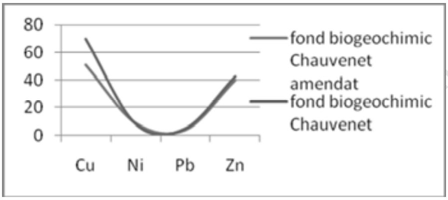

Figure 4 variation of the biogeochemical fund before and after apatite amendment

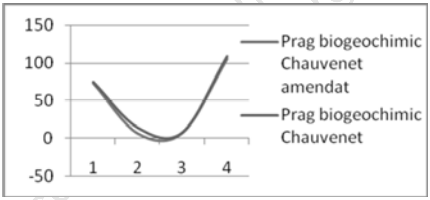

Figure 5 variation of the biogeochemical threshold before and after apatite amendment

In case of nickel the value of the ammended biogeochemical threshold increased *(tab. 3)(fig. 4)(fig. 5)*following the apatite treatment thus appeared some anomalous samples.The anomalous samples are the following: test no.16 with a value of 35 ppm respectively 3 with 26 ppm *(tab. 1)*.

The Cu, Ni, Pb and Zn absorbtion on the hydroapatite surface $Ca_5(PO_4)_3OH$, happens through complexation or coprecipitation.

The undertaken studies showed the efficiency of the apatite or hydroapatite especially for Pb immobilization[8],or in case of Pb minerals[4] [5].

In acidic soils can take place the dissolution of the apatites followed by the formation of phyromorphite type precipitations [$Pb_5(PO_4)_3X$], while in basic environment we meet hydrocerussite $Pb_3(CO_3)_2(OH)_2$or Pb fluoroxide, Pb_2OF_2 [6] [2].

Zhang and Ryan have studied the accumulation of pyromorphite in the different types of contaminated soils in the existence of phosphate materials. [9].Their conclusion was that apatite and/or Pb dissolution in soils represents a limit step in pyromorphite accumulation, thus the acidification of the soil before phosphate adding can stimulate the accumulation of the pyromorphite, according to the reactions [9] [10]:

$$Ca_5(PO_4)_3X_{(s)} + 6H^+_{(aq)} \Leftrightarrow 5Ca^{2+}_{(aq)} + 3H_2PO_4^-{}_{(aq)} + X^-$$

$$5Pb^{2+}{}_{(aq)} + 3H_2PO_4^-{}_{(aq)} + X^- \Leftrightarrow Pb_5(PO_4)_3X_{(s)} + 6H^+_{(aq)}$$

$$\text{Global:} \quad Ca_5(PO_4)_3X_{(s)} + 5Pb^{2+}{}_{(aq)} \Leftrightarrow Pb_5(PO_4)_3X_{(s)} + 5Ca^{2+}{}_{(aq)}$$

where X may be F^-, Cl^-or OH^-.

The global reaction is exoergical, ΔH standard being in case of $X^- = OH^-$ de –137,08 kJ/mol. It is logical that hydroxyapatite, is more dissoluble than fluorapatite, and will have more efficiency in the processes controlled by the speed of solvability[9].

Table 4 Variation of the intensity of biogeochemical haloes respectively of the intensity contrast before and after amendment with 25 g/kg (ppm.)

Contrast coefficient	Contrast power	Code of the haloes	Element	Value of Hawkes contrast through Chauvenet fund
0-2	low	AuZnpl - 11	Zn	1,767
2-4	moderated	AuPbpl – 5	Pb	2,927
		AuNipl - 16	Ni	3,888
		AuNipl – 3	Ni	2,888
4-6	high	AuPbpl-2-3-8-13	Pb	4,870
		AuPbpl-12	Pb	4,634
over 6	very high	AuCupl-2-3-8	Cu	6,070
		AuCupl-12	Cu	7,440

Analysing table 4 regarding the intensity contrast and contrast power of the biogeochemical halos (tab. 5) before and after ammendment with apatite 25 g/kg, we can observe a remodeling and a decrease of their values.

In case of copper can be observed a slight decrease of the values determined following the soil ammendment of 25 g/kg *(fig. 6).*More significant decreases can be observed in case of some maximal values. The general decrease following the apatite ammendment of 25 g/kg was 8,298 % versus the not ammended values.

The haloe AuCupl – 2-3-8 supports a decrease of 8,553% while the AuCupl – 12 decreased with 11,343%. The halo AuCupl – 1-2-3 disappeared following the ammendment, its values are situated under the ammended biogeochemical Chauvenet threshold.

Table 5 Coefficient and contrast power for the biogeochemical tests following the apatite amendment

Code of halo	Intensit.	Hawkes contrast through Chauvenet fund	Halo (amended)	Intensit (amended)	Chauvenet fund (amended)	Hawkes contrast through Chauvenet fund (amended)
AuCupl – 2-3-8	265	6,247	AuCupl – 2-3-8	242,333	39,917	6,070
AuCupl – 12	335	7,898	AuCupl – 12	297	39,917	7,440
AuZnpl – 1-2-3	98,33	1,409	AuZnpl – 1-2-3	-	50,933	-
AuZnpl – 12	90	1,290	AuZnpl – 12	-	50,933	-
AuZnpl – 11	98	1,405	AuZnpl – 11	90	50,933	1,767
AuPbpl – 2-3-8-13	33	8,516	AuPbpl – 2-3-8-13	20	4,100	4,870
AuPbpl – 12	38	9,806	AuPbpl – 12	19	4,100	4,634
AuPbpl – 16 - 9	13,5	3,484	AuPbpl – 16 - 9	-	4,100	-
AuPbpl – 5	10	2,581	AuPbpl – 5	12	4,100	2,927
AuNipl - 16	-	-	AuNipl - 16	35	9	3,888
AuNipl - 3	-	-	AuNipl - 3	26	9	2,888

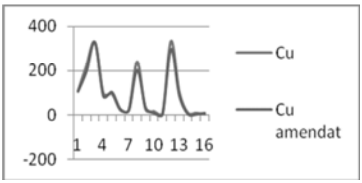

Figure 6 Variation of the ammended Cu content comparatively with the basic values

The intensity contrast *(tab. 5)*for both halos AuCupl – 2-3-8 respectively AuCupl – 12 decreased from the value of 6,247 ppm to 6,070 ppm, respectively from 7,898 ppm to 7,440 ppm.The contrast power for both halos AuCupl – 2-3-8 and AuCupl – 12 is situated in a very high contrast value area, with values over 6. We did not succeed to reduce the value of this indicator neither through ammendment.

Analysing the variation of the nickel content *(fig. 7)*we can observe that the ammendment with apatite determined the stimulation of the biodisponibilization, thus increased the quantity of this element in case of myrtillus.

As well as in the case of copper the maximal values have suffered significant changes, the difference is that in case of nickel following the apatite ammendment the analysed values increased in average with 18,033% versus the not ammended values.

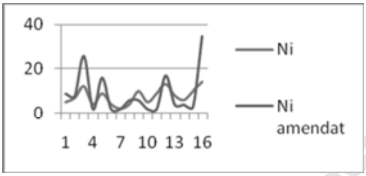

Figure 7 Variation of the ammended Ni content comparatively with the basic values

Adopting the threshold conventions and determinations, we can observe that appear two anomalous samples16 and 3. We note the two halos AuNipl – 16, respectively AuNipl – 3. In case of the halo AuNipl – 16 the value increases from 14 ppm to 35 ppm, and in case of the halo AuNipl – 3 increases from 12 ppm to 26 ppm.

Analysing the contrast power of these two new halos we can observe that are situated in the moderated contrast power category.

Following the apatite treatment of the soil with 25 g/kg,in case of **Pb** is observed a decrease of the determined content values *(fig. 8)*. Significant decreases are observed in case of the tests with high absorbtion values, the bioacumulation of this element is decreased in case of myrtillus.

The average decrease of the analysed values following apatite utilisation is 10,667% versus the not ammended values. The intensity contrast for the halo AuPbpl – 5, following the ammendment is situated in the moderated intensity area.

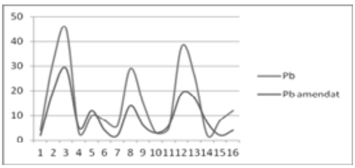

Figure 8 Variation of the ammended Pb content comparatively with the basic values

The halos AuPbpl – 2-3-8-13 respectively AuPbpl – 12 are situated in the area of a very high contrast power, having a decreasing tendence in comparison with those not ammended. Following the ammendment the biogeochemical halos AuPbpl – 16-

9disappear, *(tab. 4),* thesewere situated before the ammendment in a moderated respectively very high contrast power area. *(tab. 5)*.

Among all the elements treated with apatite ammendment the Zn values show the most significant decreases *(fig. 9)* comparatively with the not ammended values, the decrease shows an average value of 29,421%. The intensity contrast for the halo AuZnpl – 11 is situated in a slight contrast power (tab. 5), the other two halos AuZnpl – 1-2-3 respectively AuZnpl – 12 disappear, their values become normal.

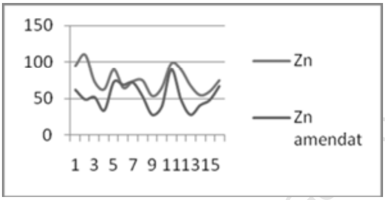

Figure 9 Variation of the ammended Zn content

CONCLUSION

Analysing the above mentioned we can observe that through the apatite ammendment of the solis in the metaliferous area of Bălan, the samples showsignificantly reduced values in case of existing heavy metals (except nickel). This fact sustains the agrogeochemical studies regarding the apatite ammendment of the contaminated or polluted areas with heavy metals.

The immobilization of the metals reduces vaporization and biodisponibility of the heavy metals, and the growing vegetation assures the soil stabilization[29]. Contrary to the "hard" remedying methods, the in-situ immobilization does not affect the texture of the soil and neither the situation of the organic materials and microorganisms in the soil. Even if the efficiency of the ameliorants decreases, these can be added continuously, or it is possible to use aother method for decontamination.

Although the results obtained till now are satisfactory, through the immobilization the heavy metals are not eliminated from the soil and the danger to be re-mobilised is existing due to the unfavourable environment conditions (the theory of "the time-bomb").

The obtained results show that the apatite ammendment method of the Spodosoils and Disticambisoils in the metaliferous district of Bălan was satisfying, andis recommended to test it also on the other contaminated soil types. The decreases leaded to the disappearance of some haloes with high concentration.

It is recommended to attention the population about the heavy metal content of the naturally contaminated areas because in these areas are frequently collected forest fuits.

REFERENCES

[1]. Buracu, O. (1978) – Prospecţiunea geochimică a zăcămintelor de minereuri. Ed. Tehnică.
[2]. Chlopecka, A. şi Adriano,D.C. Influence of zeolite, apatite şi Fe-oxide on Cd and Pb uptake by crops. Sci. Total Environ. 207**:** 195–206, 1997.
[3]. Conca, J. L. Phosphate-Induced Metal Stabilization (PIMS). Final Report to the U. S. Environmental Protection Agency #68D60023, Res. Triangle Park, NC., 1997.
[4]. Hawkes E Herbert and Webb, J. S. Geochemistry in mineral exploration: New York, Harper and Row 1962.
[5]. Laperche, V., Traina, S.J., Gaddam, P. şi Logan, T.J. Chemical and mineralogical characterization of Pb in a contaminated soil: reaction with synthetic apatite. Environ. Sci. Techn. 30: 3321-3326, 1996.
[6]. Laperche, V., Logan, T.J, Gaddam, P. şi Traina, S.J. Effect of apatite amendments on the plant uptake of lead from contaminated soils. Environ. Sci. Techn. 31: 2745-2757, 1997.
[7]. Luduşan, N.: Zăcăminte şi poluare pe Valea Ampoiului, Ed. AETERNITAS, Alba Iulia, 2002
[8]. Sauvé, S., McBride, M.B. şi Hendershot W.H. Lead phosphate solubility in water and soil suspensions. Environ. Sci. Technol. 32: 388-393, 1998
[9]. Zhang, P. şi Ryan, J.A. Transformation of Pb (II) from cerusite to chloro-pyromorphite in the presence of hydroxyapatite under varying conditions of pH. Environ. Sci. Technol., 33: 625-630, 1999.
[10]. Wright, J.W., Peurrung, L.M., Moody, T.E., Conca, J.L., Chen, X., Didzerekis, P.D. şi Wyse, E. In situ immobilization of heavy metals in apatite mineral formulation, în Milestone Five Report, 1995.

REMOVAL OF HEAVY METALS FROM WASTEWATER BY A *RHODOCOCCUS* SP. BACTERIAL STRAIN

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ABSTRACT

The study deals with a biotechnological application of a bacterial strain of *Rhodococcus* sp. CCM 4446, whose basic phenotypic and genotypic characteristics is complemented with a possible practical application in industrial wastewater treatment. To examine its reaction to toxic metal ions (Cu, Cd, Ni, Pb, Cr), used were real samples of wastewater from textile production arising during the process of dyeing and pigmentation of fabrics and containing metallic ions making part of the dye molecules or formed during further upgrading of fibres. The metallic ions were analyzed using the method of atomic absorption spectrometry. The acquired results imply that the examined bacterial strain of *Rhodococcus* sp. CCM 4446 has a significant potential in the removal or recovery of toxic metal contents in the tested wastewater.

Keywords: heavy metals, textile wastewater, bioremediation, *Rhodococcus* sp.

INTRODUCTION

Anthropogenic impacts on the biosphere are manifested by increasing contamination of the individual constituents of the environment by a whole range of substances, among which the most hazardous are persistent organic pollutants and toxic metals. Copper, chromium, cadmium and nickel belong among the most common, industrially applied heavy metals and thus among persisting metals in the environment, whose abundance shows in live systems on a variety of levels of biological and ecological organization (organism, population, community). Due to their capacity of long-term action, significant toxicity, high resistance to degradation and thus related accumulation in the abiotic and biotic constituents of the environment, the metals considerably influence environmental biochemical processes in the whole ecosystem.

As widely documented, the heavy metal content in the natural environment does not only influence the composition of the original microbial population, but it also has a significant impact on its activity and physiology. Metal compounds may have inhibition effects on microorganisms [16], [18] or may cause changes in the active conformation of biological molecules [7]. Microorganisms' adaptation to higher metal contents in the environment is manifested by various mechanisms, such as the formation of complexes with metals and their extracellular precipitation, intracellular accumulation, volatilization, formation of specific proteins (enzymes) combining heavy metals – metallophore complexes, metallothioneins, chelators, or an active transport of metals from cytoplasm into the environment [4], [19]. The resistance of microorganisms towards their toxic effects are predominantly demonstrated by blocking the cellular membrane transport [10]; however, low concentrations of many metals are essential for the growth of microorganisms and thus they significantly complement the growth cofactors in the culture media composition.

MATERIALS AND METHODS

Medium

For cultivation of *Rhodococcus* sp. CCM 4446, the following mineral salts medium with vitamins was used: Na_2HPO_4 2.44 $g \cdot L^{-1}$, KH_2PO_4 1.52 $g \cdot L^{-1}$, $(NH_4)_2SO_4$ 0.5 $g \cdot L^{-1}$ $MgSO_4 \cdot 7H_2O$ 0.2 $g \cdot L^{-1}$, $CaCl_2 \cdot 2H_2O$ 0.05 $g \cdot L^{-1}$, 10 ml of trace element solution, 2.5 ml of vitamin solution, 1000 ml of distilled water, pH 6.9; sterilized at 115°C for 15 min.

Trace element solution: EDTA 0.5 g, $FeSO_4 \cdot 7H_2O$ 0.2 g, 100 ml of element solution, 900 ml of distilled water.

Vitamin solution: 1 mg of p-aminobenzoate, 0.2 mg of biotin, 2 mg of nicotine acid, 1 mg of thiamine, 0.5 mg of Ca-pantothenate, 5 mg of pyridoxamine, 2 mg of cyanocobalamine, 100 ml of distilled water.

Preparation of wastewater

To verify the reaction of the bacterial strain *Rhodococcus* sp. CCM 4446 to toxic metal ions (Cu, Cd, Ni, Pb, Cr), real samples of textile production wastewater were used arising during the processes of dyeing and pigmentation of textiles, from benefication operations, washing the machinery and templates for printing and dyeing of fabrics. Toxic metals are present in the dyes and pigments as parts of their molecules or impurities from production (compounds of Cu, Cr, Ni, Pb, Sb, Zn, Ba, Pb, Fe, Ti, Mo, Al, Ca, Mg, Cd, and Zr are used as the inorganic components of the textile dyes and pigments; the dyeing preparations may also contain other constituents, such as dispersing agents, inorganic salts, substances preventing dust settlement, thickening and buffering agents).

The wastewater samples were drawn from production according to standard sampling and sample storage methods and were stored at 4°C. Consequently, the samples were experimentally processed within 48 hours after sampling.

Identification of the organism

The *Rhodococcus* sp. CCM 4446 used in this study has been obtained from the Czech Collection of Microorganisms (CCM), Faculty of Science, Masaryk University, Brno.

Identification of CCM 4446 was based on phenotyping and 16S rRNA sequencing.

The bacterial DNA was extracted by heating one loop of bacterial cells suspended in 500 μl of sterile deionised water at 80 °C for 20 minutes. Subsequently, the crude extract was centrifuged at 14 000 rpm for 1 min and the supernatant was directly used as a template for the PCR reactions.

Amplification of the 16S rRNA genes of *Rhodococcus* strain CCM4446 was performed using universal primers 16S F1: 5´–AGA GTT TGA TCC TGG CTC AG–3´[5] and 16S R1530: 5´–AAG GAG GTG ATC CAG CCG CA–3´[11]. The sequencing procedures were performed by Eurofins MWG Operons, Ebersberg, Germany and the sequence data were executed by the Czech Collection of Microorganism.

The partial 16S rDNA gene sequences obtained in this study for *Rhodococcus* sp. has been deposited in the GenBank database under accession number JQ776649.

Assessment of the bacterial growth and metal removal

Real samples of wastewater sterilized in an autoclave at 115°C for 10 minutes and enriched with mineral salts medium, were used for the experiments; such treated samples were inoculated with the bacterial strain of *Rhodococcus* sp. CCM 4446 in the exponential phase of its growth. The samples were observed for two weeks and the ions of the individual metals were analyzed in the samples. Bacterial cells of the strain with combined metal ions were separated from the samples using membrane filtration, i.e. microfilters Millipore of 0.22 μm pore size. To analyze the metal ion residue, we used the method of atomic absorption spectrophotometry (Varian Atomic Absorption Spectrometers AA 280 FS, Varian Australia Pty Ltd, Mulgrave Victoria); the analyses were carried out according to the standard methods (Analytical methods of flame atomic absorption spectrometry).

RESULTS AND DISCUSSIONS

Taxonomic characterization of the strain

A phylogenetic tree related representatives of validly described *Rhodococcus* species based on sequence comparison of 16S rRNA gene was (Figure 1). Strain CCM 4446 is clustered together with five other *Rhodococcus* sp. with high similarity making identification to the species level impossible. In light of sequencing results the DNA reassociation appears essential for correct taxonomic classification of CCM 4446.

Phenotypic characteristics of the strain

Rhodococcus is a genus of aerobic, gram-positive, non-sporulating, non-motile microorganisms, which manifests a dual cell morphology of rods and cocci of a mean cell size 0.5 to 3.5 μm; they appear independently or in aggregation of two and more cells in irregular groups. The study of the strain physiology and its optimal conditions characterizes the strain growth in aerobic conditions at an optimal temperature from 25°C to 35°C. On a live medium it forms shiny colonies of 2 – 4 μm of various colours – pink to orange (salmon colour) [2], [8].

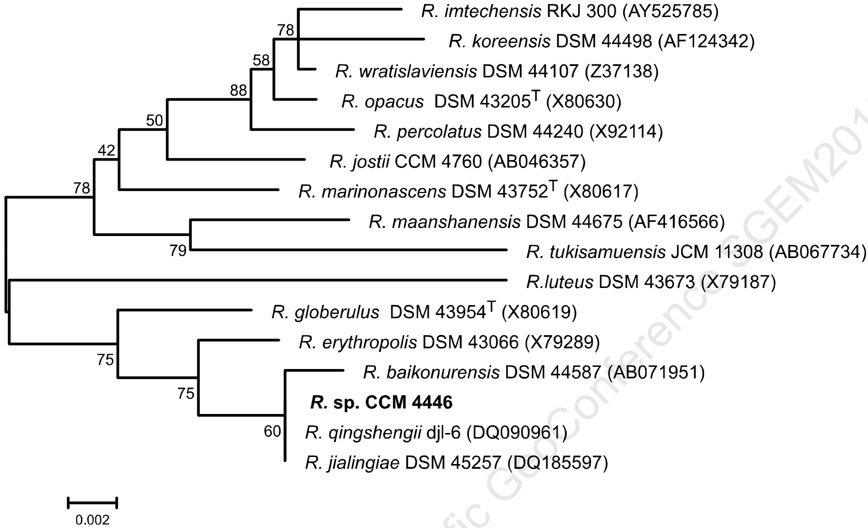

Figure 1 Phylogenetic tree based on the 16S rRNA gene sequences

The phenotypic characteristics of the strain were determined with the Biolog GP2 plate and complemented with key tube and plate tests. Strain CCM 4446 has strong catalase and urease activity, colony of CCM 4446 appeared with pale salmon pink color. Based on Biolog GP2 profile the CCM 4446 was presumptive identified as *Rhodococcus* sp. The selected phenotypic strain results are summarized in Table 1.

Table 1 Basic phenotypic characterisation of *Rhodococcus* sp. CCM 4446

Characteristic/substrate utilization	CCM 4446
Gram positive	+
Nitrate reduction, V-P test	–
Growth at 37 °C	–
Phosphatase, pyrazinamidase	+
Starch hydrolysis	–
Hydrolysis of gelatin, casein	–
Hydrolysis of Tween 80, tyrosine	–
Urease, catalase	+
α-Glucosidase	+
β-galactosidase, β-glucosidase	–
β-glucuronidase, pyrrolidonyl arylamidase	–
Assimilation of:	
Arabinose, lactose, maltose, xylose	–
Fructose, glucose, mannose, ribose	+

Assessment of the bacterial growth and metal removal

The samples of wastewater from the textile dyeing processes were examined for the contents of selected metal ions. Having applied the bacterial strain, its growth occurred and metal ions actively accumulated. The experiments imply that the action of the bacterial strain of *Rhodococcus* sp. CCM 4446 resulted in the reduced concentration of all the observed ions (Cu, Cd, Ni, Pb, Cr) in the wastewater samples. Metal removal from the solutions using the bacterial strain is shown in Figure 2. After a two-week action of the strain, the effectiveness with the ions is in the order as indicated: Cd > Cu > Ni > Pb > Cr, while the best results were obtained in Cd ions (78%) and Cu ions (43%). On the contrary, the lowest accumulation capacity was observed in Cr ions (7%).

The physiological abilities of *Rhodococcus* sp. CCM 4446 were predominantly examined in connection with its bioremediation capacity of organic pollutants in the environment [6], [12], [17]; the capacity of the strain to tolerate metal ions has been examined only in several studies [3], [9], [14], which imply a high tolerance of rhodococci to the ions of Cu, Cd and As.

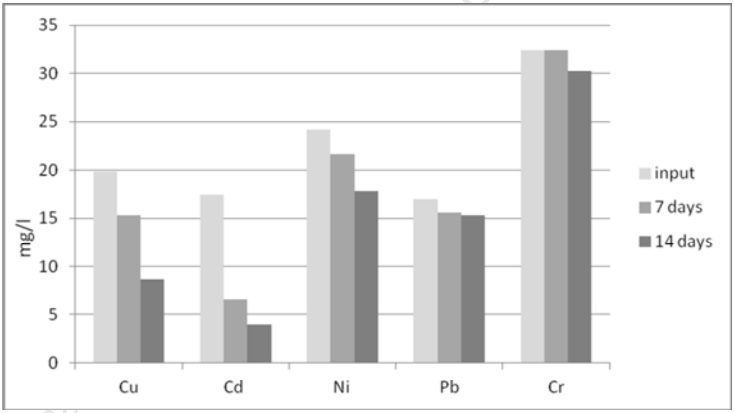

Figure 2 Removal of heavy metals from wastewater by a *Rhodococcus* sp. strain

In this study, the bacterial strain *Rhodococcus* sp. CCM 4446 was investigated in the process of metal ion removal from real samples originating from textile processing and containing the mixed metal residues in various chemical bonds. The extent of accumulation is certainly influenced both by the input metal content as well as by the chemical composition of the individual compounds and their mutual action. Therefore, an experimental verification of the bacterial strain in model solutions of the individual metals appears as a suitable alternative.

The accumulation of the metal ions by microorganisms depends on a wide spectrum of different factors, where the temperature and pH of the medium belong to the most important. Numerous studies also confirmed the significance of functional groups and the composition of the cell wall surface [1], [13], [15].

CONCLUSIONS

Biotechnological methods to remove toxic metals from contaminated wastewater arising in various industrial branches make use of the capacity of microorganisms to combine metal ions. The processes of ion precipitation and accumulation were repeatedly demonstrated in numerous bacterial species and their metabolic products. However, the mutual interactions among the cellular membranes and metal ions are conditioned by the phenotypic, genotypic and physiological properties of the applied bacterial strains.

Application of suitable bacterial organisms in the remediation technologies is both an economically and environmentally suitable alternative to physical-chemical processes of metal removal from wastewater as the advantage of the technologies is mainly lower economic intensity, minimum amounts of secondary wastes, and applying a suitable bacterial strain there is a high final effectiveness of the overall process with regard to the environmental protection. *Rhodococcus* sp. CCM 4446 showed a significant potential in the removal of toxic metal contents in the tested wastewater and appeared as a suitable organism for bioremediation.

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REFERENCES

[1] Ahalya N. & Ramachandra T. V. & Kanamadi R. D. Biosorption of heavy metals. Research Journal of Chemistry and Environment, vol. 7, pp. 1-8, 2003.

[2] Alvarez H. M. Biology of *Rhodococcus*. Springer-Verlag, Heidelberg, Germany, 2010.

[3] Belimov A. A. & Hontzeas N. & Safronova V. I. & Demchinskaya S. V. & Piluzza G. & Bullita S. & Glick B. R. Cadmium-tolerant plant growth-promoting bacteria associated with the roots of Indian mustard (*Brassica juncea* L. Czern.). Soil Biology and Biochemistry, vol. 37, pp. 241-250, 2005.

[4] Bruins M. R. & Kapil S. & Oehme F. W. Microbial resistance to metals in the environment. Ecotoxicology and Environmental Safety, vol. 45, pp. 198-207, 2000.

[5] Coenye T. & Falsen E. & Vancanneyt M. & Hoste B. & Gowan J. R. W. & Kersters K. & Vandamme P. Classification of *Alcaligenes faecalis*-like isolates from the environment and human clinical samples as *Ralstonia gilardii* sp. nov. International Journal of Systematic Bacteriology, vol. 49, pp. 405-413, 1999.

[6] Dean-Ross D. & Moody J. D. & Freeman J. P. & Doerge D. R. & Cerniglia C. E. Metabolism of anthracene by a *Rhodococcus* species. FEMS Microbiology Letters, vol. 204, pp. 205-211, 2001.

[7] Doelman P. & Jansen E. & Michels M. & Til M. Effects of heavy metals in soil on microbial diversity and activity as shown by the sensitivity-resistance index, an ecologically relevant parameter. Biology and Fertility of Soils, vol. 17, pp. 177-184, 1994

[8] Finnerty W. R. The biology and genetics of the genus *Rhodococcus*. Annual Review of Microbiology, vol. 46, pp. 193-218, 1992.

[9] Fleck W. R. The biology and genetics of the genus *Rhodococcus*. Annual Review of Microbiology, vol. 46, pp. 193-218, 1992.

[10] Foulkes E. C. Transport of toxic heavy metals across cell membranes. Proceedings of the Society for Experimental Biology and Medicine, vol. 223, pp. 234-240, 2000.

[11] Hughes M. S. & James G. & Ball N. & Scally M. & Malik R. & Wigney D. I. & Martin P. & Chen S. & Mitchell D. & Love D. N. Identification by 16S rRNA gene analyses of a potential novel mycobacterial species as an etiological agent of canine leproid granuloma syndrome. Journal of Clinical Microbiology, vol. 38, pp. 953-959, 2000.

[12] Janáková, I. & Vojtková H. & Fečko, P. Application of flotation and bacterial leaching to eliminate persistent organic pollutants in the influent stream of Cerny Prikop. 11th International Multidisciplinary Scientific GeoConference SGEM2011, Albena: June 20-25, 2011. Conference Proceeding SGEM2011, vol. 1, pp. 1069-1076, 2011.

[13] Kaduková, J. & Virčíková E. Minerálne biotechnológie III: Biosorpcia kovov z roztokov. VŠB – Technická univerzita Ostrava, Ostrava, Czech Republic, 2003.

[14] Kumar S. P. & Prashant S. & Vaidyanathan S. &Jaishree P. Biosorption of As(III) ion on *Rhodococcus* sp. WB-12: Biomass characterization and kinetic studies. Separation Science and Technology, vol. 46, pp. 2517-2525, 2011.

[15] Narvekar A. & Vaidya V. K. Role of functional groups on *Aspergillus niger* biomass in the detoxification of hexavalent chromium. Journal Environ Sci Engineering, vol. 51, pp. 233-238, 2009.

[16] Sadler W. R. & Trudinger P. A. The inhibition of microorganisms by heavy metals. Mineralium Deposita, vol. 2, pp. 158-168, 1967.

[17] Seo J.-S. & Keum Y.-S. & Li, Q. X. Bacterial degradation of aromatic compounds. International Journal of Environmental Research and Public Health, vol. 6, pp. 278-309, 2009.

[18] Sengör S. S. & Barua S. & Gikas P. & Ginn T. R. & Peyton B. & Sani R. K. & Spycher N. F. Influence of heavy metals on microbial growth kinetics including lag time: Mathematical modelling and experimental verification. Environmental Toxicology and Chemistry, vol. 28, pp. 2020-2029, 2009.

[19] Volesky B. Sorption and biosorption. BV Sorbex Inc., Montreal – St. Lambert, Canada, 2003.

RESEARCH OF ECOLOGICAL HAZARD OF BUILDING MATERIALS AFTER EXPLOITATION IN AGGRESSIVE INDUSTRIAL ENVIRONMENT

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ABSTRACT

The problem of building refuse treatment is urgent after industrial buildings dismantling. Influence of the industrial premises' aggressive conditions results in wear, surface damage and corrosion of building structures. Low shatter index and high water absorbing extent of building materials indicate toxic substance accumulation in them, so they need determination of environment hazard. Research experience of the building refuse after industrial buildings dismantling can be used for assessment of environmental threat and optimization of waste management procedures.

Keywords: building refuse; aniline production; dismantling; assessment of hazard

INTRODUCTION

Currently is difficult to imagine characteristics which will have physically and morally obsolete building structures or finish materials after 40 or more years of exploitation. Therefore research experience of contemporary waste generated during demolition and dismantling of buildings and structures (primarily industrial) can be use for the assessment of potential environmental hazard and optimizing building refuse management.

Subject of inquiry is the aniline factory which uses contact production method. Some of the Russian objects of aniline industry are inferior EU in terms of modernization what increases the risk of bankruptcy. In the process of liquidation of such companies for return of town planning value of industrial area it is important not only to identify the degree of physical deterioration of the industrial fund and provide organizational and technical solutions for demolition work, but also to solve the important issues of management of wastes from the demolition of buildings and structures [1]. Particularly it is necessary to assess a hazard of finish materials after exploitation in aggressive industrial environment, to determine amount and component composition of building refuse and to suggest ways to waste disposal subject to resource potential.

MAIN RESEARCH RESULTS AND DISCUSSION

It is common knowledge that industrial premises interior environment is formed by parameters of technological processes, which in varying degrees affect building structures and provoke their wear, surface damage and corrosion. The normalized working environment parameters of industrial building regulate by Russian State Standards 12.1.0005-88*, 30494-96 and Building Regulations II-3-79*, 2.04.05-91*. Attack degree on the concrete, ferro-concrete and arm cement constructions is established according to Building Regulations 2.03.11-85 and depend on temperature and humidity conditions of premises, service conditions (outside or inside the heated and unheated buildings), type and concentration of aggressive chemicals, type of building and facing materials.

The indoor climate of aniline production had following parameters: T = 12-24°C (cold season), 18-30°C (warm season); relative humidity - 55-75%; presence of products and intermediates in the working air (aniline, nitrobenzene) with a high probability of the excess of acceptable content norms. Industrial premises interior environment characterize as «weak aggressive» and «middle aggressive» according to the production procedures.

Reconnaissance inquiry of workshops has allowed exposing the high pollution rate of finishing materials area of industrial premises. The acid-resisting tile was sampled for analysis of mechanical properties and assessment of toxic substances, colored surface layer of the walls and floor. The representative specimens of a wall tile, a dalle, a plaster and wall concrete cores were sampled in two workshops (the contact separation and the distillation separation). Samples of the tiles were grouped according to several criteria: appearance, size, labeling, sampling sites, the pollution rate.

The information of initial properties of tile samples is taken according to Russian State Standards 961 – 57, 6787-90, 961-89. Flexural strength and water absorbing were determined by physical and mechanical methods as provided by requirements of Russian State Standard 27180-2001. The results showed that the water absorbing, and therefore porosity, grew in up to 4 times in average (Fig.1). In addition, decrease of strength properties has been also registered by indicator of bending load resistance – strength decline is up to 34% (Fig.2).

Underestimated bending strength and high water absorption detected in the tile samples which have a high level of contamination, what indicates accumulation of toxic substances in the finishing material, which functions are to protect structures in the long-term exploitation in aggressive industrial environment [2, 3].

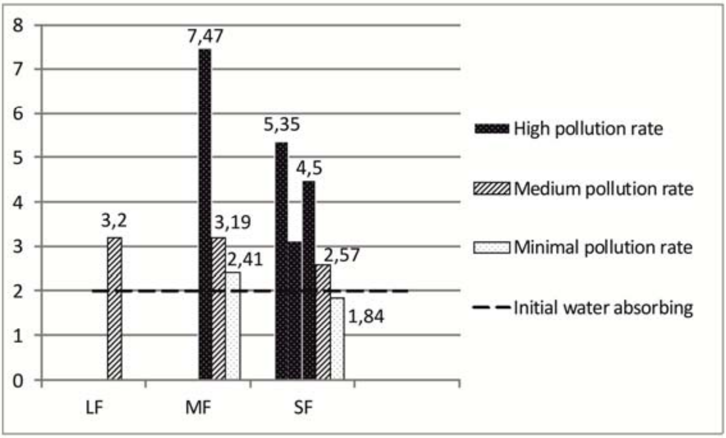

Fig.1. Histogram of water absorption changes (%) for different types of tiles (LF – large format tile, MF – medium format tile, SF – small format tile)

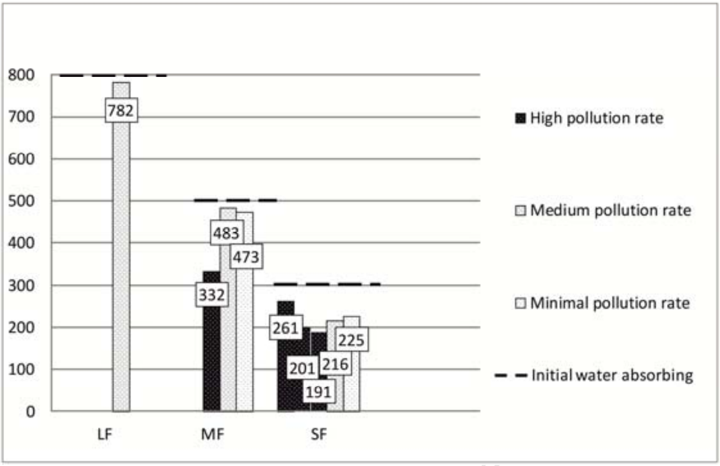

Fig.2. Histogram of bending strength changes (kgf/cm^2) for different types of tiles (LF – large format tile, MF – medium format tile, SF – small format tile)

During the research of ceramic tiles and plaster it has been ascertained that the range of water-soluble aniline concentration in finishing materials varies from 1.3 ± 0.2 to 157.5 ± 15.4 mg/kg on dry matter material.

While assessing the migration of aniline deep into walls, its maximal concentration in the surface layer of concrete is fixed at a depth of 30 mm. On the deep more than 60 mm aniline has not been detected.

The aniline concentration decreasing curve, which depend on the depth, can be approximated by exponential dependence for the distillation workshop. For the contact workshop, the aniline migration curve has a tendency to linear dependence (Fig.3):

- for distillation workshop:

$$f_1(\Delta c) = 133.808 \cdot e^{-0.601243h}, \tag{1}$$

- for contact workshop:

$$f_2(\Delta c) = -1.5131h + 82.74, \tag{2}$$

where Δc - concentration of water-soluble aniline in wall construction material, h – depth of sampling.

The findings and dependences of aniline migration (1) and (2) allow substantiate required neutralization degree of building structures and the importance of pre-cleaning of surfaces of finishing materials.

Neutralization of chemical contamination of surfaces facing materials must be preceded by dismantling of responsible building components during the demolition of buildings.

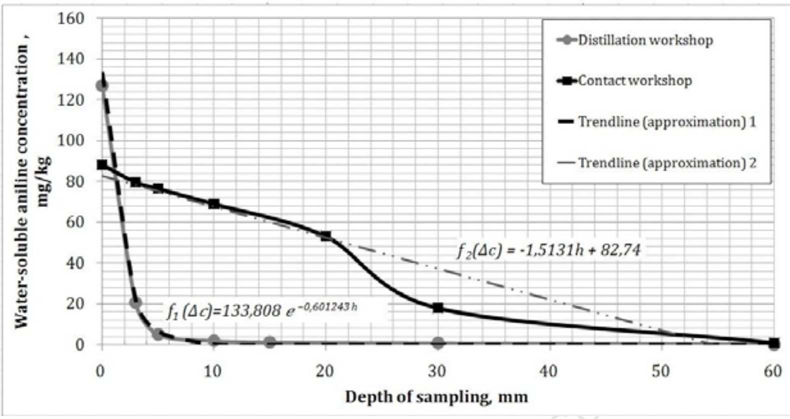

Fig.3. Regularity of aniline migration deep into structures materials of building

Determination of neutralization volume can be produced through zoning by the pollution rate in units of area (Table 1).

Table 1

Zoning of industrial premises finishing by the pollution rate

The pollution rate of ceramic tiles	Area, m^2				% of the total area	Aniline concentration range, mg/kg to dry matter material
	Distillation workshop	Contact workshop	Gas blow workshop	Total		
High	1575	1104	46	2725	46,7	more 30
Medium	525	552	91	1168	20,0	5 - 30
Minimal	525	1104	318	1947	33,3	to 5

Increasing of neutralization degree of wall panels and concrete and ferro-concrete floors, which in the areas of maximum contamination, is possible by using mechanical decontamination complex. It allows decontamination of surfaces (painted surfaces, steel, brick, concrete, cement etc.) with simultaneous collection of contaminated material in containers. The depth of processing should vary from 5 to 30 mm according to the assessment of substance migration into the structures.

In our opinion, there are three main scenarios for the elimination of objects such as considered industrial complex. The first method involves the demolition of buildings without prior dismantling of the potentially hazardous contaminated materials. In this case there is a necessity to determinate the hazard class of building refuse and their disposal at special landfills.

The second method of the elimination may include: preliminary hazardous assessment of building materials after exploitation in aggressive industrial environment; the mechanical removal of a layer of finishing and other materials which bear the environment risk; the demolition and following treatment and recycling of building refuse (for example, as rubble of various fractions). In this case the amount of hazardous waste will be minimal and the remainder waste may be subject to recycling and reuse (Fig.4).

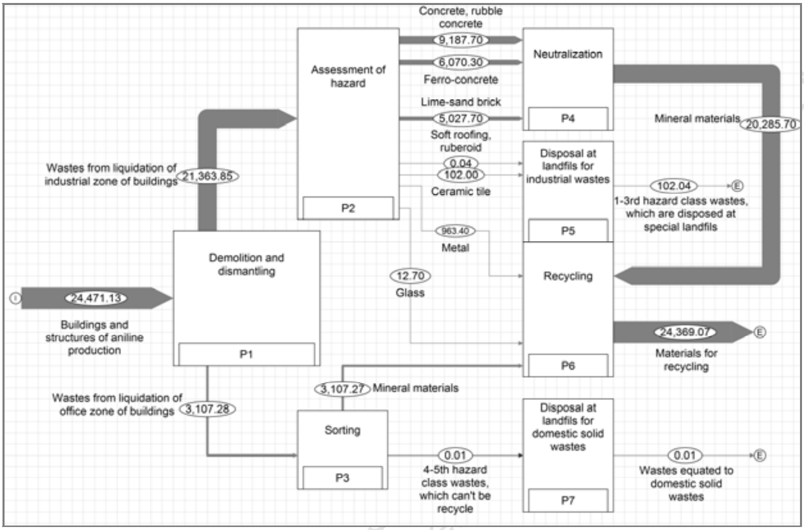

Fig.4. Modeling of the basic material waste flows from demolition and dismantling of the aniline production buildings for determination of polluted building refuse flows

The third way also includes a preliminary hazardous assessment of building materials, mechanical removal of materials, which bear the environment risk, and preparing the building for industrial use and other purposes saving a useful site area. Decreasing amount of wastes which are sent to landfill, the sustainable development proposition is implemented. Only the flow of removed high contaminated materials will be liable to neutralization or disposal at special landfills. In Russia this way is used rarely because of underdevelopment of industrial property market new sector.

Analysis of the project construction documents of the liquidated aniline production allowed to determine the total amount and component composition of potentially contaminated waste from the industrial zone buildings and structures demolition and dismantling, which are about 22 thousand tons.

The functional modeling approach is used with STAN 2.0 Beta to determine the resource potential of the main flows of building refuse (Fig. 4).

According to Russian legislation, practically all types of building refuse by environmental hazard are rated as «low hazard» (mineral wool, roofing materials and etc.) and «non-hazardous» (brickbats; lump concrete waste; lump ferroconcrete waste; lump cement waste; stoneware which lost consumer properties; breakage of uncontaminated glass). This classification demonstrates the possibility of recycling of these wastes. However, for some building materials from the industrial fund elimination experimental confirmation of the hazard class is required.

CONCLUSIONS

1. The range of water-soluble aniline concentration in finishing materials has been determined: from 1.3 ± 0.2 to 157.5 ± 15.4 mg/kg to dry matter material. It indicates the potential hazard of this type of waste and necessity of prior neutralization before disposal or processing for component reuse.

2. Low bending strength (lower than normal by 34%) and high water absorption are fixed for the tiles samples with high levels of pollution, which indicates the possibility of accumulation of pollutants in the finishing materials

3. The basic scenarios of management of wastes from demolition and dismantling are proposed. The total amount of building refuse has been determined by the functional modeling approach, which is about 22 thousand tons. The results of research can be used for prediction of treatment hazardous of wastes of newly created building materials.

REFERENCES

[1] Shirinkina E.S.& Shvetcova I.N.& Batrakova G.M. Resource potential of waste products from removal and demolition of industrial buildings and constructions, Ecology and Industry in Russia, Russia, issue 5, pp 48-51, 2011;

[2] Shvetcova I.N.& Shamanov V.A. Assessment of change physical and mechanical properties of construction materials after use in corrosive medium, Perm State Technical University. Urbanity Bulletin, Russia, issue 3, pp 91-96, 2011;

[3] Kuznetsova M.S., Tupitsyna O.V., Chertes K.L., Pystina V.N. The selection question of technologies rehabilitation of industrial sites after use for chemical weapons production facilities, International Scientific and Practical Conference «Ashirov reading», Russia, vol.1, pp 258-260, 2010.

RESEARCH OF SELECTED ACOUSTIC DESCRIPTORS OF TWO-LAYER SANDWICH ABSORBERS

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ABSTRACT

In spite of existing European and national legislation aimed at noise abatement, public interest and concern about noise are high. The EU Directive 70/157/EEC [15] for setting and controlling environmental noise is aimed at creating less noisy and more pleasant environment for European residents within "Sustainable Development in Europe". The authors are presenting a methodology for measuring selected acoustic descriptors (sound absorption coefficient and sound transmission loss) for acoustic materials, which are currently in process of development. Emphasis is put on sandwich structures of absorbers. Verification results of the proposed methodology are presented.

Keywords: environmental noise, transportation, noise wall, sound absorption coefficient, sound transmission loss

INTRODUCTION

In spite of existing European and national legislation, aimed at noise abatement, public interest and concern about noise are high. Directive of EU 70/157/EEC [15] for setting and controlling environmental noise is aimed at creating less noisy and more pleasant environment for European residents within "Sustainable Development in Europe".

In the European Union, about 80 million persons are exposed to high noise levels, which are unacceptable or result in sleep disorders and other undesirable influences. There are approximately 170 million people living in the so-called "grey regions", where noise is very annoying.

Transportation causes the main problem in the sphere of noise. In Europe, the first limits of protection against noise were specified for transportation. In this respect, the most important directive is 70/157/EEC, limiting noise for vehicles [15]. The EU has only recently started to regulate noise emissions from railway transportation (2002). Limits for air transport are specified mainly at international levels ICAO (International Civil Aviation Organization).

Noise protection measures for reducing the effect of noise caused by transportation (road, railway and air transport) can be passive and active. Active measures try to prevent the origination of noise, while passive measures are adopted only then, when noise arises. Passive noise protection measures can be divided into two groups, namely: measures preventing acoustic noise propagation (noise barriers and/or walls, noise protection embankments and the like) [6].

Attention is paid to the design process and materials used for construction of noise walls and to their properties. The authors have focused their attention on the research of new acoustic materials made on the basis of recycled raw materials and applicable for the structures of sandwich absorbers (two-layer and multiple-layer absorbers).

The paper presents a proposed methodology for measuring selected acoustic descriptors (the sound absorption coefficient α and the sound transmission loss TL) [1].

PROPOSAL OF METHODOLOGY FOR MEASURING SELECTED ACOUSTIC DESCRIPTORS OF ACOUSTIC MATERIALS, WHICH ARE CURRENTLY IN PROCESS OF DEVELOPMENT

Out of several possible acoustic descriptors, the authors have focused their attention on the two following descriptors:

- sound absorption coefficient (α),
- transmission loss (TL).

For measuring the sound absorption coefficient (α) and the transmission loss (TL) there are two theoretically available methods, namely: the method of standing wave ratio and the method of transfer function. The authors have used in their work the method of transfer function. This method can be used for measuring the sound absorption coefficient, the reflection factor, the normal impedance and the normal admittance.

The proposed methodology of measurement includes the use of the impedance tube, two positions of positioning the microphones and the system of numerical frequency analysis for determining the sound absorption coefficient of sound absorbers for normal incidence of sound. It can also be applied for determining acoustic surface impedance or acoustic surface admittance for sound absorbing materials, due to the fact that the impedance ratios of sound absorbing materials are proportional to their physical properties, such as airflow resistance, porosity, elasticity and density. [3]

This test method is similar to the test method specified in STN EN ISO 10534-1 [7] in terms of using an impedance tube with a sound source connected to one of its ends and a test specimen mounted into the tube at its other end. However, the actual test method is different. In this test method the plane waves are generated in the tube by the sound source and the decomposition of the interference field is achieved by measuring acoustic pressures in two fixed positions of microphones mounted on the wall of the tube or by a microphone shifted in the tube and the subsequent calculation of the complex acoustic transfer function, by absorption at normal incidence and by impedance ratios of the acoustic material. This test method is designated to provide an alternative method of measurement, in general much faster than that included in STN EN ISO 10534-1[8].

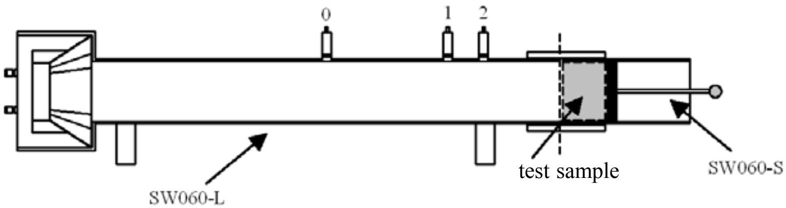
The proposal of methodology for measuring selected acoustic descriptors by using an impedance tube and by applying the method of transfer function is presented in [1].

VERIFICATION OF THE PROPOSED METHODOLOGY

The proposed methodology of measurement was verified by measuring selected acoustic descriptors, namely: the sound absorption coefficient (α) and the transmission loss (TL) for the materials, which are currently in process of development.

Instruments, software and other equipment

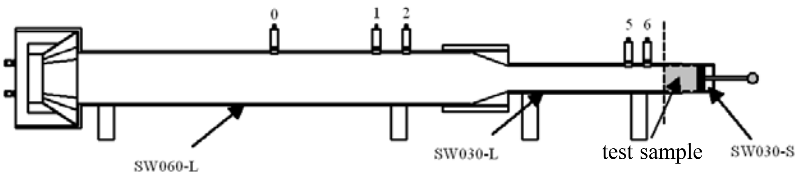
The system for measuring the sound absorption coefficient (α) (for the frequency bands of 100 Hz to 800 Hz and 400 Hz to 2500 Hz, respectively) is shown in Fig. 1. It is comprised of a tube with inner diameter of 60 mm – SW060-L and of a holder of the tested sample with inner diameter of 60 mm – SW060-S.



Legend: 0, 1, 2 – mounting sockets for microphones

Fig. 1 The system for measuring the sound absorption coefficient (100 Hz to 800 Hz and 400 Hz to 2500 Hz, respectively)

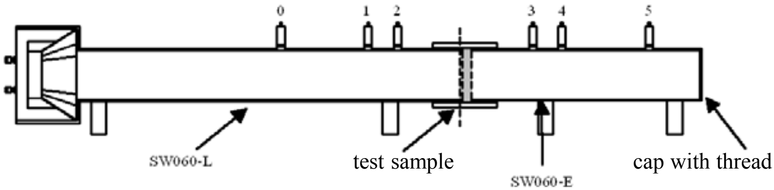
The system for measuring the sound absorption coefficient (α) (for the frequency bands of 800 Hz to 6300 Hz) is shown in Fig. 2. It is comprised of a tube with inner diameter of 60 mm – SW060-L, of a tube with inner diameter of 30 mm – SW030-L and of a holder of the tested sample with inner diameter of 30 mm – SW030-S.



Legend: 0, 1, 2, 5, 6 – mounting sockets for microphones

Fig. 2 The system for measuring the sound absorption coefficient (800 Hz to 6300 Hz)

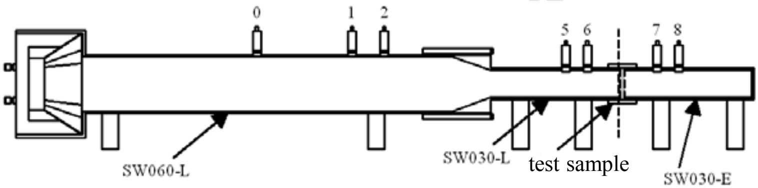
The system for measuring the transmission loss (TL) (for the frequency bands of 100 Hz to 800 Hz and 400 Hz to 2500 Hz, respectively) is shown in Fig. 3. It is comprised of a tube with inner diameter of 60 mm – SW060-L and of an extension piece of the tube with inner diameter of 60 mm – SW060-E.



Legend: 0, 1, 2, 3, 4, 5 – mounting sockets for microphones

Fig. 3 The system for measuring the transmission loss TL (100 Hz to 800 Hz and 400 Hz to 2500 Hz, respectively)

The system for measuring the transmission loss (TL) (for the frequency bands of 1600 Hz to 6300 Hz) is shown in Fig. 4. It is comprised of a tube with inner diameter of 60 mm – SW060-L, of a tube with inner diameter of 30 mm – SW030-L and of an extension piece of the tube with inner diameter of 30 mm – SW030-E.

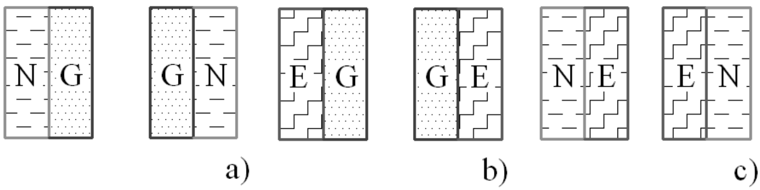


Legend: 0, 1, 2, 5, 6, 7, 8 – mounting sockets for microphones

Fig. 4 The system for measuring the transmission loss TL (1600 Hz to 6300 Hz)

Preparation of test samples

The test samples of the two-layer sandwich absorbers were prepared in various combinations of materials, such as Ekomolitan, Nobasil and recycled rubber (Figs. 5).



Legend: N – Nobasil, G – recycled rubber, E – Ekomolitan

Fig. 5 Two-layer sandwich samples

The measured values

This part of the paper presents outputs from the measurement of the sound absorption coefficient carried out for a two-layer sandwich test sample composed of 2 cm thick recycled rubber positioned closer to the sound source and of 2 cm thick Ekomolitan positioned at the end (Fig. 6), as well as outputs from the measurement of transmission loss for a two-layer sandwich having the same material composition (Fig. 7) [2], [4].

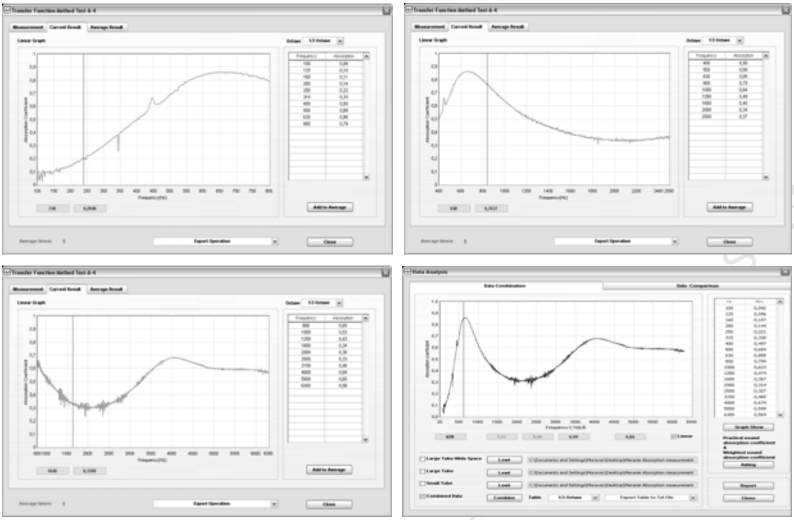


Fig. 6 Display of the sound absorption coefficient for a two-layer material, composed of 2 cm thick recycled rubber positioned closer to the sound source and of 2 cm thick Ekomolitan positioned at the end

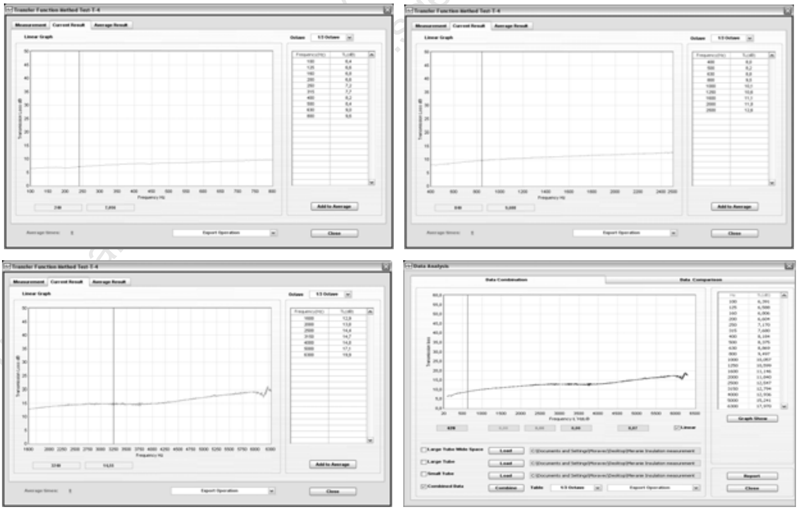


Fig. 7 Display of the transmission loss for a two-layer material, composed of 2 cm thick recycled rubber positioned closer to the sound source and of 2 cm thick Ekomolitan positioned at the end

CONCLUSION – EVALUATION OF MEASURED VALUES

The sound absorption coefficient (α) is a dimensionless number varying from 0 to 1. The closer is the measured value to 1 or is equal to 1, the sample of the measured absorber, and thus the absorber itself, will have a better (higher) sound absorption.

We have also measured the transmission loss (TL). It is a value in dB, based on the ratio of the sound wave incident at the front side of the acoustically absorbing material to the sound waves transmitted from the rear side. TL represents the sound damping properties of the material, i.e. the higher that value is, the more efficient is the damping of the sound. [9], [10]

The authors have measured the coefficient of sound absorption (α) and the transmission loss (TL) for various combinations of two-layer sandwich absorbers composed of materials such as Ekomolitan, recycled rubber and Nobasil. [5] Table 1 includes the measured values of descriptors.

Table 1 The values of the transmission loss for materials with thickness of 4 cm

	Sound absorption coefficient α [-]						Transmission attenuation TL [dB]					
Frequency f [Hz]	Recycled rubber + Nobasil	Nobasil + Recycled rubber	Recycled rubber + Ekomolitan	Ekomolitan + Recycled rubber	Ekomolitan + Nobasil	Nobasil + Ekomolitan	Recycled rubber + Nobasil	Nobasil + Recycled rubber	Recycled rubber + Ekomolitan	Ekomolitan + Recycled rubber	Ekomolitan + Nobasil	Nobasil + Ekomolitan
100	**0,022**	0,100	0,042	0,060	0,044	0,121	13,822	13,911	**6,391**	6,442	13,144	13,170
125	0,095	0,109	0,096	**0,065**	0,109	0,153	13,685	13,902	6,588	**6,586**	13,137	13,277
160	0,135	0,136	0,107	**0,078**	0,130	0,232	13,703	13,881	**6,806**	**6,806**	13,200	13,289
200	0,206	0,193	0,144	**0,097**	0,180	0,290	13,733	13,922	**6,604**	7,091	13,259	13,371
250	0,295	0,246	0,221	**0,120**	0,247	0,345	13,782	14,000	**7,170**	7,384	13,402	13,171
315	0,425	0,311	0,330	**0,159**	0,318	0,404	13,858	14,106	7,680	**7,264**	13,143	13,300
400	0,571	0,382	0,497	**0,216**	0,457	0,461	14,035	14,261	8,184	**8,057**	13,413	13,600
500	0,675	0,451	0,689	**0,294**	0,582	0,503	14,202	14,323	**8,375**	8,387	13,660	13,789
630	0,747	0,507	0,855	**0,412**	0,689	0,542	14,239	14,559	8,869	**8,831**	14,095	14,137
800	0,709	**0,562**	0,794	0,574	0,789	0,565	15,101	14,882	9,497	**9,412**	14,751	14,659
1000	0,622	0,596	0,623	0,762	0,855	**0,592**	16,537	16,126	10,057	**10,044**	15,410	15,726
1250	0,540	0,603	**0,474**	0,905	0,900	0,677	18,928	18,146	**10,599**	10,616	13,146	12,540
1600	0,460	0,655	**0,367**	0,924	0,932	0,709	17,095	16,483	**11,146**	11,260	16,576	16,346
2000	0,406	0,718	**0,314**	0,870	0,944	0,685	20,952	20,038	**11,840**	11,957	18,131	17,675
2500	0,381	0,722	**0,327**	0,933	0,969	0,709	27,005	23,036	**12,547**	12,838	20,360	20,291
3150	**0,456**	0,747	0,465	0,999	0,958	0,779	19,843	23,555	12,794	**12,676**	23,451	23,243
4000	**0,598**	0,792	0,679	0,949	0,935	0,810	23,324	26,717	**12,936**	13,143	26,127	26,120
5000	0,650	0,827	**0,599**	0,906	0,929	0,838	28,611	29,171	**15,241**	15,374	28,525	28,062
6300	0,632	0,858	**0,564**	0,940	0,955	0,862	28,947	30,473	17,970	**17,585**	30,782	32,385

The frequency spectrum of noise caused by transportation reaches its maximum in the frequency range of 500 Hz to 1500 Hz, and the most intensive noise is caused at the frequency of 1000 Hz.

Noise walls (barriers) are often constructed as noise panels with supporting frame using sandwich absorbers. For the purpose of the thesis, samples representing a sandwich composed of materials such as recycled rubber, Nobasil and Ekomolitan were made. The arrangement of individual layers of the sandwich was different. Measurements have been carried out for two-layer sandwiches. (Fig. 8 and Fig. 9).

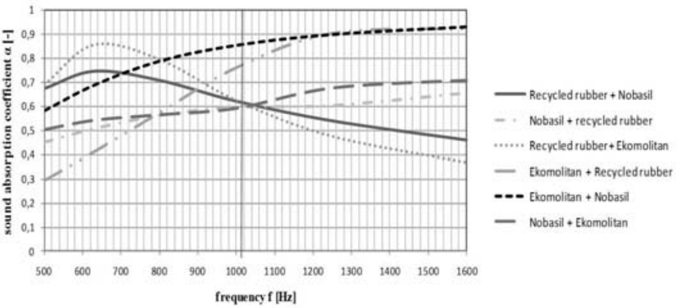


Fig. 8 Sound absorption coefficient of two-layer sandwiches
(total thickness of the sandwiches: 4 cm)

It follows from the measured values of the sound absorption coefficient of the sandwich absorbers that the sequence of individual layers (of utilized materials) is of crucial importance. The sequence of the sandwich layers of the measured materials, starting from the noise source (for the frequency of 1000 Hz), is recommended as follows:

- Ekomolitan + Nobasil,
- Ekomolitan + recycled rubber,
- Recycled rubber + Nobasil.

It can be stated on the basis of the measured values of transmission loss of the sandwich absorbers (Fig. 14) that the sequence of individual layers of materials utilized in the sandwich is also of crucial importance.

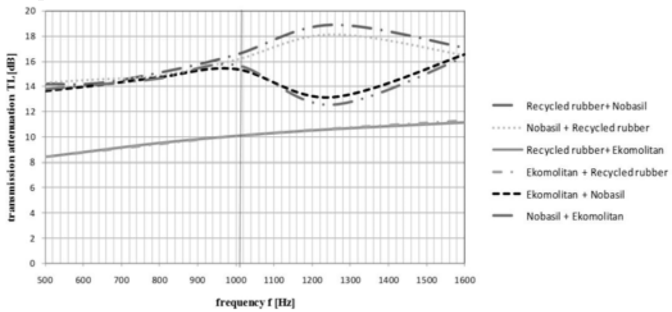


Fig. 9 Transmission loss of two-layer sandwich absorbers
(total thickness of the sandwiches: 4 cm)

The sequence of the sandwich layers of the measured materials utilized for two-layer sandwiches, starting from the noise source, is recommended as follows:

- Recycled rubber + Nobasil,
- Recycled rubber + Ekomolitan,
- Nobasil + Ekomolitan.

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REFERENCES

[1] BADIDA, M. – LUMNITZER, E. – BARTKO, L.: Možnosti znižovania dopravného hluku. Košice: Elfa, 2011. 303 s. ISBN 978-80-8086-181-0.

[2] BADIDA, M. – LUMNITZER, E. - FIĽO, M. - BIĽOVÁ, M.: Determination of the uncertainties of noise measurements. In: Annals of the Oradea University: Faculty of management and technological engineering. Vol. 7, 2008. p. 64-72. ISSN 1583-0691.

[3] BADIDA, M. – LUMNITZER, E. – ROMANOVÁ, M.: The application of recycled materials for products that provide noise reduction in living and working environment. In: Acta Acoustica United with Acoustic. Vol. 92. Stuttgart: Hirzel Verlag, 2006. p. 108. ISSN 1610-1928.

[4] LUMNITZER, Evin – BADIDA, Miroslav – LIPTAI, Pavol: Využitie recyklantov z autovrakov pri návrhu protihlukovych opatrení v lomoch. In: TOP 2010: technika ochrany prostredia, 15-17.jún 2010, Častá – Papiernicka, Bratislava. s. 251-256. ISBN 978-80-970438-0-3.

[5] MATEL, F. – OCHOCOVÁ, R. – BADIDA, M. – LUMNITZER, E.: Kompaktné prvky z gumárenského recyklátu vyrobené technológiou mikrovlnného ohrevu. Úrad Priemyselného Vlastníctva SR, Banská Bystrica, 2003.

[6] NEUBERGOVÁ, Kristína: Ekologické aspekty dopravy. Praha: ČVUT, 2005. 163 s. ISBN 80-01-003131-4.

[7] STN EN ISO 10534-1: 1996, Akustika. Určovanie koeficienta zvukovej pohltivosti a akustickej impedancie v impedančných trubiciach. Časť 1: Metóda použitia stojatej vlny.

[8] STN EN ISO 10534-2: 1998, Akustika. Určovanie koeficienta zvukovej pohltivosti a akustickej impedancie v impedančných trubiciach. Časť 2: Metóda transformačnej funkcie.

[9] STN ISO 10847: 2000, Akustika. Stanovenie vložného útlmu vonkajších protihlukových bariér všetkých typov na mieste trvalého uloženia (in situ).

[10] STN EN 1793-1: 1997, Zariadenia na zníženie hluku z cestnej dopravy. Skúšobné metódy určovania akustických vlastností. Časť 1: Určenie zvukovej pohltivosti.

RESEARCH ON DISPERSION POLLUTANTS FROM THE COMBUSTION OF LIGNITE IN POWER PLANTS ROVINARI

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ABSTRACT

Rovinari power station is located in the county Gorj, on the right bank of the river Jiu, about 20 km southwest of the city of Tîrgu - Jiu, the second largest power plant in Romania and third in Europe.
To identify and assess the potential impact caused by the operation of power plants is necessary to monitor emissions equipment and facilities to measure the flue gas a series of compounds such as total dust, SO_2, NO_x and CO.
Because the target is located in the industrial area of town Rovinari and bordered by other companies (including the ring road) that can cause pollution of ambient air to determine concentrations of pollutants in ambient air produced only objective was investigated using model OML-Multi.
Based on these considerations, the paper presents research conducted with gaussian dispersion model OML-Multi, maps generated by the dispersion and annual average concentrations and total dust, sulfur dioxide, nitrogen oxides and carbon monoxide

Keywords: dispersion, polluting, lignite, power station, Rovinari.

INTRODUCTION

The combustion of fossil fuels in steam power plants represents the main human activity, responsible for loading the atmosphere with a complex of gaseous pollutants and solid ones of inorganic and organic nature. As part of this complex can be observed, first of all, acid gases: sulphur dioxide and trioxide, azoth oxides, monoxide and dioxide of carbon. Alongside these appear dusts (ash and grime) and some organic volatile compounds (methane, aldehyde, organic acids).
Pollutants resulted from the combustion of fossil fuels lead non only to the damage of the atmospheric quality, but also of the other environmental factors, biotic and abiotic, affecting this way, directly or indirectly, human being.
Due to the greatest heights of the exhaustion chimneys (200 – 250 m), as well as of the very high elevation of contaminant plumes, the contribution of C.T.E. Rovinari at air contamination is reduced. High chimneys ensure a dispersion system which is very good on regional scale, but at the same time involved the risk of trans-border contamination, through captive layers. Taking into account the fact that these emissions are continuous, with fluctuating debits and with variable compounds it is appropriate to be realised dispersion maps of these pollutants.
Mathematical shaping of the concentration fields have been realised for the main pollutants issued by the sources afferent to Rovinari Steam Power Plant. There have

been taken into account, of course, pollutants having associated limit values for the protection of the receivers sensible to be possible affected (population from the neighbour area), these being the only pollutants for which there is the possibility of evaluating the pollution levels in rapport with legal provisions.

2. DESCRIPTION OF THE DISPERSION PATTERN

The model describes dispersion of a passive, or possibly buoyant, gas from a number of sources. The dispersion parameters are regarded as the result of contributions from several mechanisms: convective turbulence, mechanical turbulence, plume buoyancy and building downwash. Their dependence on source height is taken explicitly into account. The plume rise is modelled by methods proposed by Briggs (1984) supplemented by a number of extensions. In contrast to most conventional models, penetration of the plume into the atmosphere above the mixing layer is not simulated as an on/off process [1].

2.1. Theory of the pattern

Gaussian dispersion scheme

OML-multi is a Gaussian dispersion pattern, so concentration at the level of the soil is described by Gaussian form of the contaminant plume:

$$\langle c(x,y,0)\rangle = \frac{Q}{\pi \bar{u}\,\sigma_y \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left[\exp\left(-\frac{h_{ef}{}^2}{2\sigma_z^2}\right)\right] \tag{1}$$

where:

- Q is the intensity of the source (mass debit of emission),
- h_{ef} is the effective height of the contaminant plume,
- σ_z represents the vertical dispersion parameters.

Dispersion parameters

În OML - multi, dispersion parameters are directly correlated to the physical parameters of the limit layer describing the turbulence status of the atmosphere, unlike most of the classical pattern where dispersion parameters are calculated by the method Pasquill – Gifford - Turner. As a consequence, due to the variation, generally, of the properties of turbulence with height, the correspondent modification of the dispersion parameters makes possible an easy approach of the sources with different heights. [2]

More, dispersion parameters are calculated by the composition of all contributions from turbulences, associated to each physical phenomenon generating them. As a general rule for every σ (σ_y or σ_z) this can be decomposed this way:

$$\sigma^2 = \sigma_{turb}^2 + \sigma_{intern}^2 + \sigma_{building}^2 \tag{2}$$

where:

σ_{turb} represents dispersion due to atmospheric turbulence;

σ_{intern} is the contribution from the phenomenon of mixture of environmental air with the ascendant contaminant plume. This phenomenon is associated with the dispersion of the plumes of great bearing force;

$\sigma_{building}$ is the turbulence generated by the presence of the buildings in the proximity of emitter sources.

Based on the same principle of decomposition, having this time as a basis the statistic theory of diffusion, the term is due to the atmospheric turbulence, it can be mentioned:

$$\sigma_{turb}^2 = \sigma_{mech}^2 + \sigma_{conv}^2 \tag{3}$$

where:

σ_{mech} si σ_{conv} are dispersion parameters associated to the two processes generating atmospheric turbulence: mechanical and convective processes.

Super-elevation of the contaminant plume

OML includes a procedure of determination of super-elevation of the contaminant plume (Δh) associating different analytical forms of supra-elevation for the two types of contaminant plumes in the three types of stratification of the atmosphere:

- initial super-elevation (super-elevation of the ascendant plume – before reaching the maximum height);
- final super-elevation – in the case of ascending plume:
  - the case of neutral stratification;
  - stable stratification;
  - instable stratification.
- final super-elevation – the case of non – ascensional plume:
  - the case of neutral stratification;
  - the case of stable stratification;
  - instable stratification.

Building effect

The influence of the buildings or of other obstacles situated in the proximity of the contamination source is treated in OML using an empirical procedure.

The building effect is shaped, supposing the existence of an initial dilution of the plume, so of an initial diameter of the plume (different from the diameter of the emission chimney) - R_0.

This radius is used to modify dispersion parameters and the super-elevation of the contaminant plume. In essence, the procedure resides in the supposition that the presence of the buildings in the proximity of the sources involves the existence of an area at a distance of $2H_B$ (the effective height of the building) in the direction of wind propagation. In case the super-elevation of the contaminant plume in the points situated at this distance (there is such a point for each direction of the wind) is higher than 3HB, then it is supposed that the contaminant plume is not influences by the presence of the building.

Speed of the wind

OML uses two distinctive values of the wind speed:

- u_{hs} - wind speed at the emission level: used for the calculus of the sigma and in the estimation of the building effects;
- u_{av} - the speed of the wind mediated on the vertical, used in the calculus of the sigma and in the estimation of the transportation time.

The addiction of height of the wind is given by the similitude theory:

$$u(z) = \frac{u_*}{k}\left(\ln\left(\frac{z+z_0}{z_0}\right) - \Psi_m\left(\frac{z}{L}\right) + \Psi_m\left(\frac{z_0}{L}\right)\right) \tag{4}$$

There should be mentioned that OML considers the existence of a wind gradient on the height between the surface of the soil and the one given by the length L.[2]

Chimney effects

OML also includes the shaping of the chimney effect, effect residing in creating a turbulence area around the chimney in the presence of a high speed of the wind and the reduction of the emission height. So, the emission height is reduced with

$$h_d = 2\left(\frac{w_p}{u} - 1.5\right)D \tag{5}$$

where D is the diameter of the chimney, the other variables being already introduced.

2.2. Entrance information

The entrance information are:

- hourly weather information: generated in a specific format as a result of rolling weather pre-processor;
- information connected to source: physical parameters of the sources (punctual sources – chimneys) or geometrical dimension – length – width – height in case of surface sources;
- emission information: mass debits, evacuation temperatures;
- variation times: factors describing time variation of the emissions for each type of sources introduced in the pattern: punctual or of surface;
- information connected to the receivers net: definition of the receivers coordinates in a system of spherical or rectangular coordinates.

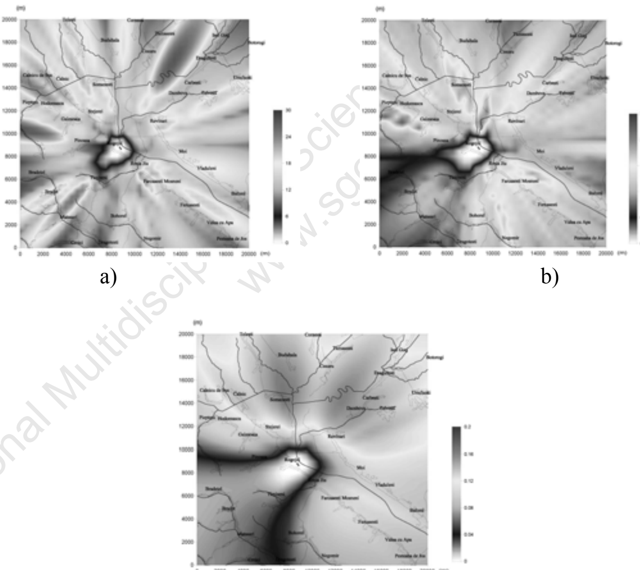
2.3. Exit information

The exit informations are represented by fields of concentrations in the joints of the defined net receptors. OML-multi generates, in al joints of the receptors nets, medium hourly concentrations, as well as monthly, yearly average and other important statistic values in the evaluation of air quality. Calculations have been realized on a scale with dimensions 20 km x 20 km with the pitch of 100 m for the main characteristic contaminants issued by the studied objective. Have been used annual weather information from the Meteorological Station Târgu -Jiu.

3. RESULTS AND DISCUSSIONS

- **Dispersion of total dusts in suspension**

The absolute maximum hourly concentration can reach the highest values (24–27 μg/m^3), at distances of 6000 – 8000 m from the objective on the directions N-NE, alongside Jiu Valley, easily exceeding the limit value imposed by legislation (fig. 1.a).
Maximum daily concentration might reach values of 2,4 – 2,7 μg/m^3 at distances of 2000 – 3000 m on northern direction or at distances of 4000-8000 m on the direction NV, being situated below the limit imposed by legislation (fig. 1.b).
Annual average concentrations reaching values higher than 0,16 – 0,2 μg/m^3 on extended areas at distances from 4000 - 6000 m on directions north west, north and north east, being situated much below the limit imposed by the legislation (fig. 1.c).



a) b)

c)

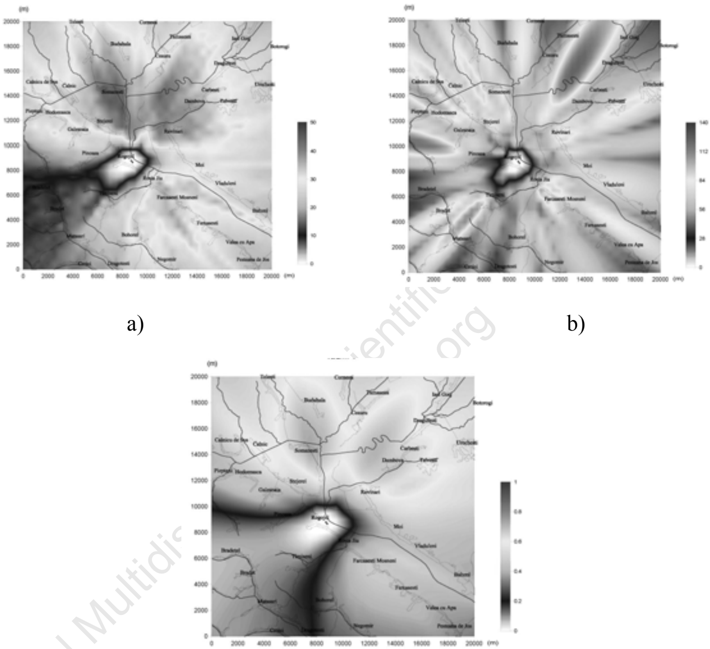
Fig. 1. Dispersion of total dusts in suspension
maximum hourly concentration, b) daily concentration, c) annual concentration

- **Contamination with azoth dioxide**

Hourly maximum concentrations (the 18th hour maximum concentration) will reach the highest values (40–50 μg/m^3) at distances of 4000 – 6000 m from the objective on the directions N - NE, being situated under the limit imposed by the legislation (fig. 2.a). [3]

The absolute maximum hourly concentration might reach the greatest values (120–140 μg/m^3), at distances of 6000 – 8000 m from the objective on N-NE directions, alongside Jiu Valley, being situated under the limit value imposed by the legislation (fig. 2.b).

Annual average concentration reaching values higher than 0,6 – 0,8 μg/m^3 on areas extended by distances of 4000 - 6000 m on the directions north – west, north and north east, being situated more under the limit imposed by the legislation (fig. 2.c).



a) b)

c)

Fig. 2. Dispersion of azoth dioxide

a) maximum hourly concentration, b) daily concentration, c) annual concentration

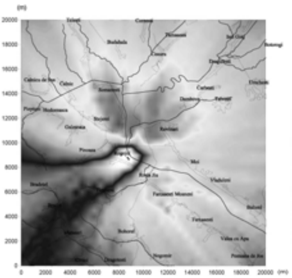
- **Dispersion of sulphur dioxide**

Hourly maximum concentrations (the 24th hourly maximum concentration) would reach the highest values (137 μg/m^3) at distances of 3000 – 5000 m from the objective N - NE, easily exceeding the limit imposed by legislation (fig. 3.a).

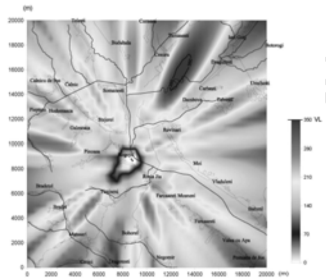
The absolute hourly maximum concentration might reach the highest values (373 μg/m^3), at distances of 6000 – 8000 m from the objective on the directions N-NE, alongside Jiu Valley, exceeding 2.9 times the limit value imposed by legislation (fig. 3.b).

The daily maximum concentration might reach values of 30 – 37 μg/m^3 at distances of 2000 – 3000 m on northern direction, being situated below the limit imposed by legislation (fig. 3.c).

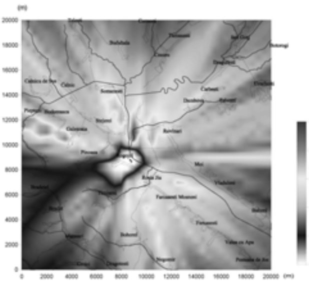
The average annual concentration reach the highest values of 1,6 – 2 μg/m^3 on areas more extended at distances of 4000 - 6000 m on north west, north and north east direction, being positioned more below the limit imposed by legislation (fig. 3.d).



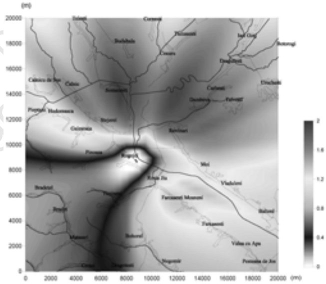
a)



b)



c)



d)

Fig. 3. Dispersion of sulphur dioxide

a) maximum hourly concentration, b) daily concentration, c) annual concentration

- **Dispersion of carbon monoxide**

The maximum concentration on 8 h (dynamic averages) might reach values of 3,2 – 3,4 mg/m^3 at distances of 2000 – 3000 m on northern direction or at distances of 4000 - 8000 on NW direction, being situated more below the imposed limit value. (fig. 4).

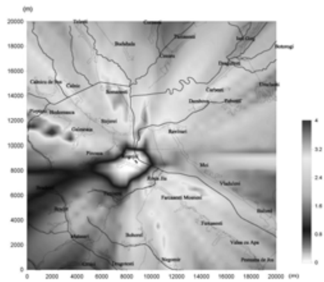


Fig. 4. Dispersion of carbon monoxide

4. CONCLUSIONS

Turbulence and atmospheric circulations play an important role in the dispersion of air contaminant agents, and some particularities of their spreading and elimination is due to the interference of molecular diffusion and aerosol sedimentation.

The dispersion of the contaminants in the atmosphere is a complex phenomenon, which makes the object of numerous theoretical and experimental researches. In this field have been obtained numerous practical results, especially concerning the case of passive contaminants (not suffering physical – chemical transformations) in conditions of flat field, but there are many problems in the research phase as, for example: diffusion in complex relief, diffusion in urban environment, diffusion of the contaminants suffering transformations etc.

Due to the fact that the objective is positioned in the industrial area of Rovinari city and is bordered by other commercial societies (including the ring road) able to generate the contamination of the environmental air, to establish concentrations of contaminants in the environment, produced only by the investigated objective, has been used the pattern OML-multi.

OML-multi is a multiple source Gaussian type pattern. The pattern has been realised in order to include in its theory the main physical phenomenon governing the dispersion in the atmosphere of the contaminants coming from industrial sources.

From the study of the dispersion maps can be observed the following:

The concentration of azoth dioxide and carbon monoxide do not exceed the limit value imposed by legislation;

The absolute maximum hourly concentration of dusts in suspension exceeds easily the limit value imposed by legislation;

The absolute maximum hourly concentration of the sulphur dioxide might reach the highest values, exceeding 2.9 time the limit value imposed by legislation.

REFERENCES

[1] Ionel I., (2000), *Noxae dispersion, theory and applications*, Polytechnic Publishing House, Timişoara, Romania, pp.101.

[2] Lăzăroiu Gh., (2006*), Dispersion of contaminating particles*, AGIR Publishing House, Bucharest, Romania, pp.86.

[3] I.C.P.E.T. ECO S.A., (2005), *C.T.E. Rovinari – Environment balance, level II*, Romania, Annex I pp.1-13

RESEARCH REGARDING ENVIRONMENTAL RISKS DUE TO COMPLEX OPERATION ROVINARI

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ABSTRACT

This study presents a study case on environmental risks due to energy complex operation in Romania. This study presents a situation from Rovinari complex which is a major producer of electricity and heat in Romania. Rovinari complex is composed of a power station with installed capacity of 1320 MW lignite mining pits on the surface. Rovinari power station consists of four power units with rated power of 330 MW lignite-operated. Combustion gases evacuated from the thermal power plant`s chimneys Rovinari contain pollutants that affect air quality: SO_2, NOx, CO, ash. Experimental results are presented on measurements of concentrations of pollutants in flue gases. Dispersion maps are presented of pollutants discharged by thermal power plant chimneys of Rovinari. There are presented the effects of pollutants in the thermal power plant boiler Rovinari and surrounding areas.. Experimental research results are made with a camera with infrared and gas analyzers, air pollution due to lignite` self-burning deposits of career Tismana belonging to Complex Rovinari.

Keywords: camera with infrared, gas analyzers, pollutants , SO_2, NOx, CO, ash, , modeling atmosferic.

INTRODUCTION

Operation Complex Rovinari a negative impact on the environment through releases of pollutants :SO_2, NO_x, CO, ash. Fuel used in boiler plant groups thermoelectric Rovinari energy is lignite. Lignite power plant is a coal conveyor collecting from quarries Tismana and Rosia. Implementation to Directive 1999/31/EC on solid fuel power plants operating between 2008 to 2013 passing the transport and storage of slag and ash hydraulic system as "dense fluid" or "aggregate" (dry mix ash, slag and gypsum [1].

Hard pine andash lignite deposit is stored Cicani Beterega, with an area of 300 ha [10]. Based on measurements of emissions was calculated atmospheric pollutant dispersion modeling system AEROMOD VIEW [4].

AIR POLLUTION FROM AUTO-COAL STORED IN CAREER TISMANA

The reference of this case study presented in this paper reference was to the technological process of extraction and storage of lignite mining in the she-wolf.

Monitoring temperature coal deposit has been made continuously for a period of 25 days between October 2011 and November 2011. To monitor the temperature in carbon storage have been established in 13 points of temperature measurement at different depths: 9m, 6m, 3m and 1m as follows: 2 measuring points at a depth of 9m; 3 measuring points at a depth of 6m; 5 measuring points at a depth of 3m; 3 measuring points at a depth of 1m. For temperature measurement were used temperature sensors type K thermocouple probe inserted into a measuring tube made of special head for the introduction to the desired depth (figure no. 1). To monitor temperature during storage (25 days) recording solution was chosen temperature all 13 measuring points and the average temperature every minute, with a system of measuring and recording temperature type SQ Squirrel 2020 Data Logger [2].

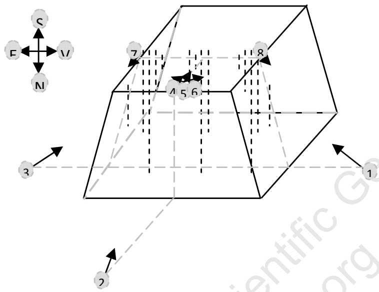


Figure no. 1. Items selected for measurements of surface temperature deposit

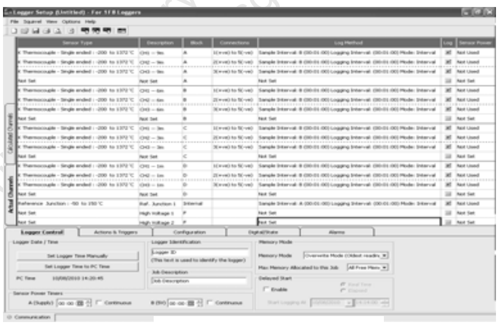


Figure no. 2 Configuration data logger

Data Logger configurable analog inputs: thermistors, thermocouples, Pt100/Pt1000 (maximum 4-wire RTD with 3 or 4 wires) [2].. Figure no. 2 shows the programming window data logger for measuring all channels with the K type thermocouple input with measuring range between -200 0 C and 13720C by measuring and storing data every minute. Figure no. 3, and figure no. 4 presents variation diagrams of temperature inside the coal deposit in the 13 measuring points throughout the monitoring period.

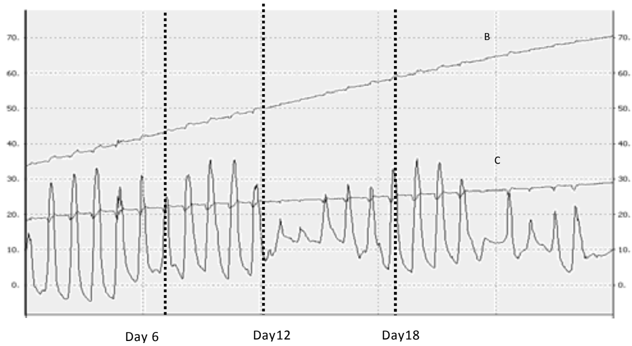


Figure no. 3 . Changes in storage temperature at a depth of 9m, the points B (eastern side) and C (center)

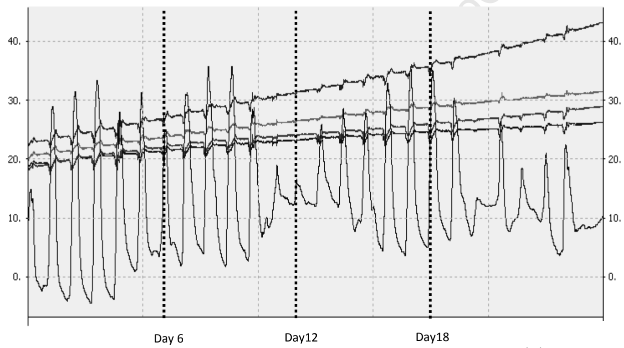


Figure no. 4. Temperature variation in storage at the point C at a depth of 1m, 3m, 6m, 9m

After analyzing thermal images taken with the thermal imager for all measurement points were identified areas where there have been any self-ignition of coal. In Figure 5 are images taken with infrared thermal imager to the area where the outbreak occurred first potential and temperature variation in Figure 6 while for these area. Also measurements were made in two areas: the area where the temperature is close to the average temperature of the stack face, and zone B where the temperature is the highest value on the stack. Measurements were made at different depths, the vertical point, progressively removing quantities of coal until it was identified that the depth from which coal has remained virtually constant temperature (no longer influenced by weather conditions). The results of these measurements are found in Table no. 1.

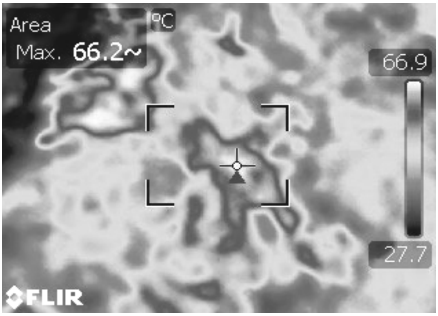


Figure no. 5. The area of the potential first outbreak

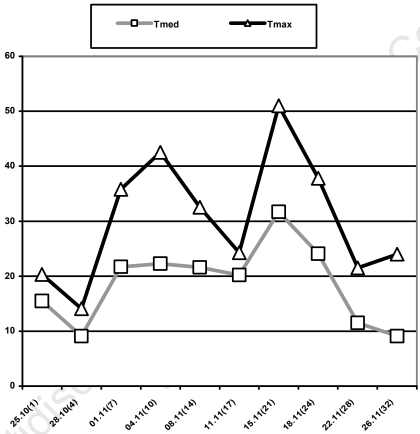


Figure no. 6. Surface temperature variation in time to deposit for the first outbreak potential

From the results we see that, from a depth of 40 cm, the temperature inside the stack is influenced in a very limited extent by weather conditions. The temperature of the outer faces of the stack depends on ambient temperature and heat exchange between the stack and the environment. From the analysis of therrmographic images there are areas with temperatures higher than average on these faces and the temperature in the vertical stack area also has higher values. This is because air and volatile released from outbreaks of ignition are hot and moving towards the outside of the stack. Since the size and form lumps of coal are very different, forming channel movement of these gases with trails that cannot be established. Gas circulation channel is achieved mainly with the lowest resistance to flow, which may not coincide with the shortest route to the surface.

It is possible that if the temperature is elevated at the surface of the focus stack to stack to be in any direction. Since the surface temperature depends on ambient air temperature and solar radiation absorbed, it has a diurnal variation that aims to change the previous factors. Consequently, the surface temperature is influenced primarily by the environment and to a lesser extent by the temperature of the stack, but the warmest areas on the surface indicates the existence of releases of higher heat in the stack. The position of these points with large heat release can be approximated but cannot pinpoint the depth at which they occur.

Table no. 1 The temperature of the stack for different depths

Depth in the stack [cm]	Temperature [^{0}C]	
	Zone A	Zone B
0	23,5	45,7
10	28,3	47,5
20	35,2	51,2
30	44,5	55,5
40	49,6	58,3
50	50,8	60,1

AIR POLLUTION BY EXHAUST EMISSIONS RESULTS IN THE LIGNITE POWER UNITS

Measurements of pollutants from power station for energy group Rovinari No.4, 2011, are presented in Table 2, and reveal exceeded the maximum permissible limits for pollutants SO2, NO_x and dust of ashes: 400 mg/m^3 – SO_2; 200 mg/m^3 – NO_x; 50 mg/m^3 – dust [8]. The emission of pollutants was done with portable equipment for determining the concentrations of pollutants in flue gas type TESTO 350 XL. With this we can determine (by direct measurement and calculation): O2, CO2, excess air concentrations of SO2,NO, NO2, NOx, CO. Measurements Were made with particle analyzer SC600.

Figure 1 shown is the structure of the four channels configured SC 600. Particle analyzer SC 600 is equipped with two software packages for Advanced Data Analysis:
EPA Reporter package that allows downloading and analysis. This facilitates the graphical or textual reports over the Period of time; PREDICT package that allows detailed analysis of the performance of electrostatic precipitators. This results in year Assessment in the time to stop for Maintenance. Figure no 8 presents screen of the application PREDICT.

To determine the dispersion of ash dust to atmospheric modeling system used AEROMOD VIEW. AERMOD View is a complete and powerful atmospheric modeling, which brings together three popular U.S. EPA models into one platform for use: ISCST3, ISC-AERMOD PRIME **és** [8]..

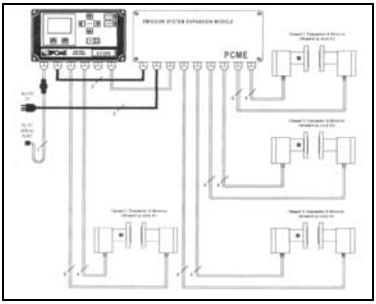


Figure no. 7 Configured SC600

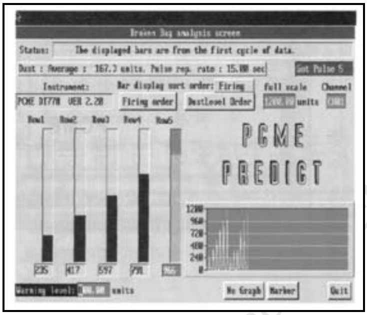
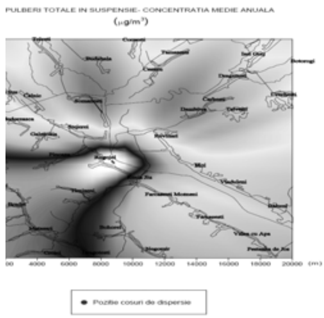


Figure no. 8
Screen of the application PREDICT

Table no. 2. Measurements of pollutants from power station for energy group Rovinari No. 4, 2011

Boiler no.4	**CO**	**CO_2**	**O_2**	**NOx**	**SO_2**	**Excess air λ**	**Flue gas temperature**
Luna	mg/m^3	%	%	mg/m^3	mg/m^3		^0C
january	92,2	9,8	11,5	468,1	6337,4	2,2	136,2
february	142,4	10,6	10,6	424,5	4529,6	1,8	132,6
march	124.5	8,4	11,2	462,5	6134,5	2,4	142,3
june	163,4	11,2	10,8	452,3	4698,4	1,7	144,8
august	101,2	6,9	8,4	284,3	4119,4	1,5	102.4
october	104,3	10,1	11,2	465,6	5668,3	1,8	132,8
november	105,8	9,5	11,4	454,3	5424,6	1,9	136,3
december	94,5	6,1	8,5	311,2	4114,2	1,4	92,6
Aaverage annual	103,1	8,1	9,3	368,2	4558,5	1.6	112,2
Dust mg/Nmc	Boiler 3	Boiler 4	Boiler 5	Boiler 6			
Projection	50	50	300	300			
Measured	60-70	50-65	270-300	280-300			

Maps of atmospheric dispersion modeling results are presented in figures no. 9 and figure no. 10. Figure no. 9 presents the dispersion map on total suspended particulates - annual average concentration in µg / m^3. Figure no. 10 is shown the dispersion map on total dust in suspension - the maximum concentration in µg/m^3. Calculated concentrations are within the limits (28 µg /m^3, 40 µg /m^3) [1].



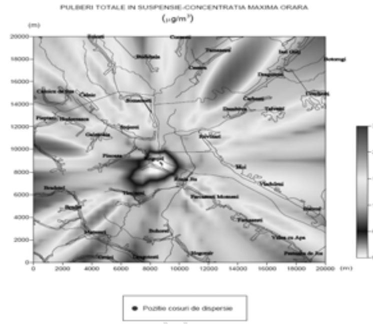


Figure no. 9 -Annual average concentration   Figure no. 10- the maximum concentration

CONCLUSIONS

Operation of power units of the complex Rovinari determine environmental risks of air pollution, with NOx, SO2, CO ash dust. Ash dust get into the environment in two ways: with combustion exhaust gas chimneys of power units and by shattering the gray surface of slag and ash deposit Cicani Beterega. Greater height (250 m) of chimneys provide better dispersion of exhaust gases containing ash dust, NOx,. According to the results obtained with atmospheric modeling system AEROMOD VIEW, annual average concentration, maximum concentration and maximum concentration of dust 24 hours did not exceed the maximum allowed by law. Ash dust, wind – blown from the surface dry storage compartments, affecting all environmental factors. Monitoring deposits of coal thermal imager can provide information on the level of the stack temperature and indicate the approximate areas where auto-ignition may occur. Analyzing graphs representing the curves of variation of temperature during storage, we can conclude that the coal temperature varies depending on the depth of the stack, and exposure to wind. Temperature close to the outer layer of the deposit is different from the temperature inside the warehouse, with a much slower growth due to better heat exchange with ambient air. Temperatures measured on the east side(the prevailing wind direction) reached values of 70 ° C, while in central and western area temperature is (20 ÷ 40) ° C, higher values being for the West. This is due to the surplus of fresh air (oxygen default) brought the wind on the exposed coal oxidation reaction is accelerated.

Deposit of coarse coal favors the creation of channels through which air enters the layers within it. For prevention the ignition phenomenon, coal deposits will be kept under continuous observation, a systematic control of the temperature inside the deposits formed is preferably performed in the early hours of morning. By observing the daily deposits of coal, we will be able to identify portions of the deposit in time that are more likely to self-heating and ignition in that the specific portions warmer , frost and dew disappear faster than the surrounding parts, snow melts more easily, and after rain the portions of the stacks dries before the other. Reducing environmental risk by closing the slag and ash deposit Cicani Betertega, can be done by: reduce the possibility of leachate by adapting a solution to close the landfill involving benthic g eocomposites use of a geo synthetic drainage layer of HDPE material, a layer of topsoil planted with grass; check the status of the drainage system and status of vegetation on the surface of the deposit; conducting regular checks every 6 months to check groundwater levels in the warehouse.

REFERENCES

[1] Gorun, A., Popescu, L.G., Gorun, H.T., Cruceru M., Sustainable Energetic Development Strategy of Gorj, County, 2nd INEEE Conference: ENERGY, ENVIRONMENT, DEVICES, SYSTEMS, COMMUNICATIONS, COMPUTERS, Venice, February, 8-10 2011,

[2] Cruceru M., Diaconu, B., Popescu L. G., *Self oxidation of romanian lignite during storage*, *6*th IASME/WSEAS International Conference in the University on Energy & Environment, Published by WSEAS Press ISSN: 1790-5095, Cambridge, February 23-25, 2011.

[3] Cristinel Popescu, Marius-Constantin Popescu Mircea Grigoriu, Thermo Process Monitoring bars Medium Voltages în Regim de Scurtcircuit under short circuit, WSEAS, Conference Bucharest April 2010.

[4] Racoceanu C, Şchiopu C., *Environmental protection and remediation of air*, Publishing House Academica Brâncuşi; Târgu Jiu, 2010.

[5] Popescu M.C., Popescu L, Popescu C – Modelling and simulation of evacuation processes of pollutants in the room, International Review of Chemical Engineering Rapid Comunication, Vol.1, nr.6, pp.525-547, November 2009.

[6] Stoenescu E., Popescu M.C., Bulucea C.A., *Assessment of Improved Transformer Thermal Models,* Proceedings of the Applied Computing Conference, Published by WSEAS Press, pp.189-195, Vouliagmeni Beach, Greece, September 28-30, 2009.

[7]. Popa R., ., Racoceanu C., Şchiopu E., C. *Techniques for air monitoring and de-contamination*, SITECH Publishing House, Craiova, 2008.

[8] Racoceanu, C., Popescu C. *Analysis of environmental impact of energy complexes,* Publishing House Sitech, Craiova, 2007.

[9] Popescu, C. Racoceanu, C., *Improve the efficiency of power plants under environmental protection,* Publishing House Sitech, 2006.

[10] Racoceanu C., Popescu C., *Assessment of pollutant emissions from burning of lignite in power CTE,* Publishing House Sitech, Craiova, 2006.

RESEARCHES REGARDING HEAVY METALS DETERMINATION (ZN, PB, CU, NI, CD, AS, CR) FROM STEAM POWER PLANT SLAG AND ASH DEPOSITED IN THE DECANTATION POND FROM CEPLEA VALLEY, IN ORDER TO DETERMINE THEIR USE OPPORTUNITY AS RAW MATERIALS IN BUILDING MATERIALS INDUSTRY

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ABSTRACT

Slag and ash ponds resulted from lignite burning in steam power plants boilers are pollution sources for surface and underground water, as a result of infiltrating the leachate resulted from precipitations and a major impact on local economy, due to removing large surfaces of land from the agricultural circuit. In order for these threatens over environmental quality to be removed, technical solutions have to be applied in order for these technological waste to be introduced in a technological circuit with economic benefits.
Starting from this hypothesis, one of the technical solutions that can decrease the amount of energetic waste and clear lands from technological loads and decrease the consumption of natural resources is their introduction in a technological flow of manufacturing building materials.
Ceplea Valley decantation pond is the slag and ash deposit of Turceni steam power plant – the biggest steam power plant in Romania and Europe as well with a rated thermal power of 2640 MW.
This paper presents the results of researches developed in order to determined the concentration of ashes and slag from Ceplea valley decantation pond in heavy metals. The purpose of these determinations was to determine whether the waste introduced in the manufacturing process of building materials can be risk factors for the beneficiary population's health.
Researches were developed in the laboratories of the Faculty of Engineering at "Constantin Brancusi" University of Târgu – Jiu, within the research contract LIFE10 ENV/RO/729 „New building materials by eco-sustainable recycling of industrial wastes".
The research methodology used in determining heavy metals was according to the standard SR EN 13656/2003 Characterization of waste – Microwave assisted digestion with hydrofluoric (HF), nitric (HNO3) and hydrochloric (HCl) acid mixture for subsequent determination of elements and standard SR EN 12506:2004 Waste

characterization. Leachate eluate. Spectrophotometric determination of Zn, Pb, Cu, Ni, Cd, As, Cr.
Samples desegregation for performing the tests was made by using the Berghof Speed Weed 3 mineraliser, and heavy metals concentrations analysis was made by using the atomic absorption spectrophotometer model AAnalyst 700 Perkin Elmer

Keywords: ash, slag, heavy metals, building materials

1. INTRODUCTION

In order to accomplish the objectives of the project „New building materials by eco-sustainable recycling of industrial wastes" there was chosen for study the ash and slag storehouses from Valea Ceplea (Fig. 1), because the area is known to be very polluted with heavy metals (Zn, Pb, Cu, Ni, Cd, As, Cr), both as a result of historical pollution and due to the present industrial activities unsupported from the perspective of environmental protection. [1]
In Gorj County there are two energetic companies (Turceni Thermoelectric Power Station and Rovinari Thermoelectric Power Station), as well as several lignite mining quarries.
Preliminarily, in order to achieve surface sampling, there was used an extraction drill to obtain 14 samples, from a 20 cm depth on a 10x10 cm^2 area.

Fig. 1. Ash and slag storehouse from Valea Ceplea – Turceni

2. EXPERIMENTAL PART

In order to determine the heavy metals in the ash and slag of the steam power plant there was used the atomic absorption spectrometer Perkin Elmer AAnalyst 700, with *oxygen-acetylene* flame. As radiation sources there were used lamps with cavity cathode of Zn, Pb, Cu, Ni, Cd, As and Cr, respectively.
Before starting the analysis, the soil samples were dried out for a week, then shredded to 2mm, homogenously mixed and sieved to remove roots and stones. The fraction less than 2 mm was grinded and sieved to 90 μm sieve. The samples were brought to a constant mass through oven-drying at a temperature of 105±5^o C. [2]
For the mineralization of the samples it was used a microwave Bergof mineralization unit and the following acids HCl 37%, HNO_3 65 %, HF 45% end H_3BO_3.

The mineralization stages of the ash according to SR EN 13656/2003 standard are as fallowing:
Stage I
– 0.5 g sample to which are added the following reagents:
- HCl 37% - 1.5 ml/sample
- Nitric acid 65% - 8 ml/sample
- HF 45% - 0.5 ml/sample
Stage II
After completing the first stage of mineralization 4% - 5ml/sample boric acid is added. After completing the two mineralization stages it continues with sample filtering followed by bringing it to the marking sign with ultrapure water in a 100 ml flask. Out of this extract there were determined the heavy metals in the flame of atomic absorption spectrophotometer. [3]
Calibration curves were raised based on the absorbance of calibration solutions. In order to achieve this, the calibration solutions were aspired in flame in ascending order of their concentration, for each element. Data editing was realized in EXCEL computer software, thus obtaining the equations of calibration curves and the correlation coefficients.[4]

3. RESULTS AND INTERPRETATIONS

The results obtained after spectrophotometric determinations of heavy metals out of the 14 samples brought under analysis are registered in table 1.

Table 1. Results registered after the determinations of heavy metals out of the analysed samples

Nr. samples	Determinations of heavy metals [mg/Kg]						
	Cu	Zn	Cr	Pb	As	Cd	Ni
1	58	55	14	9.566	12.30	0.045	11.36
2	70	44	18.4	7.970	8.459	0.072	33.92
3	71	53	26	11.42	19.53	0.106	25.69
4	68	60	9	14.40	18.18	0.053	29.90
5	65	55	22	10.69	14.67	0.048	30.51
6	64	52	38	10.56	16.86	0.055	29.97
7	62	77	31	12.07	27.86	0.083	34.43
8	80	55	18	11.48	51.40	0.387	38.88
9	92	78	10	15.53	58.68	0.096	43.60
10	68	50	28	8.499	40.71	0.090	34.71
11	67	89	14	7.658	54.82	0.087	39.81
12	77	89	14.7	6.551	57.26	0.065	35
13	92	78	23	8.342	83.31	0.063	46.21
14	137	134	28	7.162	108.5	0.058	46.26
Normal values	***20***	***100***	***30***	***20***	***5***	***1***	***20***

- *Monitoring the Cu concentration*

According to MAPM Order no. 756/1997, the normal value is 20 mg/Kg dry matter. The evolution of Cu concentration in the analysed samples is represented in Fig. 2.

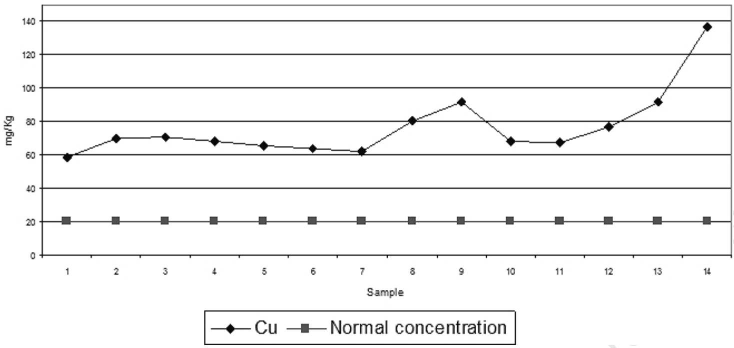

Fig. 2. Evolution of Cu concentration in the analysed samples

Comparing the measured values for Cu with the normal value, conclusions can be formulated. Analysing the registered concentrations there is observed that they all exceed the normal value. The highest value was registered at sample no. 14 (137 mg/Kg) that was 6.85 times over the normal limit, and the lowest was registered at sample no. 1 (58 mg/Kg) that was 2.9 times over the normal limit.

- *Monitoring the Zn concentration*

According to MAPM Order no. 756/1997, the normal value is 100 mg/Kg dry matter. The evolution of Zn concentration in the analysed samples is represented in Fig. 3.

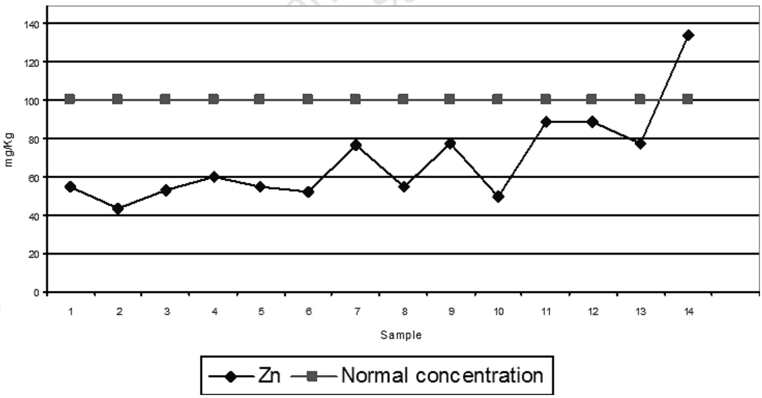

Fig. 3. Evolution of Zn concentration in the analysed samples

Analysing the registered concentrations there is observed that out of the 14 measurements, only one exceeded the normal value. The excess of the normal value was registered at sample no. 14 (134 mg/Kg) which was 1.34 times over the normal value. The lowest concentration was registered with sample no. 2 (44 mg/Kg).

- *Monitoring the total Cr concentration*

According to MAPM Order no. 756/1997, the normal value is 30 mg/Kg dry matter. The evolution of total Cr concentration in the analysed samples is represented in Fig. 4.

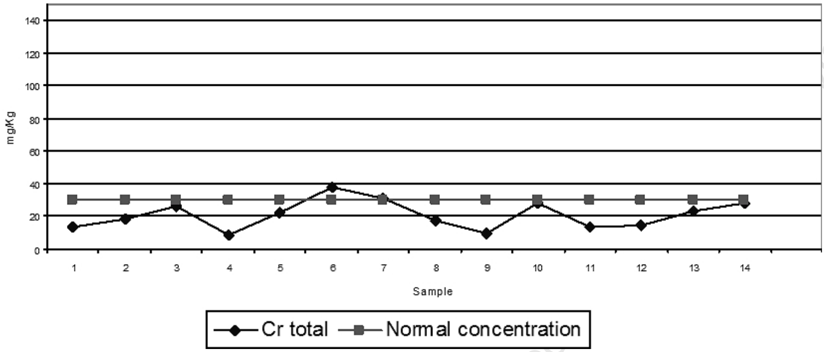

Fig. 4. Evolution of total Cr concentration in the analysed samples.

Analysing the registered concentrations there is observed that out of the 14 measurements, only one exceeded the normal value. The excess of the normal value was registered at sample no.6 (38 mg/Kg) which was 1.26 times over the normal value. The lowest concentration was registered with sample no. 4 (9 mg/Kg).

- *Monitoring the As concentration*

According to MAPM Order no. 756/1997, the normal value is 5 mg/Kg dry matter. The evolution of total Cr concentration in the analysed samples is represented in Fig. 5.

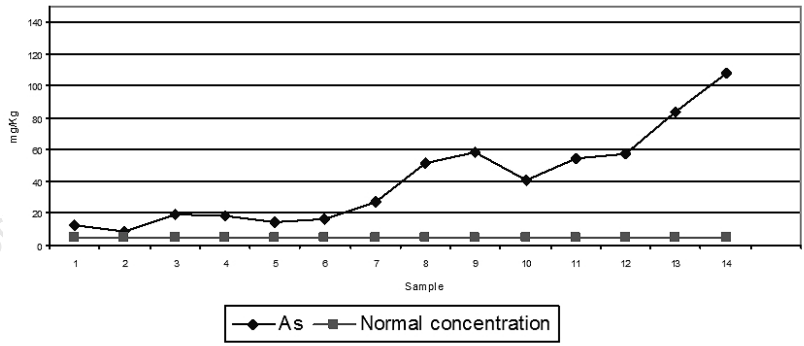

Fig. 5. Evolution of As concentration in the analysed samples

Analysing the registered concentrations there is observed that all exceed the normal value. The highest excess was registered at sample no. 14 (108.5 mg/Kg) that was 21.7 times over the normal limit, and the lowest was at sample no. 2 (8.459 mg/Kg) that was 1.69 times over the normal limit.

- *Monitoring the Ni concentration*

According to MAPM Order no. 756/1997, the normal value is 20 mg/Kg dry matter. The evolution of total Cr concentration in the analysed samples is represented in Fig. 6.

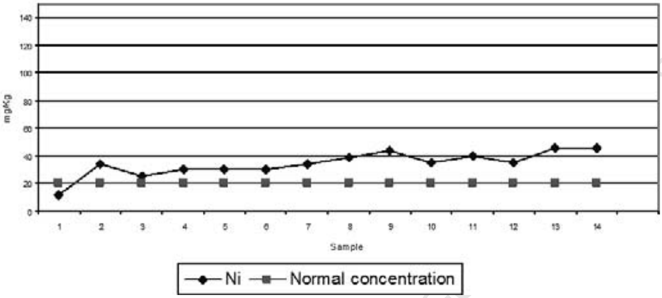

Fig. 6. Evolution of Ni concentration in the analysed samples

Analysing the registered concentrations there is observed that out of the 14 measurements, only one didn't exceeded the normal value, that being sample no. 1 (11.36 mg/Kg). The highest concentration was registered at sample no. 14 (26 mg/Kg), that was 2.31 times over the normal limit.

Lead and cadmium did not register any excess over the maximum admitted concentration.

3. CONCLUSIONS

The general conclusion as a result of the determinations is that the steam power station ash contains significant quantities of heavy metals, which may cause serious problems to the environment if used as raw material in construction and building materials industry, reason which requires low quantities of ash in the recipe which facilitates dilution of heavy metal concentration.

REFERENCES

[1] Căpăţînă Camelia, Şchiopu Emil Cătălin, The use of silica in the glass industry, Annual of University of Mining and Geology "St. Ivan Rilski" – Sofia, Part II: Mining and Mineral Processing, Tom Vol. 50, Bulgaria, 2007, pp. 145-148.
[2] Mănescu. S, Dumitrescu H, Bărbuţă Z, Diaconescu M, L, Environmental Health Chemistry, Volume II, Medical Publishing House, Bucharest, Romania, 1982, pp 128.
[3] Cotrău M., Proca M, Analytical Toxicology, Medical Publishing House, Bucharest, Romania, 1988, pp. 234 - 236.
[4] Şchiopu E., C., Cîrţînă D ,,*Methods and apparatus for measuring and controlling the environment, - Handbook of practical works*". "Academica Brâncuşi" Publishing House, Targu – Jiu, Romania, 2010, pp.89.

SENSITIVITY SOME BUILDINGS PARAMETERS HAVE ON ENERGY PERFORMANCE – CASE STUDY

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ABSTRACT

The quality of most buildings may be affected during the initial phase of architectural design. It is therefore important to optimize input parameters, which significantly influence energy efficiency. In principle it is possible to speak of a deterministic approach – which considers the input parameters to be fixed or a stochastic approach – which takes a wider set of input parameters into account. A reference building is evaluated in terms of energy performance, where input parameters are changed in order to determine a correlation coefficient. Regression were written to express the impact architectural design has on energy performance.

Keywords: shape of buildings, wall to window ratio, ratio of building side

INTRODUCTION

The optimization of input parameters is necessary because the quality of most buildings may be affected during the initial phase of architectural design.

Some guidance is available for architects to help predict annual energy performance. These case studies have shown, that the building shape dramatically impacts energy loads for heating and cooling. For example: Mahdavi [1] uses the relative compactness of buildings related to a specific shape to determine the energy performance of buildings. Ourghi et al. [2] has developed a simplified analysis tool to predict the effects of shape selection regarding annual energy use. Similarly Adnan al Anzi [3] set about a regression equation relating: the shape of buildings, wall to window ratio, and solar heat gain coefficient, to the energy performance.

PARAMETRIC STUDY OF SINGLE-STOREY HOUSES

The study consider a single-storey house (bungalow), which as a structure, has seen a surge in popularity in Slovakia. Based on the shape and structural analysis of 130 bungalow homes in Slovakia, several histograms were created describing the shape and thermal-quality single storey envelopes.

Shape and construction solutions of single-storey houses in Slovakia

Shape solutions of analysed single-storey houses (expressed through a shape factor FT [1/m]) and thermal quality of building envelopes (using the average heat transfer coefficient U_{em} [W/m2.K]) are shown in Fig.1.

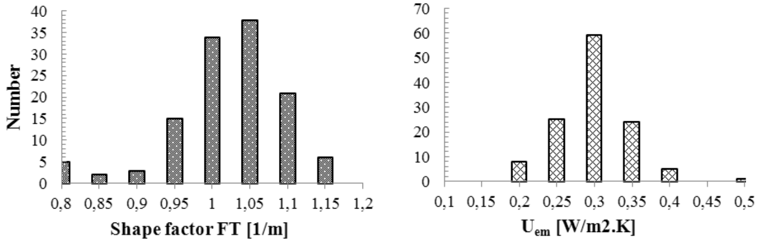

Fig.1 Histogram of single storey-hoses solution: left - shape solution FT, right - average heat transfer coefficient U_{em}

The effect that the percentage of envelope has on design and subsequent contribution to heat loss is illustrated in Figure 2.

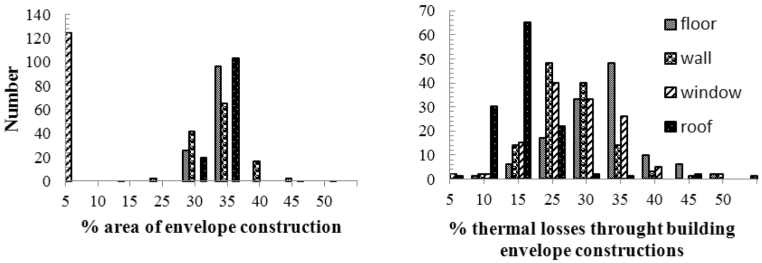

Fig.2 Histogram of single storey-hoses solution: left - % area of envelope constructions, right – thermal losses through building envelope constructions.

From a statistical processing point of view, it may be deducted that the form factor for the selected bungalows are relatively disadvantaged in comparison to multi-storied residential properties. Thermal qualities of envelopes in contrast to traditional constructions, can be overcome by implementing low-energy standards. Deposite differences in percentage areas of individual envelope elements, the % of heat loss is relatively balanced, suggesting a lower qualty of thermal and transparent structures.

Reference single-storey house – parametric study

The impact that the input parameters have on the annual energy demand is reviewed for a single-storey house depicted in Fig.3. By considering input parameters within the ranges as shown in Tab.1. The range of values considered in the calculation was partly manipulated by the statistical analysis of existing single floor houses mentioned above. Heating was calculated on a monthly basis according to STN EN ISO 13790 [6] in MS Excel.

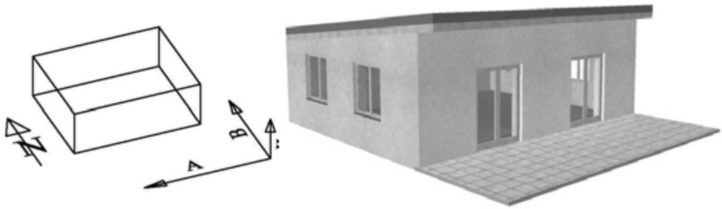

Fig. 3 Dimensions and orientation object.

Tab. 1 Input parameters and their ranges of values considered in the calculation needed for heating a references single-storey house.

PARAMETER			MED.	MIN.	MAX.
INDEX	**NAME**	**UNIT**			
A	Width	[m]	10	2	18
B	Depth	[m]	10	2	18
H	Height	[m]	3,5	2,2	4,2
U_w	Heat tr. coeff. of window	[W/m^2.K]	1.0	0,6	1,4
U_{floor}	Heat tr. coeff. of floor	[W/m^2.K]	0.25	0,1	0,45
U_{wall}	Heat tr. coeff. of wall	[W/m^2.K]	0.2	0,1	0,4
U_{roof}	Heat tr. coeff. of roof	[W/m^2.K]	0.2	0,1	0,4
%win -N	% of window to wall - N	[%]	50	10	90
%win -S	% of window to wall – S	[%]	50	10	90
%win -E	% of window to wall – E	[%]	50	10	90
%win -W	% of window to wall - W	[%]	50	10	90
G_{win} **- N**	Solar heat gaint coeff. - N	[-]	0,5	0,1	0,9
G_{win} **- S**	Solar heat gaint coeff. – S	[-]	0.5	0,1	0,9
G_{win} **- E**	Solar heat gaint coeff. – E	[-]	0.5	0,1	0,9
G_{win} **- W**	Solar heat gaint coeff. - W	[-]	0.5	0,1	0,9
ΔU	Thermal bridges	[W/m.K]	0	-0,04	0,1
Cm	Thermal capacity	[J/K]	100000	76000	124000

Computing method

Standard heating requirements in Slovakia, depending on the shape factor *FT* are depicted in standard [4]. Residential buildings are distinguished mainly by the shape, size and number of storeys, these differences can be expressed by the shape factor FT of the building. Heating is considered continouous with a standardized 3422K.day degree days. Rising coefficients of heat transfer affects the reduction of energy demand. Buildings meet requirements if the shape factor fulfils the condition $E \leq E_N$ (need for heating must be equal to or less than the need for heating stated in regulations) Fig.2. This standard specifies the maximum heat transfer coefficient *U* for building envelope constructions. Thermo-technical qualities of building envelope structures defines the mean heat transfer coefficient U_{em}. The method of calculation used in this study was based on Quasi-stationary simplified monthly method dictated by STN EN ISO 13790: 2008 [6]. A bungalow considered to consist of a single thermal zone.

Development of alternatives

The facilitate the calculation of different input parameters combinations required the use the Monte Carlo optimization method based on a stochastic random selection. The Monte Carlo method analysis is based on repeated simulations; the outputs are evaluated for each element of sample matrix. Simulation 4,0 [5] was used to generate a combination of input parameters. Annual heating requirements were calculated by utilizing the above mentioned quasi-stationary seasonal method in compliance with standard STN 73 0540[6]. The inputs for the optimiyation model are the dimension of building sides, the envelope construction U – value, _ window to wall area, solar properties of window etc. All input parameters meet the criteria of minimum thermal properties according to standard [6].

Results of parametric simulation

The sensitivity of input parameters required for heating can be expressed using the standardized regression coefficient, which determines the order of sensitivity Fig.4. in this case, the correlation coefficient was determined implementing a combination of 20000 input parameters. From this combination, it was possible to develop regression models to predict heating demands for a single-storey house. This regression models to predict heating demands for a single-storey house. This regression can be helpful for optimizing energy efficiency for architects or design engineers during initial design stages.

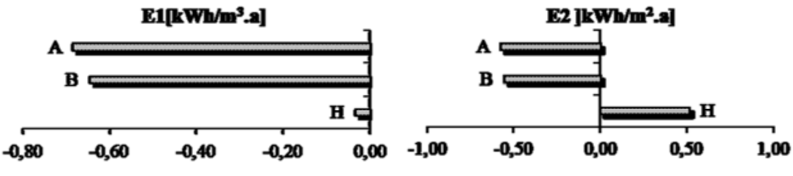

Fig. 4 Standardized regression coefficient reflecting the sensitivity of input parameters (regarding the dimension of a single-storey house) for heating requirements, left – E, right – E2.

Parameters sensitivity regarding thermal properties of the building envelope constructions of a single-storey house are shown in Fig.5. For comparisons of different climates three different Slovak climate locations were observed in compliance with STN EN ISO 13790/NA [7]. Selected cities included: Bratislava - BA (I. climatic zone), Košice – KE (II. climatic zone) and Stropkov - ST (III. climatic zone).

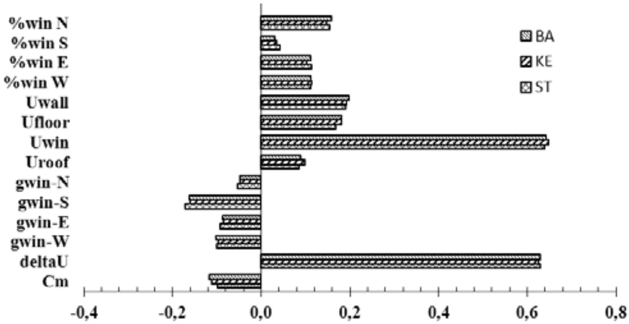

Fig. 5 Standardized regression coefficient sensitivity for input parameters (regarding the thermal properties of building envelopes) based on heating loads and expressed as: E1 [kWh/m^3.a]

From the results of the parametric analysis it is possible to develop a regression equation (1) of energy demand for the modeled building Tab.2. In this equation the above mentioned parameters are included.

$$y = \alpha_1 + \sum_{i=1}^{4} \beta_i * \%win_i + \sum_{i=1}^{4} \gamma_i * Gwin_i + \sum_{i=1}^{4} \delta_i * U_i + \varepsilon * A + \zeta * B + \eta * H \quad (1)$$

Tab. 2: Regression coefficient of modeled building

Regression constant		E_1 [kWh/m^3.a]	E_2 [kWh/m^2.a]	E_1N [kWh/m^3.a]	E_2N [kWh/m^2.a]
α_1	--	11.2497	-23.7711	62.02555	92.4434
β_1	**%win -N**	0.027392	0.09603	-0.00075	-0.00292
β_2	**%win -S**	0.00795	0.028128	-8.2E-05	-0.00019
β_3	**%win -E**	0.020019	0.070444	-7.2E-05	-0.00031
β_4	**%win -W**	0.022452	0.079203	0.000139	0.00052
γ_1	**G_{win} - N**	-0.88669	-3.12467	0.023479	0.061003
γ_2	**G_{win} - S**	-3.14043	-11.0274	0.079507	0.257434
γ_3	**G_{win} - E**	-1.88903	-6.54575	0.012969	0.066267
γ_4	**G_{win} - W**	-1.72758	-6.02722	0.008813	0.042546
δ_1	**U_{win}**	12.84802	45.02377	-0.00925	-0.00231
δ_2	**U_{floor}**	17.41174	60.97351	-0.1205	-0.32549
δ_3	**U_{wall}**	12.80278	44.73585	-0.1063	-0.4796
δ_4	**U_{roof}**	17.1769	59.55964	0.210858	0.722702
ε	**A**	-0.5084	-1.78113	-0.59435	-2.08273
ζ	**B**	-0.53842	-1.88515	-0.59185	-2.07126
η	**H**	-0.16685	17.45102	-4.19531	20.88809
R^2		0.83786	0.86031	0.94677	0.9546

CONCLUSION

Knowledge of parameter sensitivity can facilitates optimal design by quantifying tradeoffs between differing parameters, and focusing attention on the parameters that are most likely to affect energy goals of the project. The purpose of this paper is to model a single storey house using a sensitivity and regression analyses.

Regression analysis models developed in the buildings´ design predict the need for heating and promote the exploration of potential design and quantitative feedback generated by regression methods. This assists designers with energy efficient decision-making processes during conceptual design stages. The regression equation can be used in a multi-criterion decision analysis as a tool to predict annual heating demand.

Future work is needed to validate, refine and expand on the proposed method to deal with a building´s shape and determine regression coefficients for parameters of dynamic variables for each climatic zone.

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REFERENCES

[1] Pessenlehner, W and Mahdavi, A, “Building Morphology, transparency, and energy performance”, Eight International IBPSA Conference Proceedings, Eindhoven, Netherlands.

[2] OURGHI R, AL-ANZI A, KRARTI M. A Simplified Analysis Method To Predict The Impact Of Shape On Annual Energy Use For Office Buildings. Energy Convers Manage J 2007;48:300–5.

[3] ALANZI, A., SEO, D., KRARTI, M., Impact of building shape on thermal performance of office buildings in Kuwait. Energy Conversion and Management J, 2009; no 50, p. 822-828.

[4] STN 73 0540 1 až 4 Tepelnotechnické vlastnosti stavebných konštrukcií a budov. Tepelná ochrana budov, 2002

[5] Simulación 4.0, available online:
< http://www.ucema.edu.ar/u/jvarela/index_eng.htm>

[6] STN EN ISO 13 790: 2008. Energetická hospodárnosť budov. Výpočet potreby tepla na vykurovanie a chladenie.

[7] STN EN ISO 13 790/NA: 2008. Energetická hospodárnosť budov. Výpočet potreby tepla na vykurovanie a chladenie.

SIGNIFICANCE OF SURFACE WATER CONTAMINATION WITH PCE FOR FISH TISSUE PCE CONTENT

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A B S T R A C T

In the second half of 20^{th} century chlorinated ethens (CE) were widely used as an industrial degreasers, cleaning detergents and extraction agents and therefore represent frequent groundwater contaminants in the Czech Republic (CR). The contamination of groundwater in the area of SAP Mimon factory and its surroundings by tetrachloroethylene (PCE) and its degradation products is one of the most extensive contamination of important waterwork´s collector in CR and it has negative influence on surface water quality in the river Ploucnice. Site assessment started in this area in 1994. Intensive remediation groundwater pumping and new remediation techniques (air sparing and venting) started in 1997. Remediation with ozone has been initiated in 2008.

The aim of our study was to determine influence of water contamination by PCE on PCE content in the muscles of fishes from the area of SAP Mimon and to asses the effectiveness of remediation technologies on PCE content in the surface water.

13 fish have been catched from two different localities (above and below the source of surface water contamination) in summer 2011 in area of SAP Mimon for PCE testing. Three different species were selected (*Gobio gobio, Barbatula barbara and Leuciscus leuciscus)* for assessment.

PCE concentrations in muscles of fishes were measured by GC/ECD using Clarus 500 device. The obtained results were compared to the similar assessment performed in the same area in 1998. Positive content of PCE was detected in all fish samples from the locality below the source of water contamination (17-53 µg/kg, mean 27 µg/kg, seven samples analysed) in 2011. Only in two muscle samples from six fish from the locality above the source of water contamination had positive PCE detection (29 and 59 µg/kg, detection limit 10 µg/kg). The PCE contamination (30-140 µg/kg, mean 79 µg/kg) was higher in all samples from locality below the source of water contamination in the previous study in 1998 compared to the results from 2011.

PCE content in surface water in period 1994 - 2012 in profile under the source indicates great improvement in surface water quality after clean-up commencement. Despite very low PCE contents of surface water fish tissues still have measurable contamination content which is not aliquot to surface water contamination decrease.

Keywords: chlorinated ethens, contamination, fish, ecological risk, remediation technologies

INTRODUCTION

In the latter half of 20th century chlorinated ethens (CE) were widely used as an industrial degreasers, cleaning detergents and extraction agents. Therefore represents frequent groundwater contaminants in the Czech Republic (CR) and globally as well [4]. Previous publication reported that tetrachloroethylene is more persistent in groundwater, since the rates of volatilization and biodegradation are greatly reduced [5], [9]. Tetrachloroethylene (PCE) accumulate in the organs and fatty tissues of species that drink or live in the water. There is some publication of bioconcentration of PCE by fish examination. Only limited information was identified on the PCE biodegradation by examination of fish mucles in different time period.

The contamination of groundwater in the area of SAP Mimon factory and its surroundings by PCE and its degradation products is one of the extensive contamination of important waterwork´s collector in CR and it also negatively influenced surface water quality in the river Ploucnice. Site assessment started in this area in 1994. Intensive remediation groundwater pumping and new remediation techniques (air sparing and venting) started in 1997. Remediation with ozone has been initiated in 2008 [4].

The aim of our study was to determine influence of water contamination by PCE on PCE content in the muscles of fishes from the area of SAP Mimon and to asses the effectiveness of remediation technologies on PCE content in the surface water.

MATERIALS AND METHODS

In August 2011 a hydro-biological research was made in order to evaluate the extent of contamination of the watercourse and to evaluate the efficiency of remediation system. During the research, samples of fish were taken from two different sections of the river Ploucnice (above and below SAP factory in Mimon) to determine the degree of PCE contamination in fish muscles. For this research, six fish were taken from the section above SAP factory and seven fish were taken from the section below the factory. Acquired data were compared with the study which was made in the same area in May 1998.

Characteristics of the experimental site

Contaminantion characteristics

The contamination of groundwater by PCE and its degradation products at SAP factory in Mimon and its surrounding is one of the extensive contamination of an important waterworks collector within the Czech Republic. The factory was established before the Second World War and it has been concerned with biological waste processing [3].

The old ecological strain was caused by the activity of the Veterinary Decontamination Institute s.p. Mimon, the predecessor of nowadays SAP Ltd. The factory was using PCE from processed recourses to extract fat from the first half of 60s until 1988. The total consumption of PCE during this period was estimated to more than 4000 tons. Due to the lack of discipline, there were frequent leaks of the used dissolvent and PCE was present in sewage leaking into the water meadow [4].

It is estimated that about 200 tons of PCE penetrated into water table and their basin. Contamination penetrated to the depth of 40m under ground. The first trace of strain in the natural environment was the discovery of a very strong PCE contamination in the well of Borecek waterworks in the year 1986. Those waterworks are 350m far from SAP factory. Since the waterworks is located on the other bank of the river Ploucnice in the vicinity of Hradcany, it was estimated that this is the cause of contamination. In 1993 a hydro-biological research of the Borecek waterworks surrounding and SAP factory was made. The results clearly proved that SAP factory Mimon is the origin of CE contamination. In terms of an emergency remediation, intensive remediation groundwater pumping and new remediation techniques (air sparing and venting) started in 1997 [1].

In the years 2005 – 2008 an after research was made in the same location. This research specified the geological structure of the locality. The emergency remediation was focused on the layer that is 8-15cm under the surface. This after research proved that those layers contain almost a negligible amount of contamination. Nevertheless, an extensive contamination of a collector was found, in which new epicenters of contaminations were discovered [4].

Hydrogeological characteristics

The river with an average flow volume of 2.66 m3/s, forms the drainage base of the area. The groundwater table level ranges from 2 to 4 m and the permeability of Quaternary aquifer is medium [4].

Hydro-biological survey in the year 1998

During the spring of 1998 (5/98) a hydrobiological survey was made in order to evaluate the degree of long term influence of the CE stream. An analysis of the content of CE in fish muscle *(Gobio gobio)* was made. Two fish, found below SAP factory, and four fish found above SAP factory were examined from the profile. The age of those fish was between 3-5 years. Those fish that were found below SAP factory were contaminated with CE by 30 - 140 µg/kg dry matter of fish muscle. The concentration of other CE was below the measurable level of detection (detection limit 10 µg/kg). The concentration of CE found in fish flash is indicated in table 1 [3].

Table 1. Concentration of CE v the organism of Gobio gobio [3]

Place	Nr. of the sample	Results in (µg/kg)				
		1,2-DCE	trans 1,2-DCE	cis 1,2-DCE	TCE	PCE
Above SAP	nr. 8	< 10	< 10	< 20	< 10	< 20
	nr. 9	< 10	< 10	< 20	< 10	< 20
Below SAP	nr. 4	< 10	< 10	< 20	< 10	140
	nr. 2	< 10	< 10	< 20	< 10	61
	nr. 5	< 10	< 10	< 20	< 10	86
	nr. 1	< 10	< 10	< 20	< 10	30

Experimental fish

Gobio gobio. Inhabits fast flowing rivers with sand or gravel bottom but may also occur in still waters. In flowing rivers, *Gobio g.* is a habitat species. It is highly resilient towards organic pollution. On the other hand, it is sensitive to the amount of oxygen in water and overheating of water in summer. Lives up to five years. *Leuciscus leuciscus.* Inhabits moderate to fast-flowing large streams to large rivers with rock or gravel bottom. Adults aggregate in dense swarms in winter in the lower reaches of rivers or backwaters and often migrate to spawning streams in autumn and overwinter there. Lives up to 10 years. *Barbatula barbatula.* Usually found in flowing stretches of streams and medium-sized rivers with gravel to stone bottom, but also in a variety of other habitats, including sandy canals and lake shores. Tolerates moderate organic pollution and stream canalization and very sensitive to pollution by heavy metals. Lives up to five years [2].

Collection and analysis of samples

Collection and analysis of samples were taken in two locations. The first location is below SAP Mimon in the area below the new bridge registered under Borecek. The other location was in the vicinity of water cleaner Mimon. Those two locations were chosen on the bases of testing fishing reduction in order to catch desirable species of fish, notably *Gobio gobio.* Apart from this species *Leuciscus leuciscus* and Barbatula *barbatula* were caught as well.

The fish caught in the Location 1 were obtained by fording and using a petrol aggregate MBA with Honda GX 160 (2kw). Output voltage 300-650 V, max. output current 10 A, output pulse frequency 50 Hz, stainless anode 25cm in diameter. In the Location 2, fish were caught by fording using a barrier aggregate Lena, output current 6Am output voltage 240-300 V, output pulse frequency 50 – 95 Hz, stainless anode, 25cm in diameter.

To discover how old *Gobio gobio* and *Leuciscus leuciscus* were, an estimation by the analysis of their scales (they were taken from their left middle side, more precisely from the second to third row below the side line) was done. The age was estimated by a Carl Zeiss Jena machine. The fish were magnified 20 times and *Barbatula bar*batula was analyzed from its otoliths under a microscope.

The estimation of PCE was done by GC/ECD method on Clarus 500, phy. Perkin Elmer. The samples of muscles (1,5 – 3,0 g) were frozen and then mushed and extracted in unltrasound bath of methanol. From this solution a water bath was prepared in which a corresponding analyth was estimated by a usual SPME procedure. Those analysis were done in the laboratories of Institute of Public Health in Liberec.

RESULTS

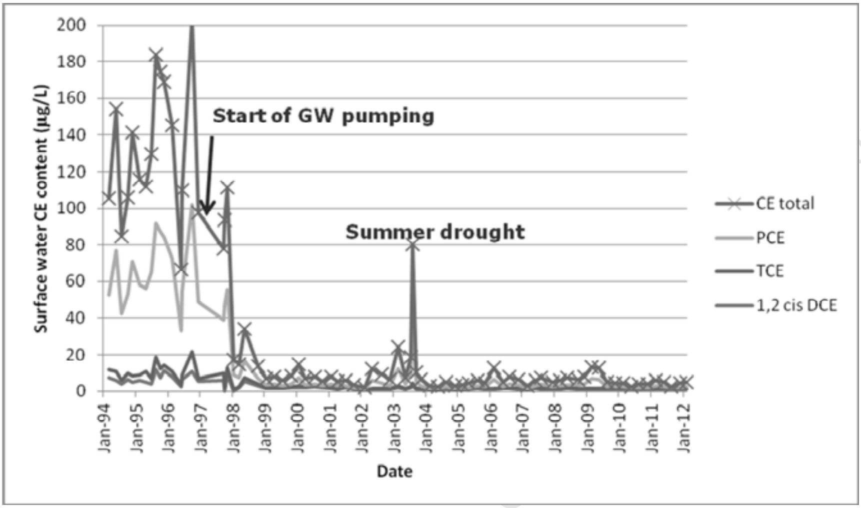
The presence of PCE in fish muscle (*Gobio gobio, Leuciscus leuciscus, Barbatula barbatula*) was analysed in April 2011. All together, six fish (aged 1-4 years of age) caught below SAP factory were subject to analysis. Concentration of PCE in fish is shown in table 2. Samples 1/4P and 1/4Pd are duplicates. The analysis clearly shows that all samples of fish caught under the source of pollution are PCE positive. From above the factory, only two out of six samples were positive. (17-53 µg/kg, mean 27 µg/kg, seven samples analyzed).

Table 2. Concetration of PCE in fish muscle. Those fish were caught in August 2011

Place	Nr. of the sample	Species	Body length (Lc)	Total weight (g)	Age	Results (µg/kg)
Above SAP	2/1H	Gobio gobio	138	46	4+	59
	2/2H	Gobio gobio	97	11	2+	ND
	2/3P	Leuciscus leuciscus	121	30	2+	22
	2/4P	Leuciscus leuciscus	103	19	2+	ND
	2/5M	Barbatula barbatula	100	13	3+	ND
	2/6H	Gobio gobio	61	3	1+	ND
Below SAP	1/1H	Gobio gobio	117	28	2+	21
	1/2H	Gobio gobio	109	22	2+	23
	1/3H	Gobio gobio	105	16	3+	17
	1/4P	Leuciscus leuciscus	163	76	3+	47
	1/4Pd	Leuciscus leuciscus	163	76	3+	53
	1/5M	Barbatula barbatula	111	17	3+	12
	1/6P	Leuciscus leuciscus	113	21	2+	28
	1/7M	Barbatula barbatula	91	12	2+	16

Figure 1 shows content of CE in surface water in profile under the source.

Figure 1. CE content in surface water in period 1994 – 2012



DISCUSSION

In August 2011 fishing reduction was made on the river Ploucnice in the area below and above SAP factory Mimon. Samples were taken from fish muscle in order to evaluate the extent of PCE. All samples caught below SAP factory were positive. Interestingly two samples out of six fish caught above the source of contamination were positive as well. Concerning *Leuciscus leuciscus* it may be considered that the reason for this might be migration. This is not valid for *Gobio gobio*, for it is a habitat species.

PCE content in surface water in period 1994 - 2012 in surface water in profile under the source (figure 1) indicates great improvement in surface water quality after clean-up commencement, but despite very low PCE contents in surface water, fish tissues still have measurable contamination content which is not aliquot to surface water contamination decrease.

As a result of remediation, a significant reduction of PCE in the watercurrent has been achived. Equaly, this contributed to the lower risk for its ekosystem. It is apparent that the watercurrent is still being contaminated by CE for there is still cumulation of PCE in the observed fish. What may potentially endanger contribute to the worsening of the situation is a repeated drainage of CE into the watercurrent of Ploucnice or interuption and untimely termination of remediation works. Due to partial bioacumulation of PCE this substance would cumulated in water organism up to several mg/kg.

PCE has the ability to cumulate in a food chain, which represents a potential risk for piscivore predators (otter or kingfisher) inhabiting this location. I tis impossible to estimate the degree of the risk, since there are no available date concerning the effects of CE on these organism.

Bioaccumulation in fish from contaminated sites can provide information that can contribute to environmental monitoring programs designed for various aspects of environmental risk assessment. The most promising fish bioaccumulation markers are body burdens of persistent organic pollutants, like PCBs and DDTs. Since PCDD and PCDF levels in fish tissues are very low as compared with the sediment levels, their value as bioaccumulation markers remains questionable [8]. Bioaccumulation of PCE in aquatic organisms is not expected to be important based on the bioconcentration factors of 39 for rainbow trout *(Oncorhynchus mykiss)* or 49 for bluegill *(Lepomis macrochirus)* but no other data that are usable are available concerning the accumulation of PCE by fresh water species [6], [7].

Given the limited date base the interpretation of the analytical results of the levels of contaminants found in the tissues of fish is generally difficult and limited by a variety of factors [6],[7]. Fish biomarkers are promising tools for environmental risk assessment (ERA), as supplements to existing chemical measures. Chemical monitoring alone is not fully sufficient for a reliable classification of water quality. The efforts toincorporate biological compounds to the ERA research will eventually be worthwhile [8].

CONCLUSION

The remediation works declined CE concentration in the contaminated area of SAP Mimon and partially reduced the ecological risk for surface water ecosystem. We found out persisting contamination by PCE in analysed fish samples despite intensive remediation works during last 14 years. Regardless of lower concentration of PCE in newly analysed fish samples it is still necessary to continue with remediation in this area.

REFERENCES

[1] Herčík F. (2007): Zpráva o sanaci podzemní vody v areálu SAP s.r.o., Mimoň za období 03/2006 až 02/2007. Earth Tech CZ s.r.o. Praha.

[2] Kottelat M., Freyhof J. (2007): Handbook of European freshwater fishes. Publications Kottelat, Cornol, Switzerland.

[3] Macháčková J., Soukup L. (1998): Analýza rizik areálu závodu SAP, s.r.o., Mimoň, KAP s.r.o. Praha.

[4] Macháčková J. [eds.] (2008): Závěrečná zpráva o výsledcích doplňujícího průzkumu saturované zóny kontaminované chlorovanými uhlovodíky v SAP Mimoň s.r.o. DRAFT, Earth Tech, CZ.

[5] U.S. EPA (1986): Addendum to the Health Assessment Document for Tetrachloroethylene (Perchloroethylene). Updated Carcinogenicity Assessment for Tetrachloroethylene (Perchloroethylene, PERC, PCE). Office of Health and Environmental Assessment. Washington DC. EPA/600/8-82/005FA.

[6] U.S. EPA (1988): Health Effects Assessment for Tetrachoroethylene. Environmental Critereia and Assessment Office. Office of Health and Environmental Assessment. Office of Research and Development. Cincinnati, OH. EPA/600/8-89-096.

[7] U.S. EPA (1988): Updated Health Effects Document for Tetrachoroethylene. Environmental Critereia and Assessment Office. Office of Health and Environmental

Assessment. Office of Research and Development. Cincinnati, OH. EPA/600/8-82-005B.

[8] Van der Oost R., Beyer J., Vermeulen Nico P.E. (2003): Fish bioaccumulation and biomarkers in environmental risk assessment: a review. Environmental Toxicolog nad Pharmacology 13, pp 57 – 149.

[9] WHO (1984): Glossary of Terms used in Health for All series. Geneva.

SIMULATION OF VIBRATION EFFECTS ON GROUND PRODUCED BY TECHNOLOGICAL EQUIPMENTS

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ABSTRACT

This paper contains a study regarding the isolation efficiency of technological equipments and improvement of the effects on ground or foundation. Based on the study of vibration transmission from the equipment to ground it can be determine a tendency of various dynamic parameters of the equipment with different modification of structural elements configuration to obtain an appropriate dynamic effect. It also has to take into account the conformity with acceptable vibration levels for vertical displacements. The theoretical suppositions were verified and validated by computer simulation on the numerical model.

Keywords: technological equipment, dynamic effects, vibration isolation, mass geometry optimization.

INTRODUCTION

This paper deals with analysis of the dynamic interaction between technical systems and ground. The optimal reconfiguration of spectral distribution of the natural frequencies area frames the research aim of this study. Functional relationship between essential functional parameters of the technical system related with masses geometry optimization completes and finalizes the analysis objectives panel.

The analysis started from the necessity to improve both the equipments performances, e.g. during the displacement over an irregular ground profile, and the ground dynamics under the vibratory actions, e.g. dynamic effects in bridge piles due to an intensive and various traffic [1].

An appropriate way to evaluate the global dynamics of the interaction between technical system and ground consist by lumped masses model utilization. Because of the reduced number of degree of freedom these models provide the unsophisticated functional relationships set between essential parameters of the system and of the ground. This kind of models also has a main advantage of structural simplicity and do not require powerful computational resources. The results briefly presented in this paper were obtained with the help of one mass and two degrees-of-freedom lumped model [2]. The main investigations were conducted in relation with mass, moment of inertia and global geometry dimensions parameters. Dimensionless ratios between the basic parameters such as stiffness or position of centre of gravity were adopted.

2DoF MODEL BASIC APPROACH

The analysis was developed based on the two degrees-of-freedom lumped model with singular mass and two visco-elastic insulations. The schematic diagram of proposed model is depicted in Figure 1.

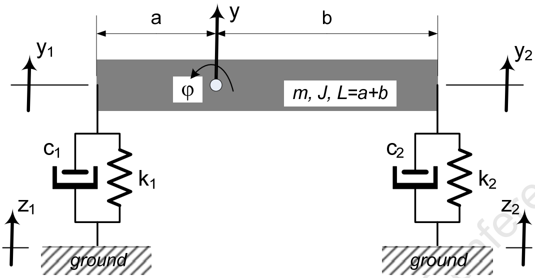


Fig. 1. Schematic diagram of 2DoF model

According with D'Alembert principle related the center of gravity displacements and using the natural coordinates transformations for the model depicted in Fig.1 results the system of dynamic equations of motion as follows [3]

$$\begin{aligned} & m\left[\ddot{y}_2\,\frac{a}{L}+\ddot{y}_1\left(1-\frac{a}{L}\right)\right]+k_1(y_1-z_1)+k_2(y_2-z_2)+c_1(\dot{y}_1-\dot{z}_1)+c_2(\dot{y}_2-\dot{z}_2)=0 \\ & \frac{J}{L}(\ddot{y}_2-\ddot{y}_1)-k_1\,a\,(y_1-z_1)+k_2\,b\,(y_2-z_2)-c_1\,a\,(\dot{y}_1-\dot{z}_1)-c_2\,b\,(\dot{y}_2-\dot{z}_2)=0 \end{aligned} \tag{1}$$

where m denote the system mass, J is the moment of inertia, L is the total length with a, respectively b the two coordinates of center of gravity, k_i and c_i denotes the stiffness, respectively the damping of insulation, $y_i(t)$ are the natural coordinates of system and $z_i(t)$ denotes the ground displacements. Using the following notations

$$\begin{cases} x_1 = y_1 - z_1 \\ x_2 = y_2 - z_2 \end{cases} \Rightarrow \begin{cases} y_1 = x_1 + z_1 \\ y_2 = x_2 + z_2 \end{cases} \tag{2.1}$$

and

$$\begin{cases} a = L\,\eta \\ b = L\,(1-\eta) \end{cases} \tag{2.2}$$

Eqns.(1) becomes

$$\begin{aligned} & m\left[\ddot{x}_2\,\eta+\ddot{x}_1\,(1-\eta)\right]+k_1x_1+k_2x_2+c_1\dot{x}_1+c_2\dot{x}_2=-m\left[\ddot{z}_2\,\eta+\ddot{z}_1\,(1-\eta)\right] \\ & \frac{J}{L}(\ddot{x}_2-\ddot{x}_1)-k_1\,L\,\eta\,x_1+k_2\,L\,(1-\eta)\,x_2-c_1\,L\,\eta\,\dot{x}_1+c_2\,L\,(1-\eta)\,\dot{x}_2=-\frac{J}{L}(\ddot{z}_2-\ddot{z}_1) \end{aligned} \tag{3}$$

Suppose the ground irregularities given in the form of piecewise functions with harmonic evolution in respect with time for a short time period and only for one input.

Hereby the expressions of the input functions are

$$z_1(t) = \begin{cases} A\sin(\omega t) & for \quad 0 \le t \le T \\ 0 & for \quad t > T \end{cases}, \tag{4}$$

$$z_2(t) = 0 . \tag{5}$$

Replacing into Eqns.(3) results

$$\begin{aligned} & m\left[\ddot{x}_2\, \eta + \ddot{x}_1\, (1-\eta)\right] + k_1 x_1 + k_2 x_2 + \cdots \\ & \ldots + c_1 \dot{x}_1 + c_2 \dot{x}_2 = \begin{cases} m\, A\omega^2\, (1-\eta)\sin(\omega t)\; for\; 0 \le t \le T \\ 0\; for\; t > T \end{cases} \\ & \frac{J}{L}(\ddot{x}_2 - \ddot{x}_1) - k_1\, L\, \eta\, x_1 + k_2\, L\, (1-\eta)\, x_2 - \cdots \\ & \ldots - c_1\, L\, \eta\, \dot{x}_1 + c_2\, L\, (1-\eta)\, \dot{x}_2 = \begin{cases} -\dfrac{J}{L} A\omega^2 \sin(\omega t)\; for\; 0 \le t \le T \\ 0\; for\; t > T \end{cases} \end{aligned} . \tag{6}$$

The natural pulsations of undamped model can be evaluated with the homogeneous differential equations system, as follows

$$\begin{aligned} & m\left[\ddot{x}_2\, \eta + \ddot{x}_1\, (1-\eta)\right] + k_1 x_1 + k_2 x_2 = 0 \\ & \frac{J}{L}(\ddot{x}_2 - \ddot{x}_1) - k_1\, L\, \eta\, x_1 + k_2\, L\, (1-\eta)\, x_2 = 0 \end{aligned} . \tag{10}$$

From Eqns.(10) results that differential equations of motion constitute a system with two coupled equations. The system solutions have to be founded in the form of harmonic functions in respect with time. Hereby

$$\begin{aligned} y_1 &= a_1 \sin(\omega_n t + \theta) \\ y_2 &= a_2 \sin(\omega_n t + \theta) \end{aligned} \tag{11}$$

Making derivatives in Eqns.(11), replacing into Eqns.(10) and grouping the terms results an algebraic equations system with two variables a_1 and a_2, as follows

$$\begin{aligned} & a_1\left[k_1 - m\omega_n^2(1-\eta)\right] + a_2\left(k_2 - m\omega_n^2\eta\right) = 0 \\ & -a_1\left(k_1 L\eta - \frac{J}{L}\omega_n^2\right) + a_2\left[k_2 L(1-\eta) - \frac{J}{L}\omega_n^2\right] = 0 \end{aligned} \tag{12}$$

which have the non-zero solutions in case of null determinant ($\Delta_G = 0$)

$$\Delta_G = \begin{vmatrix} k_1 - m\omega_n^2(1-\eta) & k_2 - m\omega_n^2\eta \\ -k_1 L\eta + \dfrac{J}{L}\omega_n^2 & k_2 L(1-\eta) - \dfrac{J}{L}\omega_n^2 \end{vmatrix} . \tag{13}$$

Supposing the stiffness ratio denoted by

$$\alpha = \frac{k_2}{k_1} \tag{14}$$

from Eqn.(13) results the characteristic equation of natural pulsations in respect with (*m, J, L,* η, α, k_1) parameters

$$\omega_n^4 - \frac{k_1 L^2}{J}\left[(\eta-1)^2\alpha + \frac{J}{mL^2}(\alpha+1) + \eta^2\right]\omega_n^2 + \frac{k_1^2 L^2 \alpha}{mJ} = 0\,, \tag{15}$$

ANALYSIS AND OPTIMIZATION OF SYSTEM DYNAMICS

Supposing the symmetry case of the model ($\eta = 0.5$) and taking into account the natural pulsations characteristic equation (15) results the condition for real solutions as follows

$$\Delta = \frac{(\alpha+1)^2\left(4J + mL^2\right)^2 - 64mJL^2\alpha}{16m^2J^2}k_1^2 \geq 0 \tag{16}$$

or

$$\frac{(1+\alpha)^2}{\alpha} \geq \beta \tag{17}$$

with $\beta = \frac{64Jml^2}{\left(4J + ml^2\right)}$ denoting the masses geometry configuration parameter.

According with the aim of this study it is necessary to evaluate the expression of dependences between the geometrical and mass spatial distribution parameters thus that it will be assure the condition (17). The three analysis cases were supplied. These analyses suppose moment of inertia, mass and total length such as independent variables and sequential evaluate the related expression leads to a minimum value for Eqn.(16).

For the first situation related to moment of inertia independent variable results that minimum value of Eqn.(16) will be assured for

$$J\big|_{\Delta\min} = -\frac{mL^2}{4}\frac{\alpha^2 - 6\alpha + 1}{(\alpha+1)^2} \tag{18}$$

which implies that condition (16) will be satisfied for $\alpha = \{0, 1, 1\}$. Note that it was adopted equality condition from Eqn.(16). Taking into account the internal configuration of expression (18) result that $\alpha = 1$ is the unique appropriate solution for Eqn.(16). In this case the squared values of natural pulsation have the singular expression as follows

$$\omega_{n1}^2 = \omega_{n2}^2 = \frac{2k_1}{m} \tag{19}$$

The second situation correspond to mass independent variable. In this case the minimum of Eqn.(16) results for

$$m\big|_{\Delta\min} = -\frac{4J}{L^2}\frac{\alpha^2 - 6\alpha + 1}{(\alpha+1)^2} \tag{20}$$

which leads to the same condition set such as the previous case of analysis.

Also in this case the unique appropriate solution is α = 1 and the squared values of natural pulsation have the singular expression as follows

$$\omega_{n1}^2 = \omega_{n2}^2 = \frac{1}{2}\frac{k_1 L^2}{J} \tag{21}$$

The last case with respect in total length parameter L such as independent variable leads to a set of three possible solutions as follows

$$L\big|_{\Delta \min} \in \left\{0\,,\,2\sqrt{-\frac{J}{m}\frac{\alpha^2-6\alpha+1}{(\alpha+1)^2}}\,,\,-2\sqrt{-\frac{J}{m}\frac{\alpha^2-6\alpha+1}{(\alpha+1)^2}}\right\} \tag{22}$$

Taking into account the realistic character of the parameter L the proper solution is

$$L\big|_{\Delta \min} = 2\sqrt{-\frac{J}{m}\frac{\alpha^2-6\alpha+1}{(\alpha+1)^2}} \tag{23}$$

and the main condition (16) results for an unique solution α = 1. The squared values of natural pulsation with singular expression as follows

$$\omega_{n1}^2 = \omega_{n2}^2 = \frac{2k_1}{m} \tag{24}$$

Selection of the appropriate values of rigidities ratio α was performed based on the analysis of the positive values of the influence term Γ in Eqns.(18,20,23)

$$\Gamma = -\frac{\alpha^2-6\alpha+1}{(\alpha+1)^2} = \left(\alpha-3+2\sqrt{2}\right)\left(\alpha-3-2\sqrt{2}\right) \tag{25}$$

Supposing now the general case related to Eqn.(15) it will be follows the initial aim to reduce the difference between the system natural pulsations.

Hereby the inequality between the squared values of natural pulsations can be evaluated as follows

$$\varepsilon = \omega_{n1}^2 - \omega_{n2}^2 = \sqrt{\left(\frac{k_1 L^2}{J}\left[(\eta-1)^2\alpha + \frac{J}{mL^2}(\alpha+1)+\eta^2\right]\right)^2 - 4\frac{k_1^2 L^2 \alpha}{mJ}} \tag{26}$$

Optimization of the mass geometry configuration with respect in position of the center of gravity $\eta = a/L$ and stiffness ratio α impose an appropriate estimation of basic parameters values. Without any significant diminishing of general character of this analysis it will be consider that the vibratory technical equipment have a mass range between (1000...3000) kg and a base insulation rigidity having k_1 = 10000 N/m.

According the previous hypothesis the diagram in Fig.2 presents the evolution of the natural pulsation difference ε as a function of the relative position η, the rigidity ratio α and three essential values of mass m. The diagrams depicted in Fig. 3, 4 and 5 shows the evolution of the ε parameter according with discrete variation of the optimization parameters. These diagrams dignify the system behaviour into the area of small differences and also reveal possible null values of ε parameter.

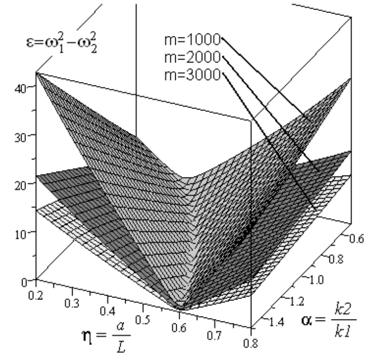


Fig. 2. Evolution of natural pulsation difference in respect with (η, α, m) parameters

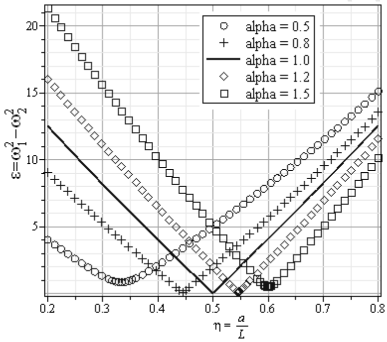
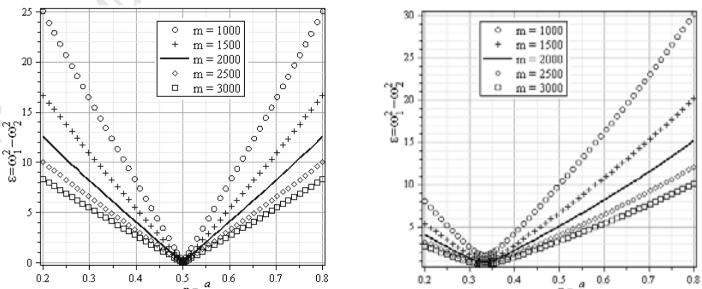
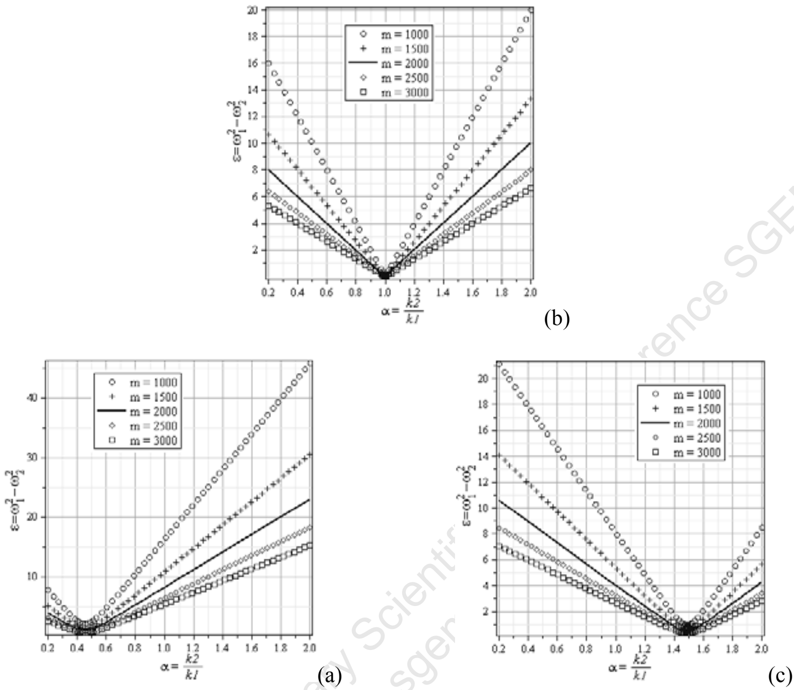


Fig. 3. Evolution of natural pulsation difference in respect with (η, α) for m = 2000



(a) (b)

Fig. 4. Evolution of natural pulsation difference in respect with η and m parameters for (a) α = 1.0 and (b) α = 0.5



(b) (a) (c)

Fig. 5. Evolution of natural pulsation difference in respect with α and m parameters for (a) $\eta = 0.3$, (b) $\eta = 0.5$ and (c) $\eta = 0.6$

DISCUSSIONS

The technical systems working in post-resonance is one of the most wanted desire of mechanical engineers. In case of technical systems with multiple degrees of freedom the area of possible resonances can be very large in some poor cases because of a spectral spilling of natural frequencies.

One of the basic ideas of this study supposes that if cannot shift the natural frequencies to the low values, try to restrain the spectral spilling at least. Hereby it will reduce the width of resonance area.

The entire study follows the hypothesis of best minimizing of the natural pulsations difference ε parameter thus that for a certain reduction of the reference pulsation it will be left-side shifted the entire resonance area. In presented case the rigidity k_1 is the appropriate element to do this intention (through different technical means).

According these hypotheses lets briefly evaluate the presented results. From the diagrams depicted in Figs.(2...5) results that unitary ratio of stiffness and symmetrical center of gravity provides a superposition of both natural pulsations. It also results that greater masses implies reduced values of ε on the entire simulated domain.

The direct linkage between stiffness ratio and relative position of the center of gravity (CG) is mainly sustained by the graphs in Fig.3. It can be observed that in the same time with stiffness ratio α reduction, results also a reduction of the CG relative position η for the minimum value of ε parameter. But the absolute minimum value of ε increases in respect with dispersion of α parameter from unitary value, regardless the dispersion direction. Analysing the (α, η) dependences depicted in Fig.(4...5) intensify the previous observations.

CONCLUSIONS

Major purpose of this study consisted by presentation and validation of some practical possibilities to adjust the specific parameter of a technical system without reducing its main capabilities but helping it to work into the post-resonance area.

Taking into account the previous paragraph remarks it had to be concluded that optimization of spatial configuration of the masses geometry provides a serviceable way to reduce dynamic effects due to the vibratory movements both of the technological equipments and of the ground.

ACKNOWLEDGMENTS

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REFERENCES

[1] Bratu P. Theoretical Mechanics, Impuls House Publishing, Romania, 2008;

[2] Debeleac C. Dynamic Behaviour Analysis of Speedy Frontal Loader on View of Qualities Performances Established, Doctoral Thesis, Dunarea de Jos University of Galati, Romania, 2006;

[3] Nastac S. Computational Engineering with Applications, Impuls House Publishing, Bucharest, Romania, 2004.

SME'S AND SOCIAL RESPONSIBILITY POLICIES IN ROMANIAN BUSSINESS ENVIRONMENT

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ABSTRACT:

By the time runs successful organizations within their economic activity and social responsibility programs at local, regional or national programs helps to increase the profit of their respective owners. A different view is considered rather financial success allows them to get involved in initiatives "generous". In addition to these economic arguments we must consider the moral arguments in favor of social responsibility of firms. Competitiveness in this area is top notch especially for multinational companies aim of occupying key positions or enter new ones. Visibility of companies in the business environment is extremely important, underestimation of their impact, with negative consequences ranging from loss of customers to drive down the darkening business or attract new clients.

Keywords: ***social responsibility, corporate social responsibility, business ethics, healthy environment, best practices***

Corporations relocate production facilities in developing countries in order to reduce costs in the global marketplace, there are sufficient conditions for the exploitation of employees with different cultural profile and divergent moral values. Globalization weakens national governments and increases corporate responsibility in terms of jobs, living standards, environmental protection, respect certain ethical criteria, etc.. New markets sometimes they compete with small companies, according to field of activity concerned can work with multinationals or they can stop work because of strong competition posed by the first. If, for international companies is relatively easy to carry out social responsibility programs, with financial strength and the necessary logistics for SMBs that, at least in the Romanian business environment, this is just the beginning. **[1]** Unfortunately, not all the reasons the actions top managers are even impossible to determine with certainty. On the other hand, all studies conducted so far, it is virtually impossible to know the direct relationship between social responsibility and profitability. Although the accumulated evidence seems to suggest a positive correlation between the two aspects, causality between them remains problematic. Often this decision you manager, of his desire to stand out, to realize an image hit the market, which often occurred in situations where it is not the owner of the company. Advantages they present each of the parts are realized in order to attract customers, loyal and social responsibility is now the brand under which all this activity takes place designed to meet the expectations of all participants of the business.

Empowering business activities is not a novelty: most enterprises, especially small ones, have always been close to communities and sought to be some good "citizens", since the beginning of trade. In fact, many entrepreneurs realize instinctively that "doing the right thing" - to serve customers, take care of the morale and safety of staff, being careful to suppliers, to be fair competition and protect the environment - is key to business success and not in any way but using best practices. These give rise to social problems and therefore have the responsibility to resolve and prevent new problems. Through technological innovation and efficiency, companies can lead to the disappearance of certain occupations and hence the increase in unemployment, labor migration, depopulation of areas affected by a structural recession and overpopulation boom areas, corporations polluting the environment, exploiting non-renewable resources, etc.. It is not morally correct as always others to bear the consequences of these phenomena, from which companies have only gained.

Relationship are forced to develop with members of these communities is a special and absolutely necessary for success. Competition for customers buying up the competition is so tough in the context of globalization that companies, whether small or large they can not afford isolation and failure to achieve an effective feedback to communities in the, social accountability. Inability or lack of political will to assume responsibility generates multiple effects that make the critical situation ethics as a hostile business that be born-typical behaviors, troubling ethical value system. Bureaucracy, corruption, excessive taxation, lack of incentives etc. sectoral policies, Are enemies of free economy. In an effort to survive managers small businesses are forced to abandon specific ethics codes of conduct. The relationship between business ethics and social responsibility is fundamental ethics policy for SMEs in Romania is a major new concept, compatible with standard imported through globalization. Emphasis becoming more the practice of social responsibility in organizations relevant to how they see managers and business transformation, which is also due to rapid changes occurring in the labor force in the evolution of technology, business internationalization the impact of economic factors and social political or economic environment, ongoing development of the private sector to the detriment of the public. Even if the initial phase of introducing the concept of best practices and business ethics, yet not over, however, social responsibility and makes its presence felt in small businesses that show motivation and which are defined by the following characteristics:

1. There is a reasonable balance between the company's revenue and implementation of good business practice in question
2. daily activities of individual members of the organization are based on ethical values
3. A system of providing for penalties and penalty to all actions corecetarea unethical character inrelatia with other market participants
4. Types of standard programs aimed at the development of corporate social responsibility programs fit into that environment and community affairs in general call:

Social responsibility programs requires efforts by all organizations, not only from the marketing department and management. In many organizations today, these activities are conducted (planned, organized, directed and controlled) in the compartment for customer problems. In late 2010 the International Organization for Standardization launched ISO 26000 standard but difficulties application on the Romanian market by companies have imposed a guide able to facilitate the application of ISO Standard 2600 **[2]**. As corporate social responsibility for SMEs is a responsibility and an opportunity, in partnership with Romanian authorities on 14 September 2011 approved the National Strategy for Promotion of Social Responsibility 2011-2016. The document in question has as main objective to promote the involvement of companies, NGOs and public authorities and social responsibility initiatives offer those interested:

• Understand the CRS for small businesses and defining problem areas specifically related to social responsibility
• Identify advantages for loading social responsibility is part of business
• Providing SMEs methodology for understanding and identifying risks clarifacre and CRS integration within the company
• Provides a guide to identify all stakeholders
• Bringing into question models of good practice

Corporate social responsibility is essentially a concept whereby a company voluntarily decides to contribute to a better society and a cleaner environment. Corporate Social Responsibility is achieving commercial success in an ethical manner with respect for people, communities and the environment. This is to respond to the legal, ethical, commercial or otherwise that society has for companies, and make decisions to balance the needs of those who have a role in the life company. In Romania, addressing the social involvement of SMEs refers rather to the scope of this involvement, the phenomenon cuntificarea difficulties against it and spread this kind of behavior, especially among local firms, as well as smaller firms and the local authorities. Romanian market shows a stage of construction, experience in involvement in community businesses. In this early stage, use as a tool to promote business activity by addressing social responsibility of any company regardless of ownership, size or area of its activity would be a way of further development of a climate and a culture of social involvement . However, companies that make use of social's responsibility and have a beneficial impact both on competition, customers and business partners and especially their own employees who are determined to work effectively within the company as long as their moral values are fully satisfied or at least part of management policy. Many of them will be more productive in their work and loyalty to the company in question will be strengthened. Any small business activity denoting a social impact, either by products or services offered or the jobs they provide, or indirectly through their effects on other businesses or social groups. Therefore, these new standards in business ethics and responsibility in SMEs require Sites to align with the responsibility which rests the impact, whether positive, negative or neutral. With a much closer relationship with most communities in which they operate small and medium enterprises can make use of their flexibility to initiate and carry out the social responsibility programs in sensitive areas such communities as follows**[3]**.:

• social assistance programs
• Support programs for environment protection
• Sponsorships
• Helping humanitarian foundations and business specific events
• Funding of specific projects or research
• Support for disadvantaged persons, humanitarian causes
• Funding of educational programs in specific areas and geographically disadvantaged

For those managers who, in most cases and business owners are concerned the profits made by initiating social responsibility programs is defined by recognizing merit, reputation and gratitude to those who have benefited from social responsibility projects. With the spreading economic crisis most top managers were in favor pronntat resettlement areas of interest of corporate social responsibility and this is especially true at small and sema medium. Even if climate change, environmental protection and pollution remain top concerns for workers rights and the human rights are known well in advance. Study BSR / GlobeScan State of Sustainable Bussiness Poll.a was performed in 29-September-11 October 2010 on a representative sample of 377 professionals worldwide representing 60% of BSR member companies and organizations (business of a better world), one of most prodigious social responsibility associations of firms**[4]**. Top-managers have the power to direct the economic strategy of an organization and tone of moral. They have a great responsibility to use this power judiciously depending on the resources they have available, they can and must become as models of ethical behavior for the entire organization. Not only through their daily behavior that must be the embodiment of high ethical principles and communication across the organization by similar expectations of employees, and by encouraging positive results. At the community level effects of these social responsibility initiatives are as follows clasificate in:

• Positioning the company in high gear in the business
• retention as high a percentage of target audience to the services, products and possible future intentions of that company
• conviction of the good intentions of other road company
• Maximizing business relationships with business customers other partners, suppliers, local authorities, etc.)
• Motivating employees through their actions that their ethical and moral perceptions agree
• Increased intake company visibility and build excellence in business
• Increased business standards and use best practices in relationships with all partners

Moreover, the model developed by the European Foundation for Quality Management, in order to quantify performance indicators to measure quality in the organization identified that corporate social responsibility requires accounting for 6% of all the factors that demonstrate the business success of a company while that financial performance is only 15% and business development strategies only 7% of total. Although these percentages may seem less can make the difference between a successful company and a major difficulties. Rather than depend exclusively on their shareholders that managers undertake small and medium business companies is based on the contribution of large and varied socio-professional groups (such as employees, consumers, shall supply ¬ dawn, local communities - in a word stakeholders), having therefore, the duty to take into account the interests of these groups. Small size of SMEs makes men vulnerable to any requirement, standard or expectations of those participating and therefore are forced to pay them more attention than large multinational companies, however, develop strategy of marketing costs in the social responsability.

Given these economic and moral arguments in favor of ownership by corporate social responsibility, it is assumed that theoretical reasoning is practicing social responsibility as may be necessary in the XXI century, and only in individual cases it is not absolute into account taken yet and that is only because of management. In practice the difficulty and costs of these decisions leads managers to delay as much can such initiatives especially as there is enough amount that can be held responsible by the shareholders or to hold corporations accountable for their behavior ethically questionable. As such, Carroll and Buchholtz offers the following definition: "Corporate social responsibility includes what society expects from an organization of economic, legal, ethical and philanthropic in some time" **[5]**. According to the authors in question there are four types of responsibilities of companies, namely economic, legal, ethical and philanthropic arranged pyramid. Ethics and social responsibility is a sensitive subject, not only in developed countries the economic European Union. The two concepts have emerged and gained substantial overseas in the U.S. in mid-twentieth century. Europeans later adopted the principles of market economy and EU today constitutes an economic model with its inherent difficulties related to the sovereign debt and the possible slippage of the euro area. Even so, this social responsibility in any underestimation of the 27 Member States can help delay or repair of economic disparities is to reduce economic growth of Member States affecting local and transnational economic actors through loss of customers, reduce operational and business volume difficulties in attracting new customers.

The consequences are implied for business reduced profitability, reduced growth prospects, a significant decrease in market value of the company. Any business participants, as social actors has its own system of beliefs and values that reflect the social environment and cultural background, as a result of adaptation to the problems and difficulties in the external environment and the integration of religious norms. Responsibility of social actors stems power relations between them and the existing institutional environment, especially its structure and function. Freedom of decision is the essential component of morality and of ethical, more relevant than any other criterion. For this reason we anticipate that the current economic and political system with free market offers the possibility for conflicts of interest between social actors in a more fair than an undemocratic system. If Maslow's theory of small enterprise model is justified in a much more pronounced than the multinationals.

Thus they are seen favorably in some social responsibility initiatives**[6]** (equivalent to the needs of self) are satisfied when the first three levels of needs, namely: survival needs (rationality of economic activity), security needs (obtaining competitive advantages), needs membership (participation in trade unions to employers). Social responsibility can be identified and as a logical consequence of the obligation arising from increased power (importance) of a firm social and correlation of this growth with social responsibility can lead eventually to the loss of the relevant economic and social contributors hence the company's decline.

REFERENCES:

[1] Mihaela Vlăsceanu. Social Economy and Antrepenoriat, Polirom, Iasi, 2010, pp15-70
[2] Imandi Eugenia & Irina Radu Filip. Ethics and Corporate social responsability in international affairs, House, Bucharest, 2008, pp 48-96
[3] Monica Heinz. The Rumanians of today's work ethic, Old Court House, Bucharest, 2005, pp 20-60
[4] Imandi Eugenia& Irina Radu Filip. Ethics and Corporate social responsability in international affairs, House, Bucharest, 2008, pp109-154
[5] Dan Christmas & Vasile Morar & Vasile Macoviciuc. Business Ethics, Paideia, Bucharest, 2006, 150-189

[6]] Friedman, Milton Friedman & Rose. Free to choose. A personal view, All, Bucharest, 1998, pp 23-46

SOIL BIOENGINEERING AS A TOOL FOR THE REDEVELOPMENT OF DISUSED QUARRIES WITH THE AIM OF IMPROVING ENVIRONMENTAL PROTECTION

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ABSTRACT

Quarrying activity is a key component of the Gross Domestic Product of industrialized economies and is closely related to several industrial sectors. However, the cessation of industrial production creates a need for redevelopment of the altered areas in order to counteract both irreversible environmental damage and visual changes affecting the natural landscape.

The effects of soil bioengineering techniques on the redevelopment of disused quarries and their effectiveness in enhancing erosion control and slope stabilization are analyzed, showing on the one hand their variability in association with parameters such as latitude, climate, and so on, and on the other hand their positive influence on the environment.

The purpose of this study is to investigate the current state of soil bioengineering strategies, focusing on how their development could be affected by geographical conditions. For this reason, the current state of the art has been examined in two different European contexts. Austria, in the central European region, and then Spain, in the Euro-Mediterranean Region, have been taken into consideration. Some indicators have also been introduced in order to compare the usefulness of soil bioengineering techniques in these regions with the current situation in Italy.

In light of the above, the valuable impact of soil bioengineering on the environment has been highlighted, and conclusive recommendations include the integration of soil bioengineering techniques with projects for the redevelopment of altered and degraded areas .

Keywords: quarry, restoration, soil bioengineering, degraded areas, environmental protection

INTRODUCTION

Quarrying activity and the need for restoration of disused quarries

Quarrying activity is an economic sector that plays a role of strategic importance in the global economy. Various productive sectors such as the construction, chemical, automotive and aerospace industries, etc., depend on it. Mining activity is also a crucial source of employment: in 2005 it was determined that within the European Union, the industries depending on it are worth 1,300 billion euros and have provided employment for about 30 million people [1].

The availability of quarrying products is vital, as they are used not only in the construction and rehabilitation of all built-up environments, but also in the naturalization of altered or degraded ecosystems and in activities related to environmental protection. Nevertheless, the extraction of building materials usually leaves behind large pits and degraded areas. For this reason, at the end of the life cycle of quarries, issues like site restoration arise as a result of the cessation of industrial production. Indeed, there are several ways to restore disused quarries, and the most suitable one should be chosen. It is also better to select possible methods before both industrial and extractive activity take place, in other words within a long-term management program of the quarry.

Among the various techniques available for proper restoration of a quarry, there are those referring to *soil bioengineering* [2], [3], [4], also known as *ecological engineering* [5], [6] or *biotechnical engineering* [7]. This subject has been defined as the use of natural materials such as living plants (cuttings, roots and stems), usually in combination with other materials (straw, wood, gabions, biomats, geotextiles, etc.), in order to create a slope protection system capable of protecting soil from erosion and preventing slopes from failing [8]. Bioengineering techniques could lead to significant advantages compared with hard-armouring conventional methods to contrast soil erosion, such as surface armouring, concrete retaining walls, precast concrete blocks, rock buttresses or soil embankments. Actually, the extensive use of living plants combined with other materials makes bioengineering a well-balanced solution for the restoration of a quarry. It is a particularly ecologically-oriented solution, since it makes use of renewable materials without involving any other environmental damage, such as the use of natural minerals taken from another quarry. Moreover, these techniques usually require minimum maintenance and prove to be less expensive than traditional methods [7], [9]. The costs of soil bioengineering techniques could also be lower than those of either comparative vegetative treatments or structural solutions alone [10]. The use of indigenous materials makes these techniques more advantageous, because plant costs are limited to manual labour and costs for transporting them to the site. Nevertheless, the labour involved in these interventions can make them more expensive in countries where labour costs are high.

Soil Bioengineering: Historical aspects and current applications

The first case of using living plants in slope stabilization can be traced back to ancient times in China [11], [12], [13]. Numerous bibliographic sources describe early examples of bioengineering throughout the world: in China, willow bundles were used in the 1st century BC in order to protect the banks of the Yellow River, whereas in Europe the Romans used faggots to build structures to control water erosion [4], [14]. Although natural methods to control soil erosion had already appeared, in the United States actual soil bioengineering practices date back to the 1920s and '30s [4], [12]. In Europe, they have been used since the sixteenth century [13] in Austria, Germany, Italy and Switzerland by forestry technicians in order to protect forests in the Alps. Afterwards, given the rising issues of slope erosion, landslide and avalanche hazards and serious stream bank degradation in those areas, bioengineering techniques were used more and more frequently to reduce erosion [15]. These practices tended to be used less frequently during the Industrial Revolution [16] and after World War II [12], but since the 1980’s soil bioengineering has once again increased with Schiechtl’s presentation of the works of many European soil bioengineers [2], making them popular within the European context [17].

As far as soil bioengineering applications are concerned, they initially included issues like soil protection (erosion control, slope and streambank stabilization). Later, they started to be used for harmonizing infrastructure with the landscape (road and railway embankments, pipelines), for coastal consolidation and for the restoration of degraded areas such as quarries or dumps. Another implementation of soil bioengineering is in reconstruction after catastrophic events, such as landslides, flooding and earthquakes. The effects of natural disasters can be worsened by incorrect use of the territory. However, by means of soil bioengineering methods (e.g: preventative and emergency protection of the soil, regeneration of the habitat, landslide prevention measures, vegetative and soil treatment measures), hydro-geological risk in soil exposed to disasters could be mitigated [16]. Further examples are related to soil bioengineering projects in urban areas, different in approach from those in rural areas. The successful restoration of three streambanks located in Atlanta, U.S.A., is one example [12].

MATERIALS AND METHODS

Literature is mainly focused on the techniques and applications of soil bioengineering. Yet, little research has been done on evaluatiing soil bioengineering methods depending on the availability of water and light for the the growth of vegetation, that is, geographical and climatic conditions. The latter play an important role in landscape morphology, since soil types vary depending on climatic zones. Thus activities developed in a specific area, such as soil bioengineering, may also be subject to variations.

Geographical and climatic data on a central European state (Austria) and a southern European state (Spain) are compared with the current situation in Italy in Table 1.

Table 1: Geographic and climatic variables reported for Austria, Italy and Spain

(sources: European Climate Assessment & Dataset, European Commission, FAO Statistics Database, World Meteorological Organization).

GEOGRAPHIC VARIABLES	**Austria**	**Italy**	**Spain**
Latitude		*Range*	
Range – North (°)	47° 20' N	47° 50' N	43° 47' N
Range – South (°)	46° 22' N	36° 40' N	36° N
Land use			
Country area (km^2)	83,879	301,340	505,370
Total land area (km^2)	82,435	294,140	498,800
Agricultural area (km^2)	31,680	139,080	276,800
Forest area (km^2)	38,820	90,710	179,973
Other land (km^2)	11,935	64,350	42,027
Inland water (km^2)	1,444	7,210	6,570
Percentage of country area covered by agricultural area (%)	38	46	55

Percentage of country area covered by forest area (%)	46	30	36
Percentage of country area covered by other land (%)	14	21	8
Percentage of country area covered by inland water (%)	2	2	1
Mountainous areas			
Mountain area (area of mountain municipalities) (km^2)	61,510	180,780	281,610
Altitude index (mountain area as percentage of total country area) (%)	73	60	56
CLIMATIC VARIABLES	**Austria**	**Italy**	**Spain**
Temperature		*Annual Average*	
Mean daily minimum temperature TN (°C)	2.91	10.41	9.90
Mean daily maximum temperature TX (°C)	10.88	19.05	19.46
Mean diurnal temperature range DTR (°C)	7.97	8.64	9.56
Sunshine		*Annual Average*	
Sunshine duration (hours)	1739.23	2266.17	2517.12
Drought		*Annual Average*	
6 months Standardized Precipitation Index – SPI	-0.13	0.34	0.17
Precipitation		*Annual Average*	
Precipitation sum RR (mm)	1013.51	658.98	651.20
Wet days (RR>=1mm) RR1 (days)	128.58	74.81	95.87
Simple daily intensity index SDII (mm/wet day)	2.73	1.77	1.75
Heat		*Annual Average*	
Warm spell duration index WSDI (number of days)	6.46	5.71	5.79
Maximum value of daily minimum temperature TNx (°C)	16.85	23.59	19.94
Maximum value of daily maximum temperature TXx (°C)	28.68	35.51	36.05
Cold		*Annual Average*	
Cold spell duration index CSDI (number of days)	5.80	5.42	4.88
Minimum value of daily minimum temperature TNn (°C)	-17.46	-4.94	-3.53
Minimum value of daily maximum temperature TXn (°C)	-10.04	2.15	3.73

In Table 2, data on mining and quarrying activity for each of the three countries are listed.

Table 2: Data on mining and quarrying activity

(source: Eurostat Structural Business Statistics).

Mining and quarrying statistics, 2008	**Austria**	**Italy**	**Spain**
Number of enterprises	350	3,220	2,693
Number of local units	665	4,115	3,098
Total land area (km^2)	82,435	294,140	498,800
Soil Consumption Index for mining and quarrying (ratio of total land area to number of local units)	124	71	161

As regards legislation on soil bioengineering, these techniques were developed recently, spontaneously and without previous planning, by forestry technicians and expert bioengineers. For this reason, legislation on this topic came years after the spontaneous appearance of several associations of bioengineers in various European countries. Although since 1948, central Europe had had several experiences in this field and Austria was one of the first countries to adopt these techniques, the "Österreichischer Ingenieurbiologischer Verein" in Vienna was founded quite recently (1997) [18]. The "Federacion de ingenieria del paisaje", was founded in Spain in 1994. In 1998, the first contract specifications on this topic were adopted, whereas in 2001 the Basque country published the first handbook on streambank stabilization by means of bioengineering, called "Ingenieria Naturalistica" [18]. In Italy, the "Associazione Italiana per la Ingegneria Naturalistica" was founded in 1989. Starting in 1990, the first contract specifications were adopted by several regions and provinces, and at the same time legislation started to mention soil bioengineering practices [18].

DISCUSSION AND CONCLUSIONS

From the data above, the following general features may be highlighted:

- Latitude exerts a dominant effect on all climatic parameters. For instance, temperature range increases with distance from the equator. Italy is influenced by extremely variable conditions across more than 10 degrees of latitude, between the Alps and the Mediterranean Sea. The shape of this country, extending far more in the north-south than in the east-west direction, makes its climatic conditions highly dependent on the relatively short distance from the sea. This especially influences the length of arid and cold seasons, expressed by the 6-SPI Index, which indeed is higher for Italy with respect to the other two countries.
- Altitude makes temperatures decrease with height, since air is less dense and cannot easily hold heat. Therefore, Austria is the country most affected by this phenomenon, presenting an altitude index of 73%, as compared to Italy (60%) and Spain (56%).
- Human activity can also affect climate, in particular through different land uses. First, centuries in which trees were cut down resulted in a reduction in forest area, with an increase in the amount of carbon dioxide in the atmosphere. Although Italy and Spain's forested areas are territorially larger than Austria's, in proportion to their total area, the former countries show a much lower percentage of it. Secondly, Italy has the highest percentage of total area covered by other types of land, comprising urban areas. These zones are affected by the urban heat-island phenomenon, bringing about a hotter microclimate (estimated at between about 0.5 and 3°C) within urban areas than in surrounding peripheral and rural zones. This is mainly due to over-cementation, an increase in asphalt surfaces, vehicle emissions, industrial plants and conditioning systems.

Moreover, each country presents differences in mean daily temperature of about 9◦C, and this high variation may result in stress on vegetation.

Austria has a continental climate. It has the highest values of precipitation and the lowest values of drought, positive conditions for vegetation growth. On the other hand, high indexes for cold and a low value for sunshine duration could be severely critical for soil bioengineering practices. However, bioengineering could prove an efficient technique, especially in the restoration of quarries and natural rocky slopes, in Austrian territory as well [19].

Spain contains various climatic zones, depending on its latitudinal extension, on its proximity to both the Atlantic Ocean and the Mediterranean Sea and also on its longitudinal extension, leading to an internal continental climate. The northwest and the north are characterized by moderate temperature and abundant precipitation, the south and east coasts present a typical Mediterranean climate with mild moist winters and hot dry summers, whereas the interior features a continental climate with cold winters and hot, dry summers.

Italian climatic conditions are principally influenced by a few factors, which are the presence of the Mediterranean Sea, its latitudinal extension and, on the other hand, its complex orographic structure, characterized by the presence of the Alps and the Apennines. As a result, meteorology ranges from typical Mediterranean conditions, with long, hot summers and mild winters, to a temperate climate, which can be warm or cool according to latitude, altitude and distance from the sea.

With respect to mining and quarrying, an index for soil consumption after these activities was calculated for each country as the ratio of total land area to the number of local units. . It means that in Italy there is a local unit out of 71 km^2, whereas in Austria one out of 124 km^2 and in Spain one out of 161 km^2. Therefore, Italy is proportionally the country with the largest number of mining units per km^2, and in the near future this will lead to an urgent need for restoration of degraded areas.

Some of the limitations of soil bioengineering are related to their difficult implementation in the Mediterranean Basin. As a matter of fact, the Mediterranean climate is often affected by desertification, whereas the mountainous areas of central Europe take advantage of the higher humidity of a forest climate. Consequently, for the two Mediterranean countries considered, drought is pointed out as a critical issue, since it could cause an inadequate water supply for soil. Indeed, the amount of water contained in soil influences root distribution and the way plants are fixed to the soil, leading to possible unsuccessful restoration using soil bioengineering techniques.

Nevertheless, bioengineering can be a useful way to cope with the desertification hazard in Mediterranean areas, as was shown in the protected area of Vesuvius National Park [20]. Before this case, bioengineering techniques had already been applied in Southern Italy, but they had always been carried out close to water basins. The activity in Vesuvius National Park pointed out that in this environment, the planting of native shrubs with moderate water requirements is objectively preferable, since living plants have to face the following issues:

- a special soil moisture regime: total humidity is limited and at its maximum in the coldest season, while the warm season, in which vegetation usually grows, is characterized by drought. Mediterranean vegetation developed a series of biological adaptations to cope with this, such as spinosity.
- vegetative dormancy, usually during autumn and early winter, is shorter than that in Alpine regions. Consequently, the period of vegetative reproduction is shorter as well. In addition, cuttings from these species are normally collected in this period, and this could lead to the limited availability of cuttings and native plants.

In conclusion, bioengineering techniques constitute an efficient method for the restoration of degraded areas such as quarries. Within the Mediterranean Basin, the vulnerability of vegetation to arid and semi-arid climates could be a weakness. In Italy, despite the possible negative influence of drought, the great geomorphologic and climatic variety can become a positive factor, as it allows the application of almost all soil bioengineering techniques recongized at the European level.

For this reason, on the local level, regions should adopt planning guidelines and criteria for the restoration of quarries, fostering the application of soil bioengineering practices. Whereas many Italian regions have specific guidelines on bioengineering intervention, yet more can be done in order to include these techniques in quarry management, in other words integrating soil bioengineering practices into the drafting process of mining plans. In particular, plans in the quarry sector should implement excavation procedures after which the ground and slopes could be modelled according to the future anchorage and development of plants to be used in the restoration process. In this way, a better result could be obtained when applying soil bioengineering techniques.

ACKNOWLEDGMENT

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REFERENCES

[1] European Commission (DGEnterprise). 2008b: The raw materials initiative - Meeting our critical needs for growth and jobs in Europe. Communication of the Commission (COM699), 2008.

[2] Schiechtl H. M. Bioengineering for Land Reclamation and Conservation. University of Alberta Press, Edmonton, Canada, 1980.

[3] Stiles R. Engineering with vegetation. Landscape Design vol. 172, pp 57–61, 1988.

[4] Lewis L., Hagen S., and Salisbury S. Soil Bioengineering for Upland Slope Stabilization - Research Report , Research Project WA-RD 491.1, Soil Bioengineering for Slopes, 2001.

[5] Bergen S.D., Bolton S.M., Fridley J.L. Design principles for ecological engineering, Ecological Engineering, vol. 18, pp 201–210, 2001.

[6] Gattie D.K., McCutcheon S.C., Smith M.C. Ecological engineering: the state-of-the-field, Ecological Engineering, vol. 20, pp 327–330, 2003.

[7] Li M.H. & Eddleman K.E. Biotechnical engineering as an alternative to traditional engineering methods, A biotechnical streambank stabilization design approach, Landscape and Urban Planning, vol. 60, pp 225–242, 2002.

[8] Schiechtl H. M. Vegetative and soil treatment measures, FAO watershed management field, 1985.

[9] Mitsch W. J., Lefeuvre J.C., Bouchard V. Ecological engineering applied to river and wetland restoration. Ecological Engineering, vol. 18, pp 529–541, 2002.

[10] United States Department of Agriculture (USDA) Natural Resource Conservation Service. Chapter 18, Soil Bioengineering for Upland Slope Protection and Erosion Reduction, Engineering Field Handbook, 1992.

[11] Riley A. L. Restoring streams in cities: A guide for planners, policymakers and citizens, Island Press, Washington D.C., 1998.

[12] Simon K. & Steinemann A. Soil bioengineering: challenges for planning and engineering, Journal of Urban Planning and Development, vol. 126, issue 2, 2000.

[13] Ying W., Jiarong G., Lan G., Bintian Q. Slope Protection Effect Contrastive Studies on Soil Bioengineering Measures for Natural Stream Bank and Artificial Slope, 2011 International Conference on Asia Agriculture and Animal IPCBEE, Singapoore, vol.13, 2011 IACSIT Press.

[14] Evette A., Labonne S., Rey F., Liebault F., Jancke O., Girel J. History of Bioengineering Techniques for Erosion Control in Rivers in Western Europe, Environmental Management, vol. 43, pp 972–984, 2009.

[15] Hall M. Earth repair, a transatlantic history of environmental restoration. University of Virginia Press, Charlottesville and London, 2005.

[16] Petrone A. & Preti F. Soil bioengineering for risk mitigation and environmental restoration in a humid tropical area, Hydrology and Earth System Sciences, vol. 14, pp 239–250, 2010.

[17] Li X., Zhang L., Zhang Z. Soil bioengineering and the ecological restoration of riverbanks at the Airport Town, Shanghai, China , Ecological Engineering, vol. 26, pp 304–314, 2006.

[18] Associazione Italiana Per la Ingegneria Naturalistica (AIPIN). Cronistoria dell'ingegneria naturalistica, in Manuale di Ingegneria Naturalistica applicabile ai settori delle strade, cave, discariche e coste sabbiose, a cura di: Regione Lazio, Italy, 2003.

[19] Beikircher B., Florineth F., Stefan M. Restoration of rocky slopes based on planted gabions and use of drought-preconditioned woody species , Ecological Engineering, vol. 36, pp 421–426, 2010.

[20] Bifulco C. Interventi di ingegneria naturalistica nel Parco nazionale del Vesuvio, Parco nazionale del Vesuvio, Italy, 2001.

SOLUTIONS FOR ENSURE FISH MIGRATION ON THE CRISUL REPEDE RIVER. CASE STUDY – THE TILEAGD AND LUGASU DAMS

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ABSTRACT

This paper proposes concrete solutions both to fish migration on the Crisul Repede River review and an analysis of the feasibility of these solutions in the context of specific problems.
Also, the paper present the case study realised for the Tileagd and Lugasu dams, located in falls on the Crisul Repede River, part of the Crisul Repede Aval hydro energetic development, having a particularly important role for defence against flooding of settlements located downstream (Oradea municipality, industrial and social objectives, agricultural areas).
These two reservoirs represent a single water body - LW 3.1.44_B5. It does not corresponds to good ecological status, and are part of the Site of Community Importance (SCI) for the protection of habitats and species ROSCI0050 Crisul Repede upstream Oradea.
The proposed solutions to ensure the fish migration upstream and downstream analysed dams (Tileagd and Lugasu dams) presents a major ecological advantage, helping to the restoration of longitudinal connectivity of the studded reach of Crisul Repede River.
The total length of reconnected habitat will be about 25 km, on the studded reach, such fits within the ranges set by the ICPDR on the length of reconnected habitats on the tributaries.

Keywords: longitudinal connectivity, fish migration, dams, fishpass, ecosystem, water course.

INTRODUCTION

Specialists have been concerned about this issue lately and, thus they manage to provide solutions for fish migration. Removal, reduction of barriers or their arrangement to ensure fish migration is an important element for good management of migratory fish species in rivers. Most of countries worldwide have already provided laws in order to ensure free fish migration requiring the existence of passages for migrating fish, regardless of obstacles.
In Romania, the need for lateral and longitudinal connectivity of watercourses and hence the issue regarding the fish migration have been established by implementation of the Water Framework Directive (WFD) 60/2000 into the national legislation regarded as "Law for Water Protection" and represent a hydro-morphological quality element necessary in elaborating Projects for Management of River Basins. It was also taken into consideration the need to protect fish populations by ecological and economical concrete measures according to the European Council Directive (78/659/EEC). Also, topicality is confirmed by Ministerial Order 1163/2007, which highlights that such works of damming water courses higher than 40 cm will be provided with fishways for migratory aquatic fauna, unless where there is no feasible technical solution or the proposed solution is disproportionate in terms of costs.

This paper continues the series of research upon the longitudinal connectivity of a river in The National Institute of Hydrology and Water Management (INHGA) since 2009 and is part of a broader study on the fish migration in the reservoirs of dams with heights between 15-50 m, that meets the WFD implementation 60/2000/CE and helps improve the environmental status of heavily modified water bodies.

This paper is to propose technical solutions in order to ensure upstream fish migration in the reservoirs with dams of 15-50 m height and to analyze the possibility of their completion in the context of specific problems of Romania.

Thus, there were two dams selected (Tileagd and Lugasu) located on the Crisul Repede River, in the north-west of Romania as case studies for applying some longitudinal connectivity recovery solutions and facilitating fish migration upstream and downstream.

DATA USED

When carrying out the work, some bibliographic data on international experience in building procedures has been used to facilitate the aquatic fauna migration on the watercourses provided with dams of 15-50 m height; therefore there have already been processed data on dams and reservoirs in Romania and further information from The Romanian Register of Large Dams, The Cadastral Atlas of Waters in Romania, INHGA and GIS database, CORINE database, information from Romanian Waters National Administration (RWNA) and Basin Water Administrations (BWA) and other public information posted on the web sites of the RWNA, ICPDR, Ministry of Environment and other specialized institutions.

STUDY AREA

Tileagd and Lugasu Dams are located on Crişul Repede River at an average altitude of 230 m and were executed on a winding section, meander with a very large floodplain (Figure 1).

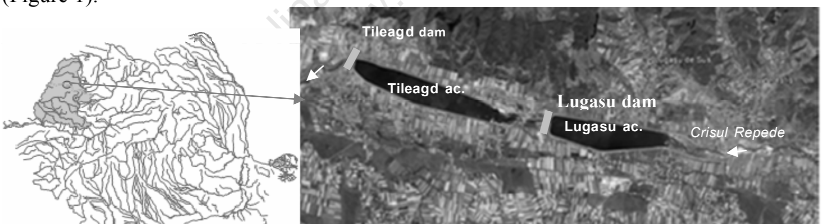

Figure 1. Location of examined dams

The two storage lakes Tileagd (L_{lake} = 7.5 km, S_{lake} = 503.41 ha at the NRN = 195.0 MDM) and Lugasu (L_{lake} = 6.8 km, S_{lake} = 538.0 ha at the NRN = 220.0 MDM) [8] are interconnected and have been enclosed in a single water body that has not a good ecological status. The designated water body does not meet the assessment criteria of hydro-morphological pressures with a 100% degree of safety – changing the category from river to lake and reservoir with complex uses – according to the Basin Management Plan. Tileagd and Lugasu reservoirs are *sites of community importance* for the protection of habitats and species *ROSCI0050 Crişul Repede upstream Oradea* where there are following protected fish species: Danube gudgeon (*Gobio* *uranoscopus*), Mediterranean barbel or Southern barbel (*Barbus meridionalis*), bullhead (*Cottus gobio*) and bitterling (*Rhodeus sericeus amarus*).

Tileagd Dam is a spillway type dam, by 37.5 m height, located in the village of Tileagd in Bihor County and it was put into operation in 1988 (Figure 2). The dam lake has a volume of 52.94 mil.m^3 beeing used for electricity generation, flood protection and water supply. Afluent flow in the Tileagd accumulation (at the mean flows) is between 6 cbm/s and 90 cbm/s and minimum downstream flow is of 1 cbm/s .

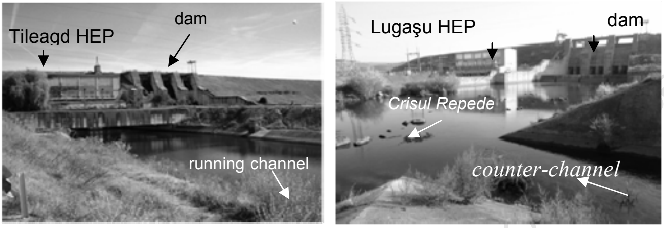

Figura 2. Tileagd (left) and Lugaşu (right) dams

Lugasu Dam has a height of 37.5 m and provides water accumulation in the lake of 63.47 million cubic meters [8] and was put into operation in 1989 (Figure 2). The dam lake is used for providing electricity, flood protection and water supply. Downstream the Lugasu Dam is ensured only the returned flow (1cbm / s). The total afluent volume water in the Lugasu reservoir is of 567.36 million cubic meters and the total deffluent volume is of 560.17 million cubic meters [8].
On the outer part of the contour dams, when speaking about Lugasu and Tileagd accumulations, at downstream leg, there are counter-channels to collect rainwater and water infiltrated through dams.
These channels have a slope of 1:2 and continue upstream up to the end of the dykes. Downstream the Tileagd and Lugaşu dams dams these are connected to Crişul Repede River bed (Figure 3). Crişul Repede River slope on the Lugasu Lake area is of 3.42 ‰.

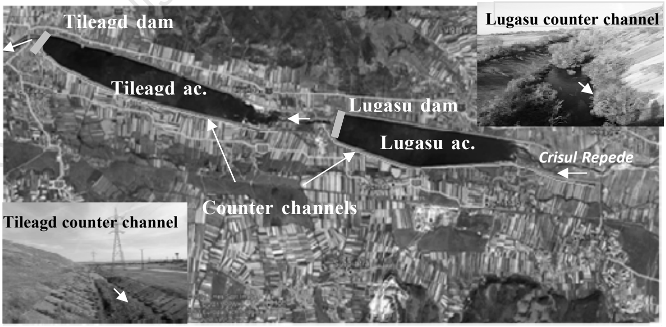

Figure 3. Location scheme of counter-channels on the left bank of Crisul Repede River

According to the fish zoning of rivers in Romania, defined by Acad. Bănărescu, Lugasu and Tileagd dams are located in the c*ommon nase's zone* – characteristic to hills area of the large rivers, the river bed is generally rocky, sometimes graveled and with sandy,

clay or muddy sections [2]. Migratory fish species characteristic for the area are: common nase (*Chondrostoma nasus*), vimba bream or zarte (*Vimba vimba*) and burbot (*Lota Lota*).
After monitoring the present ichthyofauna, in the two sections of monitoring – upstream Aleşd and upstream Oradea – there were reported these migratory fish species characteristic for neighboring areas such as: barbel (*Barbus Barbus*), Danube gudgeon (*Gobio uranoscopus*), carp (*Cyprinus carpio*) and bream (*Abramis brama*) [5].

SOLUTIONS TO ENSURE FISH MIGRATION

After viewing the sites of the two dams and reservoirs, the field situation analysis and the discussions with experts from the BWA Crişuri in order to propose solutions to ensure the fish migration upstream and downstream of the Tileagd and Lugasu dams, have been chosen the counter-channels located on the left bank of the Crişul Repede river (Figure 3).
When choosing the mentioned counter-channels as *a solution to ensure the fish migration*, the following criteria were taken into account:

- a water flow of more than 80% of their length;
- a small number of obstacles that require further development;
- presence of left tributary streams of Crişul Repede River – Mnierea and Valea Rece – bringing an amount of water into the counter-channel near the Lugasu accumulation.

The diagram of Figure 4 presents, the step by step, localized the proposed solutions to facilitate the fish migration, following the direction of fish migration and the entire route of the counter-channels and encountered obstacles.

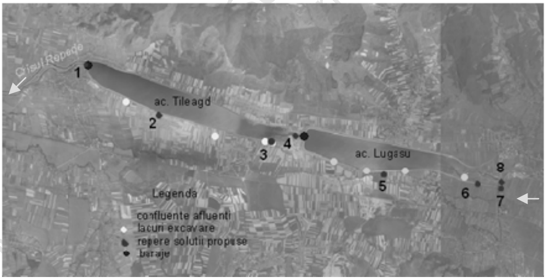

Figure 4. The diagram of the obstacles route along the counter-channel on the left bank

Step 1. *The first obstacle* that needs improvement is *the output sill of counter channel* located on the left bank of Crisuul Repede River, *downstream Tileagd accumulation* (Figure 5).

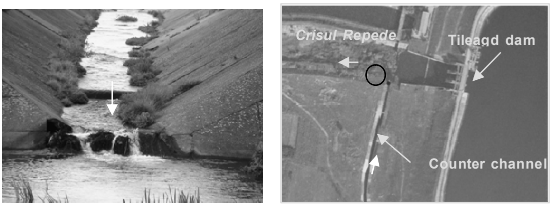

Figure 5. The output sill of counter-channel downstream of the Tileagd dam

For restoring the longitudinal connectivity, *both interconnected discharge sills of 25 cm height as well as fish ramp, made of rocks can be used as solutions to facilitate fish migration* in the output sill area of the counter channel. Also, to facilitate fish migration upstream or up to mentioned sill (in the output sill area of the counter channel) is proposed to built a poll of raising the water level with underwater window for fish access, so that the created remuneration pool creating by poll of raising the water level to allow fish to pass these sill (Figure 6).

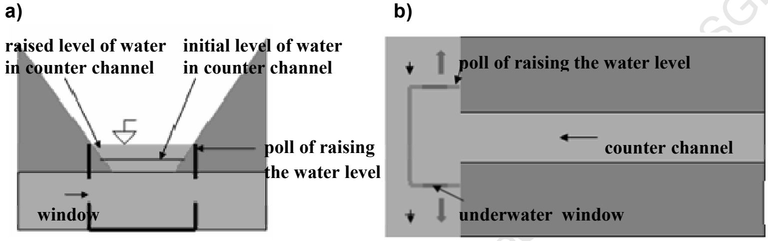

Figure 6. Sill planning scheme a) cross section, b) longitudinal section

Step 2 provides an *ecotechnical arrangement of the counter channel next the Tileag accumulation.* Since there is no possibility of un-concreting the counter channel which is clogged and full of vegetation, sometimes forming true damp woods, it will be ecotechnically arranged.

Increased abundance of vegetation will be removed partially, providing easy meanders for the resting areas necessary for migratory fish and facilitating fish migration. Willows, alders, shrubs, etc.. will be planted on the left side of counter channel in order to provide shade in summer when high temperatures are registered.

Step 3 refers to the *connection between the un-concreted end of the counter channel on the Tileagd accumulation with the Crisul Repede river bed*, downstream from the Lugasu dam through a *bypass having a length of approx. 500 m*. The bypass will provide the required flow for fish migration and will be provided with a resting pool where fish can interrupt their movement and can recover (Figure 7, red line). Average slope of the land, at the Lugasu accumulation, is of 3.48 and the average altitude is of 230 m.

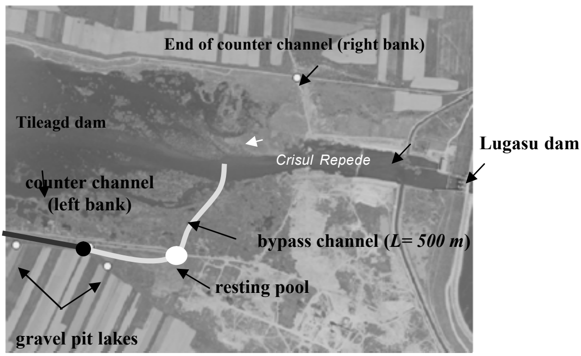

Figure 7. Scheme of bypass channel location on the Tileagd Lake

The necessary flow for planning the bypass channel for fish migration is to be assured through Crisul Repede River and the pools of water resulting from mining works of the ballast, after checking water quality. The piezometric level of groundwater in the bypass channel location is about. 0.6 m.

Step 4 involves planning another obstacle in the direction of fish migration, upstream and downstream, represented by an *output sill on the concrete counter channel, downstream from the Lugasu dam* (left bank of Crisul Repede river) (Figure 8).

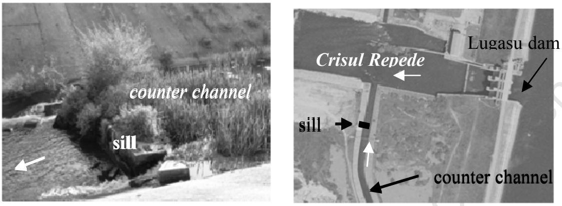

Figure 8. Location of a sill on the counter channel of Lugasu accumulation, downstream from the Lugasu dam (Picture Source: E. Luca)

For restoring the longitudinal connectivity in the sill area, located approx. 80 m upstream of the counter channel mouth two methods can be used: interconnecting sills, wood or concrete steps, along the entire channel downstream from the sill, so that the sill height to be lowered and the fish could migrate upstream.

Step 5 refers to the *ecotechnical arrangement of the Lugaşu counter channel next to the Lugaşu accumulation* see the counter channel next to the Tileagd accumulation.

The arrangement will create *an easy meandering on the counter channel, providing resting areas both for migratory fish and aquatic fauna.*

Step 6 requires the connection between the counter channel from the Lugasu reservoir and Râciu riverbed (left tributary stream of Crisu Repede river) by using a bypass channel with a length of approx. 100 m; see the pattern for Tileagd dam. On the banks of the trapezoidal canal, almost like a natural bed, various species of plants present in the area will be planted to reduce erosion. In order to provide the access to the dam, on the left bank of Lugasu accumulation, a walking board will be provided where the dam is crossed by the bypass channel (Figure 9).

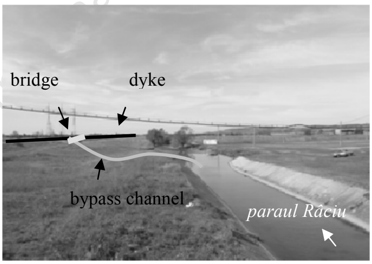

Figure 10. Scheme for bypass channel location connecting the Lugasu counter channel with Râciu creek (Lugasu Lake tail)

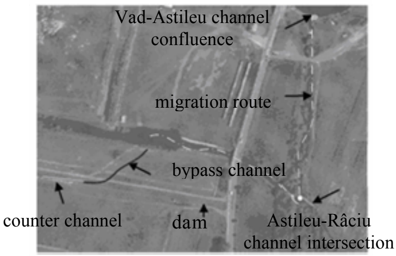

Figure 11. Scheme of bypass channel location and the fish migration route

Bypass channel slope for migrating fish should be of 1:20 as the one for the counter channel area in the contact area and the capacity should not exceed 2 m / s (for targeted fish species). Required flow for bypass channel in order to provide fish migration is assured by Râciu Creek and the pools of water resulting from mining works of the ballast, after checking water quality. The piezometric level of groundwater in the bypass channel location is about 1 m.

Next, the fish migration route will be: *the concrete bed of Râciu creek – Vad-Astileu sluice* up to its connection with Crisul Repede River (Figure 11).

The place where Vad-Astileu channel crosses the Râciu creek has an interesting hydraulic cross-type work where the Râciu bed is covered with concrete on a surface of approx. 200 m (Figure 12).

The two confluences: Râciu Creek – Vad-Astileu channel and Vad-Astileu channel – Crisul Repede bed, four sills with heights greater than 40 cm are provided, presenting a barrier to fish migration and requiring development in order to facilitate access fish fauna upstream (figure 13).

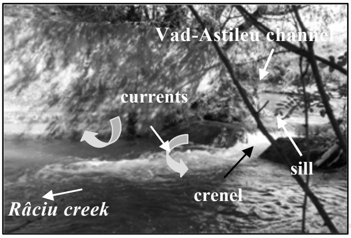

Figure 12. Vad-Astileu channel confluence with the Râciu Creek

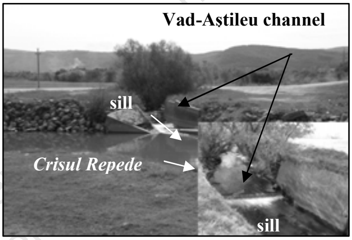

Figure 13. Sill on the Râciu Creek and Crisul Repede confluence

Steps 7 and 8 aim the development of four sills with heights greater than 40 cm, located on the migration route – *the concrete bed of Râciu Creek – Vad-Astileu bypass – Crisul Repede bed*. On this line, in order to provide such a sills, *a half tubular passing system* crossing the sills is suggested (Figure 14).

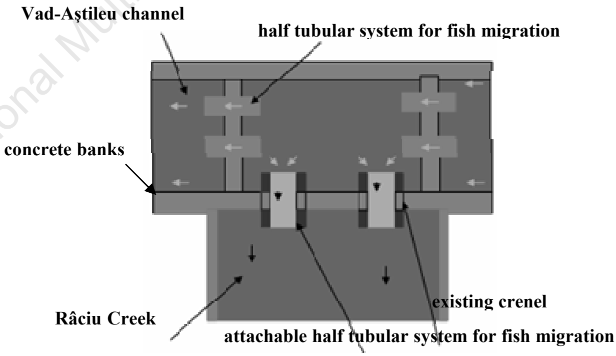

Figure 1. Scheme for sill planning at the confluence between Vad-Astileu channel and Râciu Creek

The *half tubular passing system* (*gutter type*) for fish migration will be inclined, transversally built into the existing gutters and sills, located below water level, at about 80%. This system will have the role to reduce water speed (changing hydraulic flow regime), thus facilitating fish movement through them and protecting the fish from strong currents formed where Râciu creek and Vad-Astileu bypass channel meet.

By performing all operations regarding the counter channels, sills and bypasses arrangements proposed, the aquatic fauna migration over a distance of at least 15 km (length of Tileagd-Lugasu water body) is ensured, the total length of the reconnected habitat being about 25 km *upstream Ineu sill* (h = 3m) – *downstream Aleşd sill channel* (h = 2 m) *section. The total length of the reconnected habitat will be about 25 km on the reach upstream Ineu sill - downstream Aleşd sill. channel section* and will be part of *the quality category of 20-50 km of reconnected habitat*, determined by the ICPDR for the interior rivers.

CONCLUSIONS

The technical solutions proposed for Lugasu and Tileagd dams, both for arrangement of counter channels and sills, and the bypass channel making the connection between the counter channels and the Crisul Repede River, does not require special technical knowledge and engineering, making them feasible from this point of view. The solutions are neither radical nor invasive preserving the property owned by Hidroelectrica SA (dams, counter channels, concrete channels, sills).

The cost of execution for each project is low, except for bypass channel connecting the Tileagd Lake tail (500 m), which may increase due to the price of land and the bypass channel situated at the Lugasu Lake tail (100 m), requiring the construction of a walking board, but which cannot affect their building financially.

Ensure the flow for the entire arrangement regarding the fish migration corridor does not present any problems as the counter channels are provided with a flow of 2 m / s on 80% of their length, the 20%remaining will be provided from Crisul Repede River or pools of water resulting from mining works of the ballast.

The application of these solutions presents a major environmental benefit helping to restore longitudinal connectivity of the river, facilitating migration of fish fauna, improving biodiversity and aquatic habitats, creating new habitats and protecting some fish species, invertebrates and birds of European interest ROSCI0050 *Crisul Repede upstream of Oradea.*

REFERENCES

[1] Animal Encyclopedia from Romania (systematic, biology, morphology, ecology, habitat). *www.animalia.go.ro*

[2] Banarescu, P. Fauna of P.R. R.. Academy Edition, Bucharest ,1964. (in Romanian).

[3] Cozari, T., Usatyi, M., Vladimiroff, M. Animal World of Moldova. Stiinta Edition, Chisinau, 2003. (in Romanian).

[4] Ecohydrology studies, support for achieving the environmental objectives stipulated in Water Framework Directive. Study realised by NIHWM, Bucharest, Romania, 2009. (in Romanian).

[5] Fish monitoring data for the period 2007-2010. WBA, Oradea.

[6] Fish passes – Design, dimensions and monitoring, Rome, 2002. www.fao.org

[7] National Institute of Hydrology and Water Management, Dates from NF of Hydrology.

[8] Operating Regulation for Tileagd and Lugasu dams, 2007 (in Romanian).

SOLUTIONS TO IDENTIFY ENVIRONMENTAL RISKS POSED BY MUNICIPAL LANDFILLS AN AMOUNT OF POSSIBILITIES FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

At the exploitation of every landfill risks can appear, risks that ignored can lead to accidents. Based on this information we can identify the dangerous points in land exploitation that can lead to accidents and we can propose strategies to approach the problems according to European legislation. The purpose of these actions is to prevent damages for our health and for our environment. The paper aims to identify the impact of a landfill over the environment, through a succinct evaluation involving the environment factors and the community. A few calculation relations are presented to appreciate the risk for communities at a general level, but also to estimate the risks for the landfill in particular.

Keywords: landfill, waste management, environment protection.

INTRODUCTION

According to the law and European experience in the field of waste management, wastes can be reused by the generator, can be treated and recycled or they can be transferred to a treatment plant (to reduce the hazard) or to an incinerator (volume reduction). Unrecoverable wastes are stored at the final stage. Each stage of waste management may present a potential risk to the environment, because different methods of management involve the release of pollutants into the environment.

Unconformable landfills have a negative impact on the environment because they are a source of soil pollution, basements, surface and groundwater in the area where they are located, may carry pathogens into water or air and also the emissions of CO_2 and other harmful air pollutants.

All these negative consequences of improper operation of a landfill affect mainly people with social impact and impact on their health.

Social impact is reflected in the soaring costs of waste disposal unit, mainly due to their quantitative growth, the depletion of existing facilities and difficulties in finding new storage space.

The impact on human health is manifested in epidemic (infectious diseases) that can be caused and by life expectancy at birth in more serious cases.

The concept of sustainable development is very important in this context that supports economic, social development, and environmental conservation, the only solution for improving quality of life.

1. Evaluation of environmental risk factors

For assessing the risk that a landfill it carries over the environment will be taken into consideration risk mitigation measures, and measures being taken to lower their effects. The risk is estimated by mathematical methods or by simulation, using technical information, and other information available considering several scenarios.

For the human community risk assessment requires a good knowledge of extreme natural phenomena (storms, floods, droughts, landslides), called hazards by geographers, but vulnerability it should be studied also knowing that the main way to reduce a risk is prevention [2].

Hazard is a natural or anthropogenic phenomenon that could occur in a certain period, with negative consequences for human society, due to exceeding of certain thresholds of society adaptation. Production of hazards requires the presence of human society [2].

Vulnerability expresses human exposure and its property to the hazards of different sizes. More specifically highlighted the damage is a phenomenon on a scale of 0 to 1, with one expressing the total destruction of property and total loss of human life from the affected area.

Risk is defined as the probability of human exposure and his possessions to the action of a particular hazard.

Risk (R) can be expressed mathematically by the product of hazard (H) risk factors (E) and vulnerability (V) as follows:

$$R = H \times E \times V \quad (1)$$

Using this relation we can calculate various damages caused by natural and technological phenomena.

For municipal landfills the risks on environmental factors and human communities are:

- environmental pollution: soil, surface and groundwater;
- affecting human health, flora, fauna by harmful emissions (dioxins) and solid particles;
- auto-ignition and gas emissions from fermentation processes inside landfill perimeters;
- pollution with volatile odorants.

Therefore the risk assessment for a landfill should answer the following questions:

- can it function safety after closure, without affecting the health and cause major accidents?

- how will affect the location and landfill closure the surrounding territories and their development potential?
- is there enough energy or other resources that the landfill will require?
- what human resources will require and the social impact will have over the community?
- what is the damage caused to the national values (forests, tourist areas, historical or cultural)?

The questions above derived from the concept of sustainable development, taking into consideration the three basic approaches to this: economic, social and environmental.

The Economic approach refers to the maximum income flow that can be maintained by keeping the reserve values that caused the benefit.

Socio-economic approach promotes equity in the same generation (poverty alleviation) and between generations (ensuring the rights of future generations).

Ecological approach of sustainable development promotes biological and physical stability of ecosystems.

“Sustainable Development warns us that we live in a finite world with limited food resources and energy, subordinated to environmental issues "[1].

In case of landfills risk is found in the form of annual probable gas emissions leaching or infiltration or human accidents due to unforeseen events [2]. The literature shows as calculation alternative the following formula for quantifying environmental risk:

$$R = F \times C \qquad (2)$$

Where: R – risk, losses, degradation;
F - frequency, the probability of exceeding MAC / year;
C – consequence, gravity, the average loss/event.

To apply the above relation an analysis is required that includes:

- Identification of risk - experience is decisive, a good knowledge of processes in order to determine the source of pollution and potential accidents phenomena;
- frequency estimation of accident situations - based on similar situations;
- determinate medium consequences for an event - provides an overview and creates possible scenarios and new plans for unexpected events.

No matter how safe it would seem - at first - organization - operating a municipal landfill and the operating regulations, can appear causes at all levels of decision and execution that lead to the same conclusion - the accident.

A scheme of causes that can lead to accidents could be presented in Figure no.1

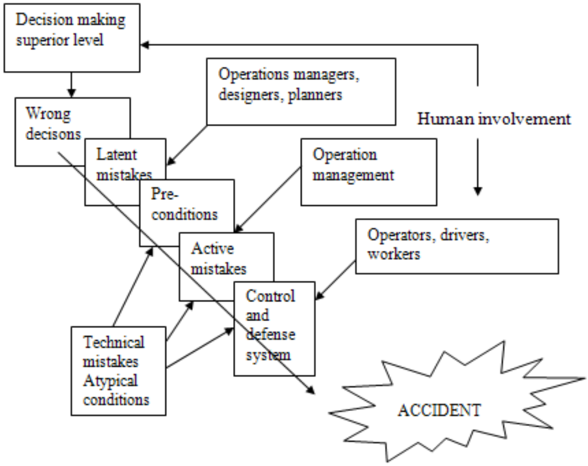

Fig. no 1 Windows at different decision levels leading to the occurrence of an accident [2]

2. Identification of dangerous operation points in landfill exploitation

There are a number of weaknesses points inside a landfill that can cause problems in the proper operation of the landfill and trigger points can turn into accidents. In these points the risk exhibit increased probability of occurrence.

The main charges that the deposit components and its interior materials have to deal with (Fig. no. 2) are:

- precipitation (rain, snow,);
- weight of compaction vehicles, and other means used to close the ramp;
- the weight of the waste;
- sliding slope trends;
- hydrodynamic and hydrostatic loads from water infiltration and leaching;
- heat transfer;
- upward movement of biogas which can cause deformations: tension of slip, shear stress, subsidence, contraction - expansion, moisture variations, which materials in their composition must face a long time.

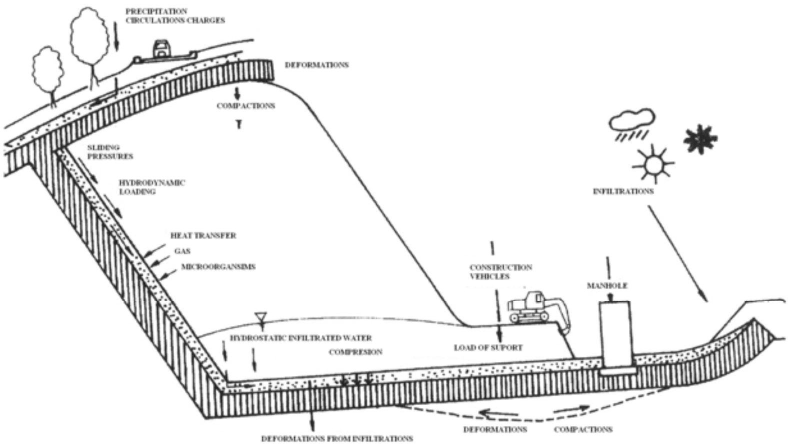

Fig. no. 2 Critical loads and deformations produced on the landfill body [3]

Improper or incomplete demands approach, the use of inappropriate materials in landfills execution, feasibility studies prepared incorrectly, local interests technically inadequately supported can lead to unequivocal accidents and hence environmental pollution difficult and costly to repair or irreversible.

3. Strategies proposed taking into account the national situation

National Report on Status of Environment has identified about 900,000 ha of heavy metals (Cu, Pb, Zn, Cd) and sulfur dioxide contaminated soil as examples Zlatna, Baia Mare, Copsa Mica. Among these areas are territories excessively polluted up to about 200,000 ha. Other 50,000 ha are polluted with oil and salt water from oil exploitation. All these data come from a soil monitoring program conducted in 1992 and 1997 because currently there is no description of soils contaminated areas in Romania.

Proposed actions and strategies are similar for both landfill areas and for other areas that have as consequence soil and groundwater pollution with dangerous waste materials. All actions will have the purpose to prevent and eliminate existing damage for the environment. These objectives are also set in the environmental legislation in Romania. An important objective derived from the concept of sustainable development is to avoid the formation of new areas with contaminated soil and protecting water and soil for future generations.

Strategies proposed for areas with contaminated soil management involve the following main aspects:

- approaching a policy of management for historical landfills by identification, remediation and strengthening the institutional system in order to prevent soil contamination from uncontrolled landfills in the past;

- establishing responsibilities for storage operators, landowners, and local authorities for the historical polluted area, to do the evaluation and adoption of appropriate remedial measures;
- implementation of a database at the county level and then national for the contaminated areas;
- establish procedures for identifying data, investigation, remediation;
- identify priorities for starting a cleaning program areas where they will begin work to reduce risk exposure;
- enforcement of pollution control and waste disposal to prevent the occurrence of other contaminated areas;
- implement cost effective measures to prevent exposure such as enclosure, panel indicators and scale restrictions on land use;

Proposed management actions aimed at inactive areas, contaminated areas to reduce/eliminate environmental risk. Strategies include actions on short, medium and long term, as they emerge from the Regional Waste Management Plan 2006-2013 [1].

5.Conclusions

Romania's accession to the EU must solve problems of water supply, sewage, and landfills. It is very important how to approach these problems created by waste pollution.

Identified the following measures can be an answer to today's problems

- civic awareness and education programs;
- sorting, presorting and processing of the wastes;
- technical funding and means to enable the design, construction and operation of clean landfills;
- programs to enable an effective management.

All these measures can be addressed in the context of current European legislation.

REFERENCES

[1] Environment and Water Management Ministry Regional Waste Management Plan 2006-2013, Romania.

[2] Ozun A. “Hazard and risk elements in polluting industries” Accent Publishing House, Timişoara, Romania, 2000;

[3] Wehry A., Orlescu M. “Recycling and waste management” Mirton Publishing House, Timişoara Romania, 2000;

SPACE EFFICIENCY IN BUILDING DESIGN

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ABSTRACT

The purpose of a good design is to identify the aspects that contribute to obtaining the most functional aspects from a given space. The aspects of space efficient design are: -the reduction of exceeding space -evaluating the necessary functions destined for the building -a study of the spatial form in order not to create any unnecessary spaces -evaluating the construction methods that facilitate a certain type of openings -providing a flexible design -providing a balanced proportion between the used area and the built area This article explores the possibilities to design efficiently so that building and maintenance costs will be lower.

Keywords: space efficiency,modular design, flexible design

The premises of a space efficient design:

The purpose of this paper is to raise awareness about the importance of space efficiency taking into account the housing affordability crisis. The necessity for modular and space efficient building usually appears as a consequence of economical and demographical problems, as a necessity to accommodate a large number of people and also in order to create a healthy living environment for the latter.

Space efficiency can be reached by the collaboration of design communities (engineers and architects)that are willing to experiment and design modular homes in order to create affordable & environmentally friendly homes. Further on this paper takes into account the possibilities for the implementation of modular and prefabricated constructions. Instead of practising a formalist design, architects all over the world struggle with new issues such as: low costs, using recyclable materials, saving energy through design, in one word, building green.

The concept of modular construction is already widespread throughout Europe. In the United Kingdom, 90% of single family residences are using modular structures. Still, in many countries from Eastern Europe the idea of modular construction is being rejected because of its communist reminiscence. Because in all communist countries many blocks of flats have been built (especially in the 80's and 90') out of prefabricated panels creating grey suburban areas, people have the tendency to mentally reject the idea of modular buildings for living.

On the other hand, after the fall of communism, a new phenomenon of compensation emerged, that of each individual building according to his own will and personality, trying to show off through the architecture of the building.

This paper analyzes the benefits of space efficiency and modular building in order to go back to the principles of prefabricated modules of living, in addition taking into account the premises of comfort.
A very good example of prefabricated building is Alvar Aalto's concept of standardization. In 1920-1930, Alvar Aalto designed a few prototypes of modular buildings, both functional ,comfortable and affordable. Later on he started a project for standard houses destined to shelter workers of the Ahlstrom factory, Varkaus. The Varkaus housing were part of the standard house factories . A module contained a living room, a kitchen and two bedrooms. These houses served Aalto as inspiration for a housing system he called “AA”, analyzing different spacial conformations of a home. In his article : “Post war reconstruction, rehousing research in Finland , which he published in 1940 in New Your, he presented a programme with a good explanation:The city he proposed was a synthesis of the wooden houses of Varkaus, the terraced houses of Kauttua, the ROT houses of Sulina.
He also defines the concept of “elastic standardization”. Which implies taking into account elements like the orientation of the site, the shape of the landscape, the toxicity factor.[1]

We also can relate to Le Corbusier' s theories, which later materialized into functional buildings. Corbusier promoted the theory of mass productions as a way to solve the post-war crisis and as a way to build efficiently. This is how the concept of “machine a habiter “ emerged. Corbusier visualized the house as a machine to live in and presented the relation between man and his house as being oriented on functional design. This is how the house serves the owner's needs. Starting from this theory he would promote an architectural approach as efficient as a factory assembly line**.**
Nowadays we are facing a similar crisis because of the economic, demographic and environmental crisis we're in right now. It is estimated that in 2050 the number of people on the planet will be 40% more than in 2011. Also it is estimated that by 2060 some of the earth's resources (like petroleum and natural gases) will decrease by 50% if exploitation goes on in this rhythm.

Factors like calamities, demographic growth, economical crisis and environmental issues (energy resource crisis) all lead to an approach in building design similar to that of Le Corbusier 's , with the mention that we have to take into account new issues**,** like low costs, a quick on site building of the structure and also preventing a energy resource crisis. Space efficiency is determined by the space that can be modified without spending too much money when the functional requirements change.

The constructed space has to last in time and to maintain its features
There are different ways to obtain a space efficient design.

An important step is choosing the location.
Another is to choose a good design layout.

An efficient building should use the site efficiently.

Thus a building has to have a correct ratio between the constructed area and the construction's footprint on the ground. This ratio results according to the local urbanism , but the purpose is to use as much of the area as possible.
If the site is not entirely occupied it is best to think of a future development of the building in such a way as to finally make use of the site.
It is also important to take into account site orientation, sunlight and on-site vegetation.
Plants can protect against dust, powerful sunlight or noise.
A green roof for example can protect against extreme temperatures and in this way it can reduce construction costs.

Space efficiency is obtained through a good architectural design

In order to obtain a space efficient building we have to search ways to eliminate exceeding space. The calculation of the necessary functions destined for the building is recommended and a study of the spatial requirements of the module has to be done. It is important to avoid exceeding space by:

Avoiding corners & avoiding irregular building shapes[fig.1]

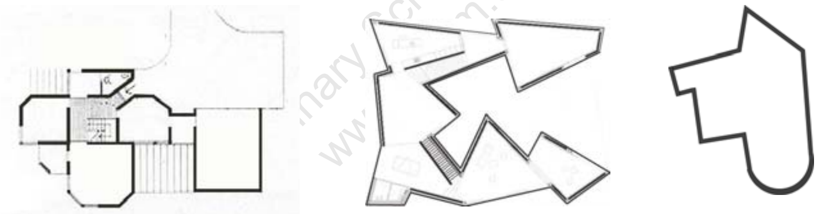

Fig.1.

Avoiding attics and complex roofing [fig.2]

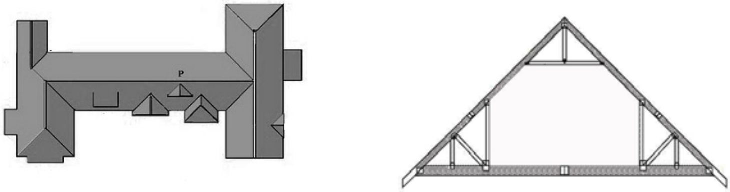

Fig2.

Evaluating the construction methods that are optimal for an efficient design means using slender structural elements, designing an open space, designing a flexible space, having different furnishing possibilities and finding a balance between used area and constructed area.

Obtaining space efficient interior design

An efficient interior design has to be in such a manner as to offer the possibility of performing different activities in the same space taking into consideration economical factors.

The purpose of space efficiency

The purpose of this research is to identify the aspects of design that contribute to space efficiency. One of the main benefits consists in reducing maintenance costs. By this meaning both construction and building costs.[2]
In order to design such a building, the architect has to take into account the following:

- the minimum space that is necessary for a good creative and working environment
- the minimum space that is required for day-to-day activities
- the minimum space that is necessary for a good creative and working environment
- using space in question in connection with the time spent using it (calculating the percentage of hours it is being used is required)

The structural possibilities of modular design:

An efficient design can be done by using container modules in different positions in a order to obtain different spacial structures. From a structural point of view, there are three main structural possibilities:

-using a single modular unit
-using modular units placed one on top of the other
-using modular units placed in a spatial structure

Using a single modular unit:

A single container unit is used usually in the case of low-cost vacation homes. It can also be a solution in cases of emergency situations when the temporary constructions are placed on site separately. In the following figure it is shown how a shipping container of (2,40x5,90x2,35m) can be used as single independent unit for living.[Fig.3]

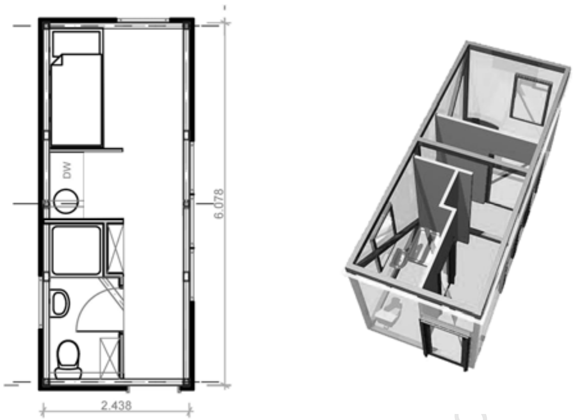

Fig 3.A modular housing prototype

Using modular units placed one on top of the other:

The structural approach in the case of placing the containers one on top of the other can be approached in two different manners:
Container modules in a centric position(as shown in [fig.4])

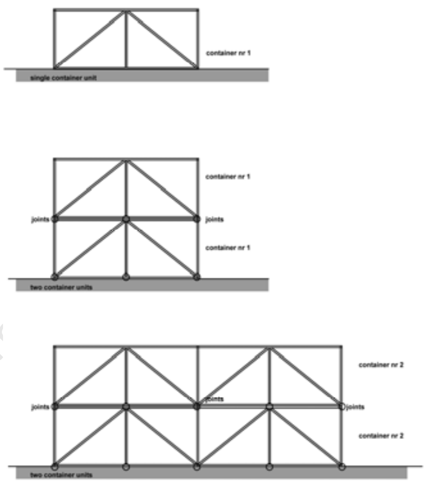

Fig 4.

Container modules in an eccentric position(shown in [fig5])

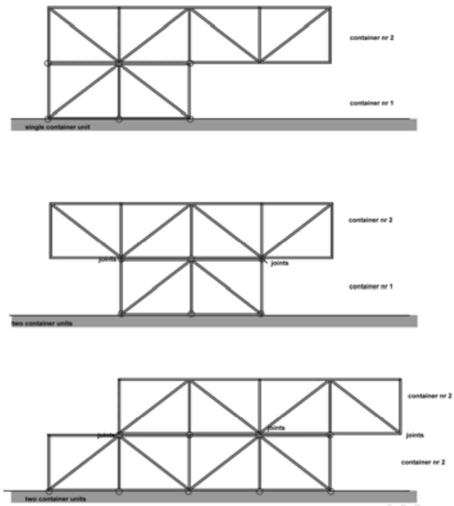

Fig.5

The positions of the containers (the centric and the eccentric) differ from a structural point of view, the eccentric positions being more vulnerable to wind , earthquakes and other construction loads.

Using modular units placed in a spatial structure:

A good example of a construction made of container modules in a spatial structure was designed by by Antal Zoltan and Lazar Casba.[3] The two students made a proposition for a Collective Housing in Cluj, Romania and received a prize at the "Dare " competition in Iasi in 2011. This is a sign that the concept of modular buildings is already embraced by the young architects in Romania, even though it has been rejected by the previous generations of architects.[fig.6]

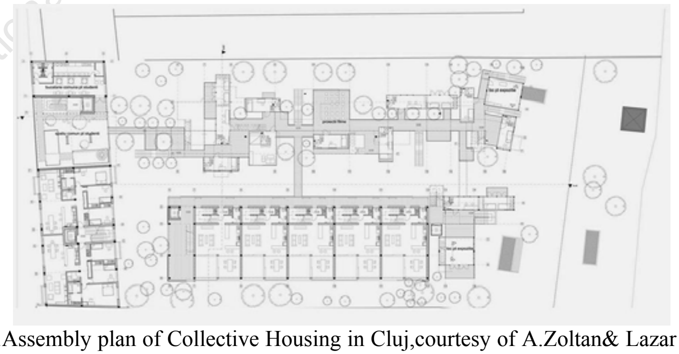

Fig 6.Assembly plan of Collective Housing in Cluj,courtesy of A.Zoltan& Lazar Casba

In their article "Modular design for high-rise buildings", RM Lawson and J Richard make a structural analysis in the case of a steel framework with modular units.
In order to design a modular structure for high-rise buildings, a new series of tests had to be performed.
The material used for a single unit is usually light-gauge steel. On the other hand, for the buildings which are taller than eight stories a more robust primary structure is recommended. According to RM Lawson, the strategies employed to ensure adequate stability of modular assemblies, as a function of the building light, are:

a) diaphragm action of board or bracing within the walls of the modules (suitable for a six-story building)
b) separate braced structure using hot-rolled steel members located in the lifts and stair area
c) reinforced concrete or steel-plated core (suitable for taller buildings)

It is also recommended that in more complex structures the corners of the modules should be tied together structurally in order to transfer wind loads and not get damaged.
All in all, from the structural point of view steel structures are recommended to be used in modular buildings.[4]

Steel structures are the most appropriate structures for creating a flexible space because of the large spans between the studs, and also because steel structures appear to be light, open, airy and adaptable. Steel structures can also accommodate larger construction tolerances.

Fig 7.Module with corner and intermediate posts supported by a structural frame,courtesy of Yorkon and Jule engineers.

The workshop facilities associated with modular construction aren't too complicated. Steel structures require simple construction techniques without heavy equipment. Members can be densely packed for transport and can be cut to length on site. This study mainly concerns modular prefabricated buildings, because of their economical benefits. The purpose is to study the advantages of modular buildings in terms of space efficiency, sustainability but also in terms of factory production and labour costs.

REFERENCES

[1] Iulius Cristea ,Industrialization of housing in Finland, “Ion Mincu” University of Architecture and Urbanism,Bucharest,May 2006,page 18-19

[2] Space Management Group, chairman:David Chiddick, Promoting space efficiency in building design, UK Higher Education Space Management Project, March 2006,pages 9-12

[3] stud. arh. Antal Zoltán – Lázár Csaba Collective housing in Cluj, Arhitext; nr 5(219) /september-october 2011/ISSN 1224-886 X,page nr 36

[4] R.M. Lawson, R.G. Oden - Modular design for high-rise buildings ,Proceedings of the Institution of Civil Engineers Structures and Buildings 163,June 2010 Issue SB3,Pages 151–164,doi: 10.1680/stbu.2010.163.3.151,Paper 800013

SPATIO- TEMPORAL ANALYSIS OF ROMANIA'S RURAL POPULATION ACCESS TO SANITATION SERVICES IN THE CONTEXT OF EU ACCESSION

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ABSTRACT

This paper analysis the disparities between Romanian Counties regarding the spatio-temporal evolution of rural population acces to sanitation services for pre-accession period (2003-2006) and the first two years since Romania is part of the EU-27 (2007-2008) highlighting positive or negative changes occurred in this period.Romanian counties were mapped and divided into five typological classes,using multivariate analysis such as hierarchical cluster analysis method.Each class has different values of rural population served by waste collection services related to the Romania average (expressed in standard deviations).Limited access to sanitation services from rural areas lead to uncontrolled waste disposal.Despite improvement of public access to sanitation services in rural areas compared to 2003 most of population still lack access to waste collection services in 2008.In this context, implementation of the acquis communautaire on municipal waste management is difficult to achieve in rural territory.

Keywords: spatial analysis,sanitation services,rural territory,waste management

INTRODUCTION

The waste management problem has a complex spatial pattern of waste arisings[1]. These flows should be analyzed taking into account the peculiarities of territory concerned [2].First of all,full coverage of urban and rural population to sanitation services is a basic condition for a proper waste management system.Partial access of population to waste collection services lead to illegal dumping of uncollected waste [3].Waste collectors had to change their patterns of behaviour and their way of thinking, but they were institutionally locked in the existing routines[4].The development of these services is very slow in Romania particularly in rural territory,considering the fact that Romania was obliged up to July 16, 2009 to close all rural dumpsites and to provide full collection of waste generated[5].This paper highlights the disparities between Romanian counties regarding the spatio-temporal evolution of rural population access to sanitation services from 2003 to 2008 reflecting the poor solid waste management systems from rural territory.

EU acquis compliance imposes the improvement of sanitation services in urban and rural territory and local authorities are resposable to provide these services for their community.Private sector involvement and cooperation between local authorities can provide viable solutions for waste management issues from rural areas [6].

METHODS

Statistical data regarding the access of the rural population to waste collection services were processed by hierarchical cluster analysis method resulting a map that divided Romanian counties in 5 classes with various evolution than Romanian average,these values being expressed in standard deviations and arithmetic average (chart).Data was provided by the 8 Regional Environmental Protection Agencies for all 41 counties. Also,paper performs a comparative analysis between 2003 (first year for which data are available at county level) and 2008,concerning the share of rural population without access to sanitation services.Thematic maps show the percentage (%) and absolute values (number of people) necessary for a proper interpretation due to demographic differentiation between Romanian counties.

RESULTS AND DISCUSSION

Rural population had a limited access to waste collection services (<10%) in 2003 and usually of these services benefited villages in the close proximity of large cities.In most counties,the share of rural population without access to sanitation services were over 90%.Also,in counties where rural population is majority the number of people without access to waste collection services were very large (Neamț,Bacău).Absolute values (number of people without sanitation services) are intended to help in interpreting the results due to demographic differentiation between Romanian counties (fig.1)

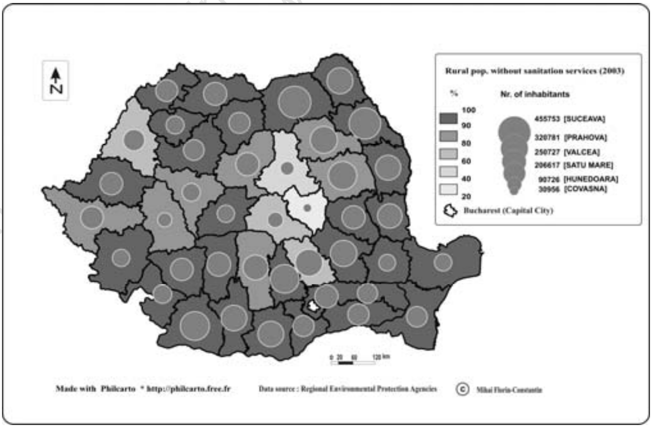

Fig.1 Rural population unserved by waste collection services in 2003

A well-populated county like Prahova,although the share of unserved rural population is 70.53%,the number of people (320781) is higher than in counties without sanitation services in 2003 such as Giurgiu (200364 inhab.),Călărași (195773 inhab.) etc.Waste generated and uncollected from rural areas are uncontrolled disposed being pollution sources on local environmental factors (surface water,groundwater,soil,agricultural land, protected areas etc.).Lower share of rural population without access to sanitation services of Harghita and Covasna (sparsely populated) limits the illegal dumping from these regions.Unlike 2003,improvements on the extension of sanitation services in rural territory have occurred mostly in the counties of Transylvania (Cluj-significant decrease of rural population without access to sanitation services from 92.7% in 2003 to 18% in 2008;Năsăud, Alba Mureș, Sibiu, Hunedoara).

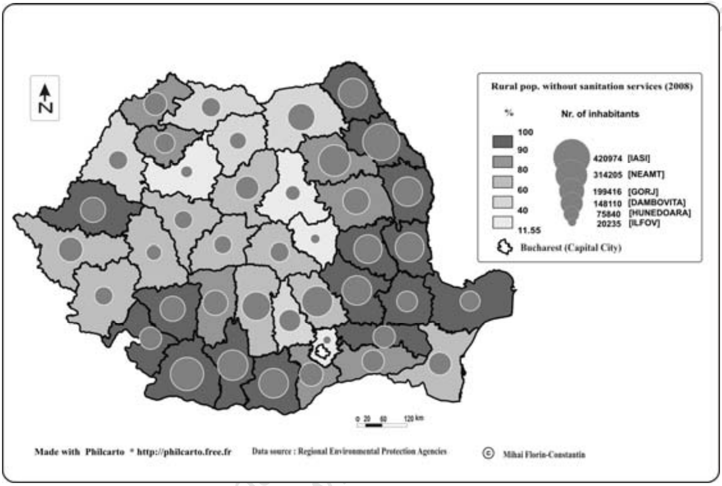

Fig.2 Rural population unserved by waste collection services in 2008

In 2008 the situation has improved but not enough.The adoption of the EU acquis,creating the regional and local waste management plans were the first steps in the development of waste management facilities. In addition, pre-accession funds such as ISPA and PHARE financed the integrated waste management projects for cities and rural areas in proximity.Local authorities are obliged to provide collection and transport of waste generated or to sign contracts with private operators,especially since July 16, 2009 (deadline for closure of rural dumpistes).Until then,rural localities served by sanitation services,collected and disposed the waste generated in open dumps,these sites being established by local agreement or in best scenario the amounts of waste were transported to a non-complliant urban landfill in the neighborhood.The most common and "convenient" disposal method of waste were open dumping ussually in the proximity of villages or on river banks particularly in mountain regions.In this backdrop,in 2008,the share of rural population without access to sanitation services was more than 90% in 15 Romanian counties (from which 8 completely lacking of sanitation services) including counties outside the Carpathian arch in North-East,South-East and South ofRomania and counties with a varied landscape (Buzău,Vrancea,Gorj,Mehedinți, Arad).Furthermore,significant share of rural population without access to sanitation services (80-90%) were in counties Neamţ,Bacău,Sălaj,Satu Mare,Giurgiu and Călărași.Insignificant changes in Brasov and Prahova suggests that development of waste management facilities was limited.Unlike in 2003,improvements on the extension of sanitation services in rural territory have occurred mostly in the counties of Transylvania (Cluj - significant decrease of rural population without access to sanitation services from 92.7% in 2003 to 18 in 2008; Năsăud,Alba Mureş,Sibiu,Hunedoara).Rural population without access to waste collection services decreased in some counties from North-West and West (Satu Mare,Bihor,Timiş) or in counties Dâmboviţa, Argeş and Vâlcea.Harghita and Covasna maintain their decreasing trend and it noticed that in Ilfov county,population without access to waste collection services has decreased significantly from 97.21% in 2003 to 11.55% in 2008!

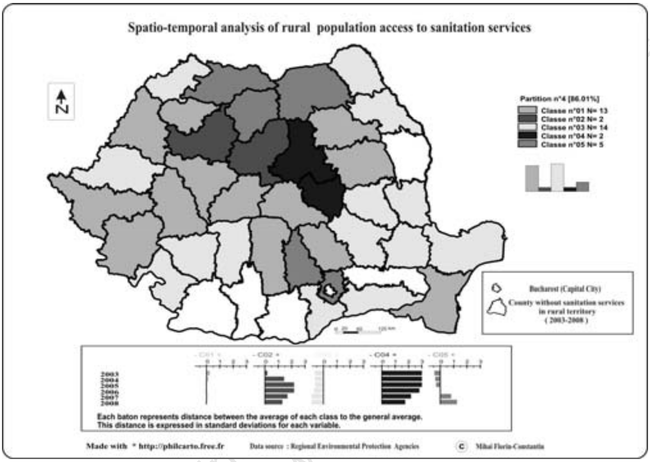

Fig.3 Disparities in rural population acces to sanitation services (2003-2008)

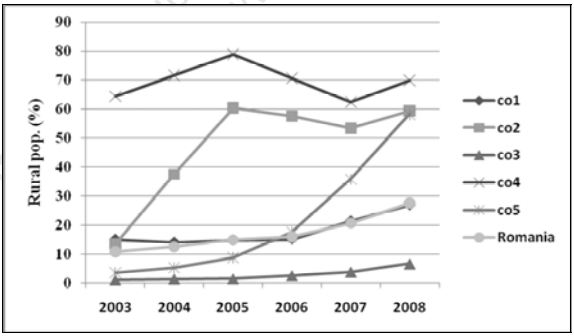

Fig.4 Multiannual average of represented classses (fig.3) related to Romanian average

There are some major disparities at county level compared to the Romanian average regarding the access to sanitation services because of several factors such as:socio-economic level,various geographical conditions,rural population share of county total population,access to national or EU funds for the development of an integrated waste management system, policy makers etc.Unfortunately in the period 2003-2008,five counties of Romania (Vaslui,Ialomița,Teleorman,Olt and Dolj) did not provide waste collection services in rural areas.These counties have a predominantly rural population,located in hilly and plain regions with low living standards due to a less developed agricultural sector,being most vulnerable to waste dumping.Lack of sanitation services as well geographical conditions (plain and hilly landscapes) have favored the waste disposal in open dumps reflected in the large number and occupied ares (ha) of these dumpsites inventoried in 2009.In 2007-2008, in three counties there were no sanitation services in rural territory such as Tulcea, Brăila and Vrancea their number reaching in 2008 to 8!

Class 1:includes counties that have less access to sanitation services below the Romania average,with a slight increase during 2003-2008, from 15.2% in 2003 to 26.96 % in 2008.Waste collection infrastructure is poorly developed,only periuban villages have access to waste collection services provided by urban operators.In mountain regions from Neamț, Bacău and Caraș-Severin counties waste is often dumped on rivers banks in the proximity of human settlements, summer floods playing the role of "collector" for different types of waste.Uncontrolled dumpsites are more common,compact and stable over time in the plains and plateau regions which have a lower risk to flooding.Also this class inlcludes counties with a lower share of rural population of the county's total population (Brașov, Hunedoara).Usually based on field observations made particularly in Neamt County,recyclable waste are disposed in open dumps (paper/cardboard,plastic,PET,wood) construction and demolition waste to which are added agricultural wastes (garden wastes,sometimes manure, etc.).Food waste and others biodegradable are commonly used in households as a source of food for livestock or individual composting.

Class 2: Cluj and Mureș counties have a significant expansion of sanitation services in rural areas during 2003-2006,the values are far above the Romanian average.In 2007-2008, the share of sanitation services decreased significantly in Mureș county unlike Cluj where continued its upward trend and reached more than 80% in 2008. Basically,Cluj is the county with the largest increase of public access to sanitation services from Romania, achieving significant investment in this sector.

Class 3: 14 counties of very low access of rural population to sanitation services (<10%) far below the Romanian average having a negative trend from 2003 to 2008.During this period,waste collection served only the suburban villages and uncontrolled waste disposal in open dumps was the most frequent method of treatment.Furthermore, sanitation services were temporary in following counties:Brăiala and Vrancea (2003-2006),Tulcea (2003-2005).Thus, no sanitation services was provided in these 3 counties for the period 2007-2008.Rural areas of these counties were the most exposed to the open dumping.The situation reflects the lack of involvement of local authorities on waste management issue.Some household waste is recovered (especially biodegradable fraction usesd as compost or as source of food for livestock) the remaining waste (including recyclables) are uncontrolled disposed.This is proven by the large number of dumpsites counted in 2009 especially in counties outside the Carpathian arch [7].

Class 4:includes Harghita and Covasna,less populated counties but predominantly rural, half of population already had access to sanitation services since 2003,these counties having the highest share (over 60% for the entire period) although there has been some decline until 2008.Favorable context has reduced the number of open dumps inventoried in 2009.

Class 5: counties had a positive evolution from low levels under Romanian average (2003-2005) to sharp increase in 2006-2008.Several communes (without sanitation services) were declared as towns in this period,this fact led to rural population decline from country's total population which reflected in the sharp increase of population access to these services. For instance, in Suceava County in the year 2004, 8 communes without sanitation services have become cities: Broşteni, Cajvana, Dolhasca, Vicovu de Sus,Frasin,Liteni,Milişăuţi,Salcea) increasing the percentage of urban population to 43.4 % to 35% in 2001 [8].Satellite cities of Bucharest (fully served by sanitation services) develop these facilities to rural areas in the neighborhood (Ilfov County).

CONCLUSIONS

Despite some improvements compared to 2003,most rural people still do not have access to sanitation services in 2008.Thus,uncontrolled waste disposal were a common bad practice.Geographical distribution of rural population (%) access to sanitation services reflects the regional disparities between Romanian counties.Quality of these services is still rudimentary,it provides mostly traditional collection of waste (mixed) and transport to urban landfilles after the closing of rural dumpsites. It is expected a more rapid development of waste management facilities in rural areas otherwise illegal dumping can not be restricted.

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REFERENCES

[1] Shmelev S.E.& Powell J.R.Ecological–economic modelling for strategic regional waste management systems,Ecological Economics,U.S.A.,59,pp.115-130,2006

[2] Passarini F.& Vassura I.& Monti F.& Morselli L.& Villani,B Indicators of waste management efficiency related to different territorial conditions,Waste Management, Italy,31 pp.785–792,2011,

[3] Mihai F.C. & Ghiurca A.& Lamasanu A Estimation of urban waste generated and uncollected in Romania,Analele Universitati Oradea,Fascicula:Protectia Mediului,Romania,17,pp.719-724,2011

[4] Wolsink M.Contested environmental policy infrastructure:Socio-political acceptance of renewable energy,water, and waste facilities,Environmental Impact Assessment Review, Switzerland, 30, pp. 302–311,2010,

[5] Apostol L.& Mihai F.C.The process of closing down rural landfills Case study : Neamţ county, Present Environment and Sustainable Development,Romania,5/issue 2, pp.167- 174, 2011

[6] Bel G. & Mur M., ,Intermunicipal cooperation, privatization and waste management costs: Evidence from rural municipalities,Waste Management,Italy,29, pp. 2772–2778,2009

[7] Apostol L. & Mihai F.C.Rural waste management:challenges and issues in Romania, Present Environment and Sustainable Development, Romania, 6 /1, in press

[8] Local waste management plan for Suceava County ,Romania,2008

STUDY OF ENERGY SAVING IN BUILDINGS FOR IMPROVED COMFORT CONDITIONS

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ABSTRACT

Buildings rehabilitation and modernizing are measurements to improve living conditions and especially for energy saving in order to respect the standards of thermal insulation. In parallel with the reducing of energy demands it are realized two main objectives of a sustainable development such as a primary energy saving and the decrease of polluting emissions in the environment, the risk of condensation on the inside surfaces of exterior walls is removed and the thermal discomfort as effect of the cold asymmetric radiation is eliminated. The paper proposed the thermal analysis of 3 blocks of flats placed in Romania before and after their rehabilitation from energetically point of view and including aspects of the thermal resistances variation of exterior building elements.

Keywords: thermal rehabilitation, thermal comfort, energy saving, environmental protection.

INTRODUCTION

Buildings during time are considered in a continue evolution they must be rehabilitated and modernized in order to correspond to the demands established by users in a certain stage. At present of great inters are the analysis and interventions that concern energy saving and the assurance of adequate comfort conditions. In parallel with the reducing of energy demands it are realised two main objectives of a sustainable development such as a primary energy saving and the decrease of polluting emissions in the environment. In Romania the buildings made during 1960-1989 are great energy consumers because of their reduced values of heat transfer coefficients, in many cases the thermal comfort conditions are not assured and it exist the major risk of condensation on the inside surfaces of buildings.

Rehabilitation / thermal modernising of a building represent an improvement method to maintain inside the heating energy. That means to add thermal insulation, tightness, improvement, even replace of windows and doors as well the improvement of equipments and installations of buildings [1]. The paper analysis from thermal point of view three buildings of Romania placed in Resita town.

Energy consumption of buildings depends significantly on the criteria used for the internal environment, as temperature, ventilation and lighting and on the building design and operation, including systems.

A good indoor quality can improve men's performances, while uncomfortable occupants are likely to take actions to make themselves comfortable which may have energy implications.

CONSTRUCTIVE DESCRIPTION OF THE BUIDINGS

a) Block of flats placed on Tineretului street no. 3 in Resita town, built in the year 1966, with a number of 140 bachelor's rooms, named as building no. 1. The building is of tower type with one underground and 10 over ground levels, with a rectangular shape. The utile heated area is 1472 m^2 and the utile heated volume is 4634 m^3. The main façade of the buildings is SE oriented, the roof is realised as a not circulated terrace composed by reinforced concrete plate, with thermal and hydro insulation. The exterior walls are made of reinforced concrete and they have mortar and painting layers. Finishing coat of floors is made of parquet and mosaic. Joineries are for the commune spaces with metallic frames, single pane glass window and the apartments have double pane glass windows with wooden frames. The buildings structural resistance is made in a mixed system with frames and diaphragms of reinforced concrete. The upper structure is entirely made by reinforced concrete; the diaphragms are realized by dragging technology and the floors are as prefabricated elements. The exterior diaphragms have a 20 cm thickness while the interior one is 16 cm thick. The not structural walls are made of cellular concrete with a thickness of 12.5 and 7 cm. The longitudinal facades and the parapets under windows as well as the exterior longitudinal frames are without thermal insulation. The floor that covers the underground level is with a thermal insulation made of cinder and with a hydro insulation. The exterior diaphragms are provided with cellular concrete plaque with 20 cm thickness as thermal insulation. The values of thermal resistances for exterior building elements are:

- Exterior walls 0.49 m^2K/W;
- Exterior windows in rooms 0.32 m^2K/W;
- Exterior windows of commune spaces 0.17 m^2K/W;
- Terrace floor 0.631 m^2K/W;
- Floor over the underground level 0.76 m^2K/W.

The mean thermal resistance of the building is 0.508 m^2K/W while the compactness index is 0.472.

Heat supply is assured by the town's centralised heating system. The interior heating system is made with cast-iron radiators as two pipes rising system.

b) Block of flats placed in 1 Decembrie Square in Resita town, with 36 apartments composed by 2, 3 and 4 rooms, built in 1987, named as building no. 2.

The building is of tower type with one underground and 9 over ground levels, with an almost square shape. The utile heated area is 3151.65 m^2 and the utile heated volume is 8509 m^3.

The main façade of the buildings is NV oriented, the roof is realised as a not circulated terrace composed by reinforced concrete plate, with thermal and hydro insulation. The exterior walls are made of reinforced concrete and they have mortar and painting layers. Finishing coat of floors is made of parquet, grit stone and Venetian mosaic.

Joineries are for the commune spaces with wooden frames, double pane glass windows and the apartments have double glazed windows with wooden frames, in some of them are thermo pane windows with plastic frames. The buildings structural resistance is made in a mixed system with frames and diaphragms of reinforced concrete. The upper

structure is entirely made by reinforced concrete; the diaphragms are realized by dragging technology and the floors are as solid elements.
The exterior diaphragms have a 20 cm thickness; the not structural walls are made of cellular concrete with a thickness of 12.5 and 10 cm. The floor that covers the underground level is with a thermal insulation made of cinder and with a hydro insulation. The exterior diaphragms are provided with thermal insulation by cellular concrete plaque with 20 cm thickness.
The values of thermal resistances for exterior building elements are:

- Exterior walls 0.55 m^2K/W;
- Exterior windows with wooden frames 0.43 m^2K/W;
- Exterior thermo pan windows 0.55 m^2K/W;
- Terrace floor 0.45 m^2K/W;
- Floor over the underground level 0.76 m^2K/W.

The mean thermal resistance of the building is 0.531 m^2K/W while the compactness index is 0.37.
Each apartment has his own heating installation with a boiler Q=24 kW. The interior heating system is with steel or cast iron radiators and bathroom radiators.
c) Block of flats placed in Doman Street in Resita town, with 32 apartments composed by 1 and 2 rooms, built in the year 2009, named as building no. 3.
The building is a block of flats with one underground and 4 over ground levels, with a rectangular shape. The utile heated area is 4567 m^2 and the utile heated volume is 6020 m^3. The main façade of the buildings is east oriented and it has a ceramic tile roof. The exterior walls are made of bricks with 30 cm thickness and with a thermal insulation of 8 cm thick polystyrene, a mortar and painting layer. Finishing coat of floors is made of parquet and mosaic. Joineries are for the commune spaces and for the apartments made with thermo pane windows and plastic frames. The buildings structural resistance is made with resistant brick walls and kernel of reinforced concrete and concrete floors.
The not structural walls are made of efficient brick with 15 cm thickness. The floor that covers the underground level is with a thermal insulation made of extruded polystyrene with 10 cm thickness while the floor over the attic is with mineral wool panels with 20 cm thickness.
The values of thermal resistances for exterior building elements are:

- Exterior walls 1.58 m^2K/W;
- Exterior thermo pan windows with plastic frames 0.50 m^2K/W;
- Exterior thermo pan doors with plastic frames 0.55 m^2K/W;
- Attic floor 4.25 m^2K/W;
- Warm floor over the underground level 2.98 m^2K/W;
- Warm floor over the underground level 2.90 m^2K/W;
- Warm floor on the ground 4.40 m^2K/W;
- Warm floor on the ground 4.34 m^2K/W.

The mean thermal resistance of the building is 2.34 m^2K/W while the compactness index is 0.418.

ENERGETICALLY ANALISYS OF HEAT CONSUME

These buildings are placed in the climatic zone with -15°C outdoor calculus temperatures and in the IV wind zone with 4 m/s wind velocity [1].

Energy consume for buildings heating is calculated in function of the numbers of necessary heating days, established according to the average monthly outdoor temperature and the balanced temperature [1], [2].

The calculation method in order to establish the annual thermal energy need for buildings heating is based on the standard SR ISO 13790 that transposes the European Norm EN ISO 13790.

The energetically balance includes the fowling terms (only the sensible heat is considered) [6]:

- Heat looses through transmission and ventilation from the heated environment to the outdoor; ;
- Heat looses through transmission and ventilation between neighbor zones;
- Internal utile heat gains;
- Solar gains;
- Heat losses related to the producing, distribution, heat emission and for regulation of the heating system;
- Input energy in the heating system.

The total heat transfer of a building as single-zone with assuring a uniform indoor temperature for a calculation period is established with the relation [2], [3]:

$$Q_L = H \times (\theta_i - \theta_e) \times t \tag{1}$$

where:

θ_i is the indoor conventional temperature;

θ_e is the outdoor mean temperature during the calculation period (outdoor mean monthly temperature or for the heating season);

t is the calculation period;

H is the heat transfer coefficient of the building.

The heat transfer coefficient of a building as single-zone, with assuring a uniform indoor temperature for a given calculation period or less, is defined with the following relation:

$$H = H_T + H_V \tag{2}$$

where:

H_T is the transmission heat transfer coefficient, calculated according SR EN 13790/2005;

H_V is the ventilation heat transfer coefficient.

The internal heat sources Q_i, is the sum of all internal heat sources in the heated space, other then the heating system:

- Metabolically heat gain from occupants;
- Heat gains from apparatus and electrical lightning.

It is recommended to use the mean monthly values or the values for the heating period. The calculating relation is [2]:

$$Q_i = \left[\Phi_{i,h} + (1-b)\,\Phi_{i,u}\right] t = \Phi_{i\,t} \tag{3}$$

where:

$\Phi_{i,h}$ is the mean heat flow rate for internal gains in heated spaces;

$\Phi_{i,u}$ is the mean heat flow rate for internal gains in unheated spaces;

Φ_i is the mean heat flow rate for internal heat gains;

b is a reduction factor defined in SR EN ISO 13790.

The soar gains depends on the solar radiation, normally present on the respective placement, depending on the orientation of the receiving surfaces, on the permanent shadowing, on the transfer and absorption characteristics of the solar receiving surfaces. As receiving surfaces are considered the glazing, the internal walls and the floors of sunspaces, the walls placed behind a transparent covering or a transparent insulation. For the opaque surfaces exposed on solar radiation it must be consulted the attachment F.

For a given calculation period, the solar gains are calculated with the relation [2]:

$$Q_s = \sum_j \left[I_{sj} \sum_n A_{snj} \right] + (1-b) \cdot \sum_j \left[I_{sj} \sum_n A_{snj,u} \right] \quad (4)$$

In this relation the first term is for the heated space and the second term for the unheated space. The solar gains from the unheated spaces are multiplied with (1-b), where b represents the reduction defined in factor SR EN ISO 13789.

In each term the first sum is made for all the j orientations while in the second term for all the n surfaces that receives the solar radiation , where :

I_{sj} is the solar radiation, for example the total energy of solar radiation globally during the calculation period for 1m² surfaces with the j orientation, in J/ m²;

A_{snj} is the equivalent receiving area of the surface n with the orientation j, it means the area of a black body that leads to the same solar gains as the considered surface.

The energy need for heating (O_h) is determined for each calculation period/season with the relation [2]:

$$Q_h = Q_L - \eta Q_g \quad (5)$$

where:

- Q_L is the heat losses,
- η is the utilization factor
- Qg is the heat gains.

For the calculation of these heat losses the following subsystems of the heating system are considered:

- The heat transfer (emission) system to the consumer, including the control and regulation devices;
- The heat distribution system to the consumer, including the control and regulation devices;
- The storage system, including the control and regulation devices (if it exist);
- The heat generating system (for buildings with individual heating sources), including the control and regulation devices.

The total heat losses of a heating system in a building Q_{th}, is expressed as sum of heat losses for all of the above mentioned subsystems, thus:

$$Q_{th} = Q_{em} + Q_d + Q_s + Q_g \quad (6)$$

where:

Q_{em} is the heat losses caused by an un-ideal heat transfer system to the consumer, in J;

Q_d is the heat losses of the distribution system to the consumer, in J; the value of this heat losses depends on the configuration of the distribution network system, on there placement, on the insulation type, on the flow temperature, on the types of control and regulation devices i.e.

Q_s is the heat losses of the storage system (if it exist), in J;

Q_g is the heat losses of the generating system during the functioning period.

The total energy consume for heating is obtained as a sum of the terms presented in the former paragraphs, respectively:

$$Q_{f,h} = (Q_h - Q_{rhh} - Q_{rwh}) + Q_{th} = Q_h + Q_{em} + Q_d - (Q_{rhh} + Q_{rwh}) \quad (7)$$

Thus, for building no. 1 on Tineretului Street results a number of 220 heating days, for building no. 2 on 1 Decembrie Square a number of 216 heating days and for building no. 3 on Doman Street a number of 204 heating days. Energy consume for heating is determined for each month of the heating period. For the building no. 1 the heating season begins at the 26th of September until the 5th of May, for the building no. 2 it begins at the 28th of September until the 3rd of May and for the building no. 3 it begins at 4th of October until the 25th of April.

The annual specific heating energy consume is:

- Building no. 1 with 201 kWh/m^2year, energetically class D and 48.2 kg CO_2/m^2 year emission of CO_2.
- Building no. 2 with 151.9 kWh/m^2year, energetically class C and 30.4 kg CO_2/m^2 year emission of CO_2.
- Building no. 3 with 112.1 kWh/m^2year, energetically class B and 22.4 kg CO_2/m^2 year emission of CO_2.

It is made a thermo graphic analyse of building no. 1, with the following air parameters:

– Indoor air temperature t_i=+20,5°C;
– Outdoor air temperature t_o=-5°C;
– Relative humidity hr=95%.

BUILDING THERMAL REHABILITATION

According to the energy consume and thermal resistances of the buildings no. 1 and no. 2, it is necessary there energetically rehabilitation. Thermal rehabilitation of the buildings no. 1 and 2 needs a series of measurements to reduce the heat looses through the exterior buildings elements by increasing the heat transfer resistance, as follows:

- Terrace – the existent thermal and hydro insulating layers will be removed and it will be applied a cold bituminoid emulsion, basaltic mineral wool of 12 cm thickness, hydro insulating membrane.
- Walls – the exterior damaged mortar layer will be repaired, it will applied an adhesive layer for fixing an 8 cm thick polystyrene, a fibreglass bats covered with an adhesive, grunt layer and decorative mortar.

Exterior windows will be replaced with low-e and argon glazed windows and plastic frames.

In table 1 are presented the values of thermal heat resistances for the rehabilitated building elements. The corrected thermal heat resistances are determined according the correction coefficients for materials conductivity [4].

Table 1 Thermal heat resistance of exterior building elements

Building elements	**Building no.1**	**Building no.2**	**Building no.3**
	Rehabilitated m^2K/W	**Rehabilitated m^2K/W**	**Existent m^2K/W**
Terrace floor	3,05	3,28	4,25
Exterior walls	1,41	1,55	1,58
Floor over underground level	1,68	1,71	2,90
Windows	0,55	0,55	0,55

After the buildings rehabilitation, a thermal examination gives the following annually specific heating energy consumes [2], [3]:

- Building no. 1 with 116 kWh/m^{2}year, energetically class B and 28.1 kg CO_2/m^2 year emission of CO_2, that assures a reduce of thermal energy with 42% and a reduce of CO_2 emissions with 41%.
- Building no. 2 with 101 kWh/m^{2}year, energetically class B and 19.9 kg CO_2/m^2 year emission of CO_2, that assures a reduce of thermal energy with 34% and a reduce of CO_2 emissions with 33%.
- Building no. 3 does not need thermal rehabilitation measures, it has a annually specific heat consume of 112.1 kWh/m^{2}year and it is placed in the energetically class B.

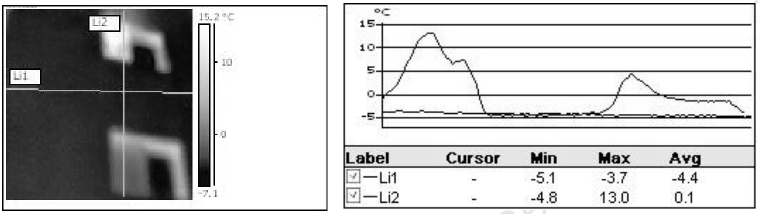

Fig. 1 Temperature variation at the outside rehabilitated wall surface for building no. 1

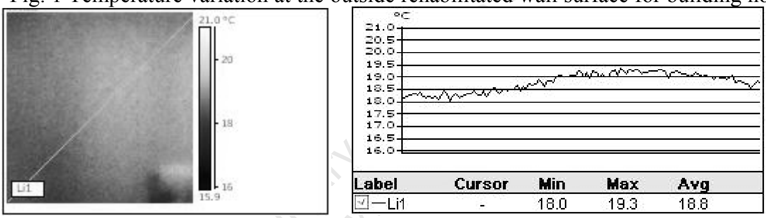

Fig. 2 Temperature variation at the inside rehabilitated wall surface for building no. 1

As observed in fig. 1 the temperature on the opaque outside rehabilitated surface is nearly constant by a t_{wo}=-4,4°C value. Thus, the thermal bridges on the opaque surface are reduced and the thermal resistances increase 2.87 times. For this conditions, as presented in fig. 2, the temperature on the inside wall surface has an average value of t_{wi}=+18,8°C, value that respects the given temperature difference between indoor air and inside surface of exterior elements. Therefore the risk of condensation is reduced by a relative humidity greater then 85%, situation that occurs when rooms are insufficient ventilated and the fresh air is not assured [4].

Thermal comfort is largely a state of mind, separate from equations for heat and mass transfer and energy balances. However, the perception of comfort is expected to be influenced by the variables that affect the heat and mass transfer in our energy balance model. The most common approach to characterizing thermal comfort for the purposes of prediction and building design has been to correlate the results of psychological experiments to thermal analysis variables. The level of comfort is often characterized using the ASHRAE thermal sensation scale. The average thermal sensation response of a large number of subjects, using the ASHRAE thermal sensation scale, is called the predicted mean vote (PMV) [7].

The recommendations made by ASHRAE Standard 55 are shown in Table 2. These thermal conditions should ensure that at least 90% of occupants feel thermally satisfied.

Table 2: ASHRAE Standard recommendations.

Season	Operative temperature [°C]	Acceptable range [°C]
Winter	22	20 - 23
Summer	24.5	23 - 26

PPD means Predicted Percentage of Dissatised and is an indication of the percentage of people who could complain about the thermal quality of a given indoor environment. For rehabilitated Building no.1 PMV and PPD is calculated in table 3.

Table 3 Input and results parameters for thermal comfort

Parameter	Input	Parameter	Results
Clothing [clo]	1.10	Operative temp. [°C]	20.3
Air temp. [°C]	21.8		
Mean radiant temp. [°C]	18.8	PMV	-0.5
Activity [met]	1.0		
Air speed [m/s]	0.15	PPD	12.5
Relative humidity [%]	55		

CONCLUSIONS

Thermal rehabilitation of civil buildings in Romania, built during 1960-1989, is a necessity in order to reduce heat losses during the winter period and to realise corrected thermal resistance values of building elements close to European one.

Due to this rehabilitation process the risk of condensation on the inside surfaces of exterior walls is removed but it is conditioned by a periodical room's ventilation. Also, the thermal discomfort as effect of the cold asymmetric radiation is eliminated.

Concerning this two analysed buildings, the specific heating energy consume decreases with 41% for building no. 1 and with 33% for building no. 2, that leads to a reduce of the bills account for thermal energy consume and to a reduce of CO_2 emission in the burnt gases during thermal energy producing.

The building no. 3 realised in 2009 has the energy consume in the given domain ranges and it respects the given values for the thermal resistances of exterior building elements.

REFERENCES

[1]. Ilina, M. Manualul de Instalaţii. Instalaţii de încălzire, Ed. Artecno, Bucuresti, 2002.

[2]. * * * Metodologia de calcul Mc-001/1, 2, 3 privind reabilitare termică a clădirilor. Bucuresti, 2007.

[3]. * * * Metodologia de calcul Mc-001/4 privind reabilitare termică a clădirilor. Bucuresti, 2009.

[4]. Glück, B. Zustands und Stoffwerte. Wasser. Dampf. Luft. Verbrennungswerte Verlag für Bauwesen, Berlin, 1990.

[5]. Hell, F. Grundlagen der Wärmeübertragung. VDI – Verlag Düsseldorf, 1982.

[6]. * * * SR EN ISO 13790 – 2005 Performanţa termică a clădirilor. Calculul necesarului de energie pentru încălzire.

[7]. * * * SR EN ISO 7730 – 2006, Ambianţe termice moderate. Determinarea indicilor PMV şi PPD şi specificarea condiţiilor de confort termic.

STUDY OF THE INVERTEBRATES FAUNA ASSOCIATED OF THE MACROALGAL BIOMASS FROM THE ROMANIAN BLACK SEA COAST

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ABSTRACT

The study was conducted for three years (2009 - 2011), near the shore of Singol-Constanta - to the southern tip of the Romanian Black Sea littoral, characterized by the presence of dams to protect beaches and submerged limestone platforms. Starting with prevernal/vernal season periods with significant development of macro-algal communities were recorded producing large clusters in shore area in the context of a greatly increased flow of the Danube and a significant amount of vegetation transported and deposited on beaches to Vama Veche, we decided to perform a study of invertebrate communities using the organic matter. In this purpose we have established five sites: Cape Singol / Constanta, Eforie, Costinesti, Mangalia and Vama Veche where samples were taken monthly from marine biomass (vegetal, invertebrates and whole and fragments shells of mollusks); invertebrate fauna was extracted from plant biomass and divided into two major groups: macro and meiofauna (depending on their size, using two sieves: mesh size 1mm, for invertebrates with size greater than 1mm - macrobenthic and 0.250 mm for meiofauna). We identified the taxons of flora and fauna, plant biomass was weighed by major groups: limnic and marine origin, the green, brown and red maroalgae species and invertebrate's benthic species associated. The hard substrate is mostly covered by a vegetal blanket dominated by macro-algae species: *Ulva*, *Enteromorpha* and *Cladophora* (**Chlorophyta**) and *Ceramium* (**Rhodophyta**). Though relatively isolated and on small surfaces, there were also encountered areas with *Corallina* (**Rhodophyta**) and *Cystosera* (**Phaeophyta**), at greater depths. These taxons are dominant in the marine biomass from the beaches. The invertebrate fauna associated with this type of substrate is typical and it has a phytophile character, the vegetal blanket being also shelter (the shallow zone is characterized by a strong water mass hydro-dynamism) and food resource. The invertebrate community associated to the phytal substrate is dominated mostly by crustacean species (**Amphipoda**, **Isopoda** and Harpacticoida-**Copepoda**) and to a lesser extent by worm species (the latter developing considerable populations, especially in meiobenthos); without present phytophile character, mollusks are present in high proportion (especially mussels) by their affinity to the hard substrate.

Keywords: macro-algae, macrofauna, meiofauna, benthofauna, phytophile

INTRODUCTION

The study was conducted mostly done in the prevernal, vernal, estival and autumnal seasons, 2008-2010, within the "Wastewater Treatment of sludge and marine biomass from Romanian Black Sea coast as innovative bio-solid composite" Project no. KNRIN 2008/115241, Norway Grants – Innovation Norway: "Norwegian Cooperation Programmes for Economic Growth and Sustainable Development in Bulgaria and Romania". The Romanian coastal zone is divided in two geographical and geomorphological units [1]:

- northern unit (N, Fig.1) occupies 2/3 of the littoral length, it lays between Musura Bay, at the mouth of Chilia branch, and Cape Singol, including the shore of Danube Delta Biosphere Reserve: - this area is characterized by sandy beaches, with low altitudes and reduced as amplitude sub-marine slopes.
- southern unit (S), occupying 1/3 the length of the Romanian seaside, lays between Cape Singol and Vama Veche, and is characterized by narrow beaches, interrupted by limestone platforms that extend over the water and high cliffs; shallow sediments include a large variety of mollusks shells and pebbles, these beaches being composed of sand with average and coarse particle size.

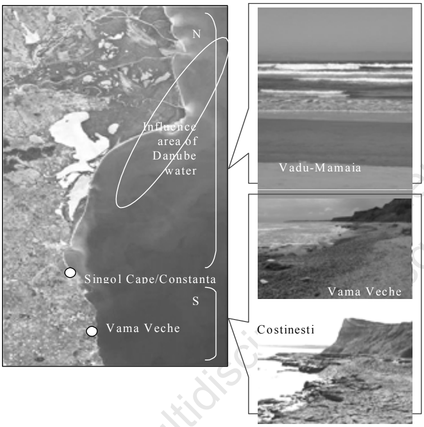
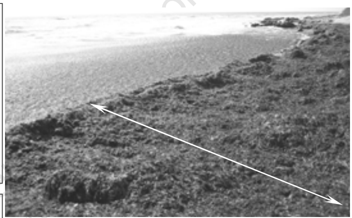
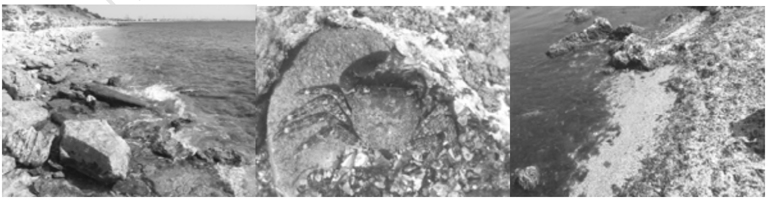


Figure 1 – Romanian littoral of the Black Sea (Harta www. imag. ro; Picture: Paraschiv)



Phyllum	After data:		
	Bavaru 1977	**Vasiliu 1980-1995**	**Sava 2007**
Chlorophyta	31	22	16
Phaeophyta	14	9	5
Rhodophyta	41	24	10
Total	**86**	**55**	**30**

The decrease of number of macrophytae algae species during 1977-2007 [3]



a) The stone platform area from mediolittoral -Agigea b) *Pachigrapsus marmoratus* c) macroalgal deposits in the breaking zone of the see

Figure 1. Aspects of the study area (original photo)

Marine biomass accumulated in the Black Sea (a sea without tides)has episodic variations, with significant amounts of variation specially after stormy days; during the cold season biomass is dominated by bivalves mollusks and to a lesser extent gastropods and crustaceans decapods while in the summer is dominated by macroalgae biomass, so shallow coastal area is practically invaded by large amounts of macroalgae (especially species of the green group), forming a rich trophic resource for invertebrate communities, but also the a factor of stress due to increased consumption of oxygen dissolved in water.

The present study aims to follow the qualitative structure of invertebrate communities associated macroalgae deposits near the shore, in relation to the type of vegetation and water masses movements.

MATERIAL AND METHODS

a) Collection of biological samples

To collect biological samples a method of the sampling was applied (square sample area of 360 cm^2), along a perpendiculars transect to the shoreline at five sites (Figure 1): Cap Singol /Constanta, Eforie, Costinesti, Mangalia and Vama Veche. The last four locations where samples were taken are located in the southern Romanian coast, characterized by the presence of the high cliffs, submerged limestone platforms in mediolittoral and infralittoral (which develops a rich epibiosis) and a weaker influence of Danube waters. The first site listed, is the northernmost location of the study, where the hydro-meteorological conditions in 2010, the Danube flow values were the biggest in the last 50 years, the influence of the Danube waters were felt and is characterized by the absence of cliffs limestone and platforms (the only stone surfaces that develop epibiois are protection dams) and by the extension of surfaces with sediments: on the beaches of this location we have reported significant amounts of vegetation and fauna of deltaic origin, transported by the Danube and deposited on beaches due to sea currents.

b) Processing and analyzing fauna samples

Samples collected were processed fresh, plant biomass was separated from shells material and fauna; the analysis was made taxonomic, identifying by genus/ species [9], but the processing and presentation was made at environmental group level.

Sampling Samples were collected from collection points from the lower beach area, stored in plastic bags and containers and transported to the laboratory;

Separation Sedimentary material was separated from the biological one by integral sample washing through granulometric sieves (mesh size 5 mm, 1 mm and 0.5 mm, Figure 2).

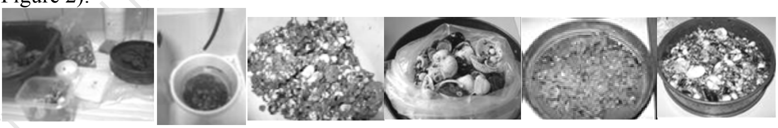


Figure 2. Samples processing

Triage and identification of biological material - it is essential to identify the ecological dominant groups, after separation follows the triage and proper identification of organisms, identification made on the basis of taxonomic characters emphasized by stereomicroscope and Nikon microscope from Applied Ecology Laboratory.

RESULTS AND DISCUSSIONS

The effects of the last periods modifications are still felt today [3], [4], [5] [7], 86 macroalgal species were cited in the 1970s-1980s [2], 69 species were cited in the 1980s-1990s and only 55 species after 1990 [8], [9]. This decrease in the number of species (apart from the pollution phenomenon) was attributed to climate changes – frost at the Romanian littoral (for unprecedented long periods of time) on the one hand and to the deposits of clay sediments on limestone platforms (fraction mobilized and brought to the sea mass as a result of hydro-technical constructions in the Harbors of Cape Midia and Agigea South) on the other hand.

From **Chlorophyta**, the most abundant and frequent species are from taxonomic groups: Ulvales, Cladophorales and Bryopsidales; they are found along the Romanian coast, but more developed in the south sector (Constanta-Vama Veche); the mass development of the macroalgal carpet in this sector is explained by the very presence of limestone platforms which cover almost entirely the shallow waters and which represent the ideal substrate for their attachment [6]. Brown algae prefer cold marine waters (**Phaeophyta**), developing exuberantly at greater depths than green algae; the most representative species at the Romanian littoral from this group (Cyclosporeae) is *Cystosera barbata* (Good *et* Wood) Ag.). The representatives of **Rhodophyta** group make up the phytobenthos in the deep zone of the infralittoral; the algal deposits register an increased biomass compared to brown algae, but reduced in comparison to green algae. Two classes have representatives in the Black Sea. There are four representatives of Ceramiaceae: *Callithamnion corymbosum* Lyngb. and three species of the genus *Ceramium* (these develop significant biomasses in the shallow zone – depths between 1.5 to 4-5 m), in the prevernal and vernal season [6].

At the onset of vernal period of 2009, significant developments of macroalgal biomass were reported. In June most of the southern sector of the Romanian beaches was invaded by the biomass (Fig. 1), similar episodes were also encountered during the summer until late September, so from this point of view, 2009 was the most productive year of the studied period.

In the first part of vernal period of 2010, in the biomass collected from the sea a very important component was represented by the freshwater species: *Trapa natans* *Miriophyllum*, *Cerathophyllum* and *Potamogeton* species (Table 1, Figure 3).

Table 1. Annual and seasonal variation of the macrophytal species numbers from studied area

No crt	No. Taxa of macrophyta	Years					
		2009		2010		2011	
		Preverna -Vernal	-Estival Autumnal	Preverna -Vernal	Estival Autumnal	Preverna -Vernal	Estival Autumnal
1	Freshwater	-	-	8	-	1	-
2	Brackish euribiontic	3	6	1	9	4	7
3	Brackish marine	1	2	-	3	2	2

In this year the typical marine macroalgae vegetation was relatively low (both qualitative and quantitative), especially in the summer times; this is explained by the existence of long periods with very heavy rainfall in spring and at the onset of summer, generating increased flows on major rivers and especially on the Danube; strong floods have brought (especially in the northern coastal are of the Black Sea) besides a large volume of fresh water large amounts of vegetation and associated fauna, characteristic to freshwater basins in Danube Delta.

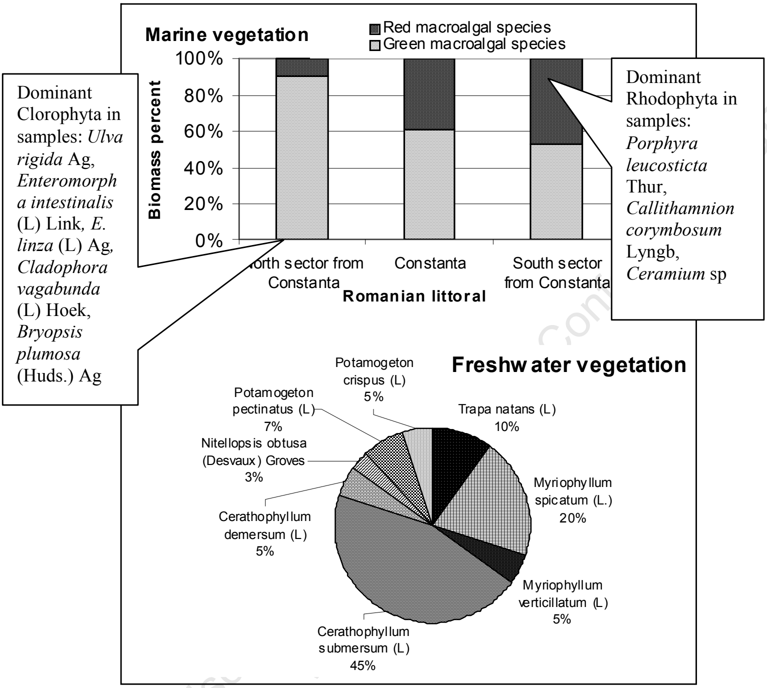


Figure 3. The perceptual content of macro algae groups in dried biomass samples, collected from Cape Singol/Constanta and southern sector of Romanian seaside (dried biomass /at 250g mixture of humid macro algae biomass)

The faunal community on this area is dominated by macrobenthal species with high affinities for hard substratum: the crustaceans groups- Gammaridae (**Amphipoda**), *Idotea baltica* and *Sphaeroma* (**Isopoda**) and crabs species (**Decapoda**: *Carcinus*, *Eriphia*, *Pachygrapsus*, *Xantho*) and the *Chironomus* group (**Diptera**, in the algal layer at the superior limit), presents in Figure 4.

The analysis of the faunal samples (resulted from the lab processing and field observations) showed relative constant fauna that mollusks, worms and crustaceans dominate the medilittoral zone. Among the worms, dominant species are polychaetes, while among the crustaceans, the dominant are the meiobenthal forms of harpacticoids (crustacean copepods) and nematods.

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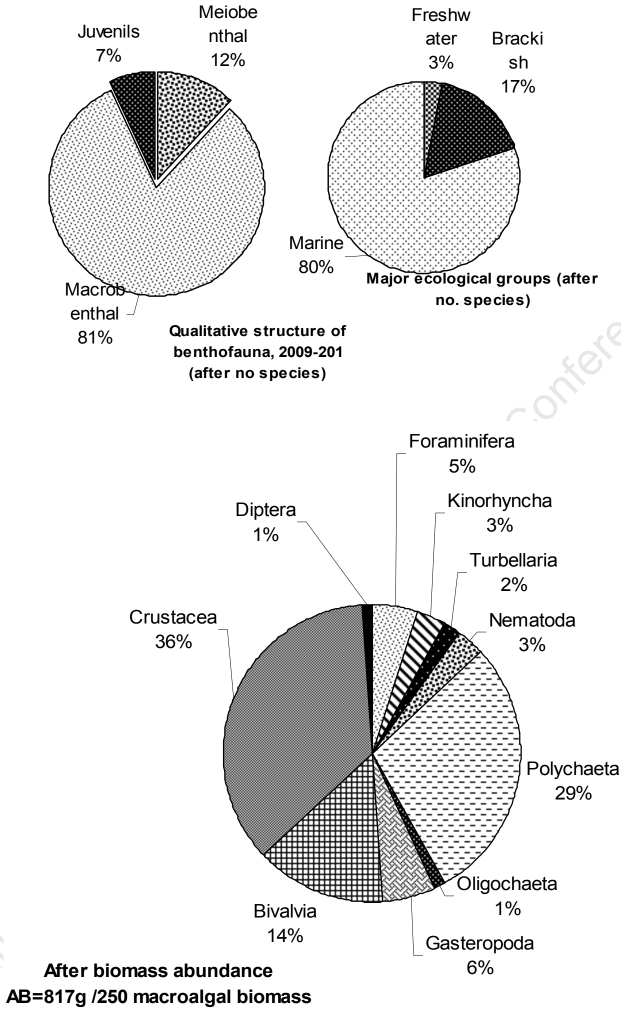

Figure 4. Structure of the benthofauna communities associated macroalgal deposits

CONCLUSIONS

In the particular methodological and hydrological conditions of 2010, with very heavy rainfall and flooding unprecedented in recent decades on the Romanian coast, given that in 2009 there were more episodes and successive, a great development of Pontic coastal macroflora had occurred and we conclude:

1. we identified in plant biomass in the shallow area of study from the Romanian coast, 18 species of marine and brackish macrophyte (large ecological valence regime in terms of saline) and 8 species of freshwater (shipment of the Danube and made the beaches of coastal marine currents) associated fauna community is represented by 10 supraspecifici taxa and 25 specific taxa, being detected in Cape Singol second half of june, 2 species of amphipods crustaceans such as *Dikerogammarus* (Danubian species) and two species of gastropods attached to vegetation deltaic origin (*Radix* and *Sphaerium*);

2. dominants in plant biomass throughout the season were dominanted by macroalgae from **Chlorophyta** group and to a lesser extent **Rhodophyta** group, in associated invertebrate communities the dominant forms are macrobentale, in which species of isopods and decapods crustaceans and polichaets is about 60% of total biomass benthofaunei;

3. in the period studied there were no significant seasonal variations in the structure of macrobentale invertebrate communities; the most present were Gammaridae (**Amphipoda**), *Idotea baltica* and *Sphaeroma* (**Isopoda**) and the *Chironomus* species (**Diptera**);

4. meiobenthale taxonomic groups, which were presence during our study are: **Kinorhyncha**, **Turbellaria**, **Nematoda** and **Polychaeta**, although the mass of these groups represent a insignificant share of the total benthofauna biomass .

REFERENCES

[1] Băcescu, M., G.I. Müller, M.T. Gomoiu, *Benthal Ecological Research in Black Sea; qualitative, quantitative and comparative of Pontic benthic fauna* - Marine Ecology, vol. 4, Ed. Romanian Academy, Bucuresti, Romania, 1971, pp. 357

[2] Bavaru, A., *Contribution of algal association study from rocky substratum of Black Sea coast*, PhD Thesis, University of Bucharest, 1977, pp. 195

[3] Bologa, A.S., Destruction of marine biodiversity – a case study of the Black Sea. IOI-*Pacem in Maribus* XXVII Conference, Proceedings, pp. 249-254, 2001

[4] Gomoiu, M. T., Some problems concerning actual ecological changes in the Black Sea; *Marine researches*, IRCM-Constanţa, 14, pp.109-127, 1981

[5] Sava, D., *The Pollution Ecological Assessment of Macrophytic Algal Communities from Romanian Black Sea*; PhD Thesis, "Ovidius" University Constanţa, Romania, 2002, pp. 373

[6] Sava, D., *Illustrated Macroalgal Guidebook, Macrophyt Algal from Romanian Black Sea Litoral*, Ed. Ex Ponto „Ovidius" University Press, Constanţa, Romania, 2006, pp. 179

[7] Sava, D., Samargiu, M.D., Paraschiv, G.M., *Macroalgal Flora from the Romanian Black Sea Coast Diversity, Ecology, Present Trend*; Ed. Pelecanus, Brasov, Romania (The 8th National Conference for Environmental Protection - Biotechnology), pp. 100-104, 2007

[8] Vasiliu, F., *Macrophytic Algal Production from Romanian Black Sea Coast*; PhD Thesis, University of Bucharest, pp. 210, 1984

[9] *Ecological Consideration of Macrophytic Species List from Romanian Black Sea Coast*; *Naturalia* – Piteşti, St. cerc. II-III, pp. 432-444, 1996

[10] Vinogradov, K. A., Losovskaya, G. V., *Klass mnogoshetinkovye chervil – Polychaeta/ Opredelitel`Fauny Cenogo I Azovskogo Morey*, Naukova Dumka I, Kiev, pp. 251-359, 1968

STUDY OF THE SELECTED METALS IN CEMENT MATERIALS

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ABSTRACT

The cement manufacturing sector has been always concerned in problems related to the environment. Cement contains heavy metals, which are among the dominant pollutants in building materials having the toxic effects on the environment and human health.
In this work, the content of selected metals was studied in cement and cement composites with special regard to chromium concentrations. The concentration of the total chromium measured by XRF method was 178.5 ppm in Portland cement and ranged from 180 to 233.5 ppm in studied cement composites. The water soluble hexavalent chromium was investigated in the water environment in accordance to the Slovak standard method of cement testing. The average concentration of water soluble hexavalent chromium in the Portland cement was measured 3.19 ppm and the leaching rate calculated reached the value of 1.79 %. The leaching rate of the other investigated metals was measured from 0.1 to 1.46 %. Summarising the results, only the small part of the metal content was released into the water environment from the cement composites studied in this study.

Keywords: cement, metals, chromium, barium, building materials, environmental assessment

INTRODUCTION

Cement as a mineral binder in a powder form is an inexpensive material, easily stored and transported. Portland cement is produced in almost every region of the world. It can be prepared from a large variety of raw-materials and set to become solid when, mixed with water in a hydrating process. This hydraulic binder can be used in the producing of concrete, mortar and various building prefabricated [1]. Commercial cement manufacture causes the important environmental problems [3]. Nowadays cement industries contribute significantly to reducing their negative impacts on the environment, especially with its production and application of new technologies by adjusting the quality of end products [4]. The cement significantly affects the environment not only by manufacturing process but throughout the whole life cycle. Therefore it is important to make the assessment of cement for different perspectives.

Heavy metals belong to the most significant hazardous elements presented in cement and cement compounds [4]. These elements originate mainly from the raw materials, but also the others sources could add metals to cements, such as refractory bricks lining the kiln, mineral admixtures or the grinding media (normally high-chromium white cast iron) in the final finishing mills. The heavy metals concentrations in raw materials vary widely from one location to another and the potential for emissions to the atmosphere or its leaching potential is affected by very complex mechanisms [5]. Furthermore, metal concentrations from wastes used as fuel varies with the waste origin.

Chromium is an indelible non-volatile trace element of raw materials used in cement clinker production [3]. It occurs in natural materials (clay, limestone and iron additives in particular) in the form of chromium (III). Trivalent chromium is modified to hexavalent chromium at high temperature in an oxidizing atmosphere and alkaline conditions in cement kilns [6]. According to method based on the fully dissolving Cr (VI) in an acid solution, it was estimated that the content of Cr (VI) in cement samples is about 50–90 % of the total Cr [7]. Hexavalent form of chromium is harmful and allergenic and having very high water solubility can easily come into contact with the masons' skin. Eugeniusz reported a limit of 10 mg/kg of Cr (VI) as a risk of allergic reaction [8]. The medical studies carried out until now show the complexity of allergic reaction due to a combination of various hazardous elements such as Ni, Co, Ba, Pb etc.

This paper is focused on the assessment of the leaching of selected elements with special regard to chromium from cement materials.

MATERIAL AND METHODS

Cement composites preparation

Three types of cement composites (S1 – S3) were prepared for the experiment in accordance with the Slovak standard STN EN 206-1 – C35/45 using cement CEM I 42.5 R The recipes of prepared cement composites are presented in Table 1.

Table 1 Mixture composition of tested samples

Materials		Samples type		
		S1	S2	S3
CEM I 42.5N (kg)		360	360	360
water (L)		170	200	198
microsilica (kg)		–	20	–
aggregate (kg)	0/4 mm	825	800	825
	4/8 mm	235	235	235
	8/16mm	740	740	740
plasticizer (L)		3.1	3.1	2.6

The samples prepared were treated during 28 days in water environment. Then, several samples of set S3 were again immersed into the water (S3a) and others (S3b) were treated in dry environment by covering with plastic wrap.

The cement composites as well as used cement as a reference material were investigated in terms of the chemical composition and selected metals releasing. Hardened cement composites were crushed into the powder form by using MSK-SFM-1 Desk-Top planetary ball miller (MTI Corporation, USA).

Method for chemical composition testing

The samples of cement and cement composites were prepared as pressed tablets (pellets) of diameter 32 mm by mixing of 5 g of sample and 1 g of dilution material (M-HWC) and pressed by pressure of 0.1 MPa/m^2. The prepared tablets were studied by X-ray fluorescence spectrometry. The chemical composition of samples was determined by using SPECTRO iQ II (Ametek, Germany) with silicon drift detector SDD with resolution of 145 eV at 10 000 pulses. The primary beam was polarized by Bragg crystal and Highly Ordered Pyrolytic Graphite - HOPG target. The samples were measured during 300 s at voltage 25 and 50 kV, at current of 0.5 and 1.0 mA, respectively. The standardised pellet method of fundamental parameters was used for measurements.

Method for water leachate testing

The leachates were prepared with accordance to STN EN 196-10 Methods of cement testing (Appendix C) [9]. 25 g of sample was mixing with 25 ml of ultra-pure water (Rodem 6) with conductivity of 5.72 μS/cm and pH of 6.81 during 15 minutes at laboratory temperature. The prepared paste was separated by vacuum filtration through the glass filter with porosity 4 (Morton). The obtained filtrate was adjusted to final volume of 250 ml and the concentration of the basic elements was measured in leachates by XRF. The leachates were measured during 180 s the same way by using the method of fundamental parameters for water samples.

The trace concentration of soluble hexavalent chromium was measured in leachates by the spectrophotometery. The determination of chromium (VI) was based on the reaction of hexavalent chromium with diphenylcarbazide by forming the purple coloured complex. The concentration of soluble chromium was measured by the DR 2800 spectrophotometer (Hach Lange, Germany) at 540 nm.

RESULTS

The chemical composition of cement used and cement composites samples studied measured by XRF spectroscopy is summarised in Table 2 as percentage of principal oxides.

The chemical composition of studied cement composites was similarly to the chemical composition of the assessed Portland cement except for calcium and silicon content. The content of SiO_2 in cement was measured 19.65 %, in cement composites ranged from 25.97 to 45.63 %. The content of SiO_2 in the composites increased as supposed due to the aggregate addition. The content of CaO in cement was 58.15 %, in cement composites was in the range 26.17 – 32.00 %. Differences in composition also depend on the structure of the composites as well as on the processes that take place in composite materials during hardening.

Table 2 Chemical composition of the studied materials (% mass)

Oxides	Samples				
(% mass)	CEM I 42.5N	S1	S2	S3a	S3b
MgO	3.823	3.040	2.727	2.868	2.964
Al_2O_3	4.390	5.209	5.385	4.533	5.033
SiO_2	19.65	30.16	45.63	25.97	29.75
P_2O_5	0.093	0.096	0.094	0.089	0.097
SO_3	3.171	2.889	2.718	2.954	2.885
Cl	0.012	0.016	0.019	0.016	0,017
K_2O	0.583	0.766	0.794	0.785	0.785
CaO	58.15	31.27	26.17	31.56	32.00
TiO_2	0.212	0.269	0.258	0.260	0.263
MnO	0.352	0.375	0.364	0.376	0.373
Fe_2O_3	3.245	4.037	3.748	3.777	3.820

The concentrations of selected metals released into the water environment from the cement composites comparing to the concentrations measured in powdered cement composite samples are summarized in Table 3.

Table 3 Concentrations of selected metals

	S1		S2		S3a		S3b	
(mg/kg)	leachate	pellet	leachate	pellet	leachate	pellet	leachate	pellet
Al	330.5	27570	317.2	28500	315	23990	325.8	26640
Ti	3.200	1615	2.900	1548	2.60	1558	2.700	1577
Mn	28.40	2901	34.70	2821	38.3	2914	42.10	2892
Fe	30.20	28230	32.50	26220	30.1	26420	27.80	26720

The aluminium reached the highest content in range of 315 – 330.5 mg/kg in cement leachates; followed by manganese in range 28.40 – 42.10 % and iron with 27.80 – 32.5 %. The minimum content (2.6 – 3.2 mg/kg) was detected for titan. The leaching ratios were also calculated by dividing the leachate concentration by the pellet concentration. The results of the leaching ratios in various types of cements were previously published in our work [10].

The comparison of the leaching ratios of the studied metals in tested cements is illustrated in Figure 1.

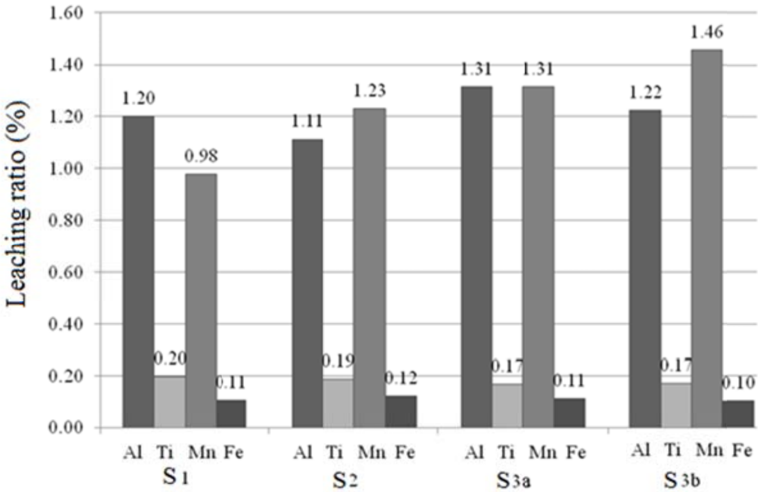

Figure 1 Comparison of the leaching ratio of selected heavy metals

The results of measurements of studied metals content in water leachates showed that only a small part of their content was extracted from the cement into the water environment. The highest leaching ratio was calculated for manganese (1.46 %) in the sample S3b and the least one for iron (0.1 %) in the sample S3b. The highest leaching ratio of aluminium was noticed in the sample S3a (1.31 %) and the least leaching ratio of aluminium was calculated for the sample S2 (1.11 %). The highest leaching ratio of titan was calculated for the cement sample 1 (0.2 %) and the least one for the samples S3a and S3b (0.17 %).

The special attention was paid to the both water-soluble chromium and total chromium concentrations in tested cement composite samples (Table 4). The leaching ratio calculated by comparison of the total and water-soluble chromium is also included.

Table 4 Content of total Cr and Cr (VI) in tested samples and its leaching ratio

		Samples				
		CEM I 42.5N	S1	S2	S3a	S3b
Cr total	(mg/kg)	178.5	180.4	233.5	164	180
Cr (VI)	(mg/kg)	3.19	0.22	0.13	0.15	0.19
leaching ratio	(%)	1.79	0.12	0.06	0.09	0.11

The content of water soluble chromium was measured to be lower in cement composites leachates than in cement leachates. The concentration of water soluble hexavalent chromium in CEM I cement reached the value of 3.19 mg/kg; the concentrations in cement composites samples (S1 – S3) were in the range 0.13 - 0.22 mg/kg. The minimum chromium leaching ratio (0.06 %) was detected for sample S2 and the highest one for the CEM I cement (1.79 %). The slightly higher leaching ratio was detected in our previous study [11], where the cement leaching proceeded into the rain water. Authors in [12, 13] referred that between 30 % and 90 % of the total chromium in cement clinkers are Cr (VI) compounds and 8–26 % of the total amount of Cr (VI) species is water soluble.

CONCLUSION

The paper aimed to present the results of the study of selected metals releasing from the cements materials into the water environment. The results of measurements of selected metals concentrations in water leachates showed that only a small part of their content was extracted from the cement into the water environment.

Cements are one of the building product groups in the Slovak Republic for which the required criteria are stated and the national eco-label is possible to obtain. The maximum value of soluble chromium (VI) content in cements relating to the Slovak eco-labelling process is 1.8 mg chromium (VI) per 1 kg of cement (1.8 ppm) [14]. The water soluble hexavalent chromium concentrations exceeded the Slovak eco-labelling limit and were measured much more higher in case of CEM I than in case of cement composites. To make the relevant conclusion, the more extended investigation is needed and is still in progress.

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REFERENCES

[1] Winter, N. Understanding cement: An introduction to cement production, cement hydratation and deleterious processes in concrete. WHD Microanalysis Consultants Ltd, United Kingdom, 2009.

[2] Bentaieb N., Lachemet A., Zirour R., Belaadi S. and Frances C. Thermal analysis of composite cements, Chemical Engineering Transactions, vol. 24, pp 685-690, 2011. DOI: 10.3303/CET1124115

[3] Amorim R.P., Miranda M.S., Oliveira M.B.R., Rodrigues F.A. Synthesis, hydration and durability of rice hull cements doped with chromium, Journal of Hazardous Materials, vol. 186/no 1, pp 497-501, 2011.

[4] Reference Documents on Best Available Techniques in the Cement, Lime and Magnesium Oxide Manufacturing Industries [online]. European Commission: May 2010 [cit. 2010-10-22]. <ftp://ftp.jrc.es/pub/eippcb/doc/clm_bref_0510.pdf>.

[5] Laforest G., Duchesne J. Immobilization of chromium (VI) evaluated by binding isotherms for ground granulated blast furnace slag and ordinary Portland cement, Cement and Concrete Research, vol. 35, pp 2322–2332, 2005.

[6] Berge B. Ecology of Building Materials, Second edition, London: Elsevier, 2009.

[7] Yamaguchi O., Ida M., Uchiyama Y., Hanehara S. A method for the determination of total Cr (VI) in cement, Journal of the European Ceramic Society, vol. 26, p. 785-790, 2006.

[8] Eugeniusz S. Chromium in Portland cement, Cement wapno gips 1, pp 1-16, 1985.

[9] STN EN 196-10: 2006 Methods of testing cement, Part 10, Determination of the water soluble chromium (VI) content of cement.

[10] Potgieter S.S., Panichev N., Potgieter J.H., Panicheva S. Determination of hexavalent chromium in South African cements and cement-related materials with electro thermal atomic absorption spectrometry, Cement and Concrete Research, vol. 33, pp 1589-93, 2003.

[11] Palaščáková L., Eštoková A., Bálintová M., Petriláková A. Assessment of the content of chromium (VI) in selected types of cement as a part of cement eco-labelling. Pollack Periodica; 2011, 6, 123-9 DOI: 10.1556/Pollack.6.2011.3.12.

[12] Yamaguchi O., Ida M., Uchiyama Y., Hanehara S. A method for the determination of total Cr (VI) in cement, Journal of the European Ceramic Society, vol. 26, pp 785 – 790, 2006.

[13] Palaščáková L., Eštoková A., Sičáková A. Analysis of selected elements releasing from cements by XRF, Construmat 2011: 17th international conference, Košická Belá, Slovakia, 2011, pp. 401-407

[14] Estokova A., Palascakova L. Evaluation of heavy metals releasing from the cements in relation to the Slovak eco-labelling process, SGEM 2011: 11th International Multidisciplinary Scientific GeoConference, Bulgaria, 2011, pp 347-354.

STUDY ON EMISSIONS OF POLLUTANTS COMING FROM THE RUBBER DEVULCANIZATION S.C. ARTEGO S.A. TG-JIU - ROMANIA

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ABSTRACT

SC ARTEGO SA, Rubber and Renewable Department and Power Station, following the processes or different technological operations, removes residual gaseous effluents, which contain pollutants: CO, NOx, SO_2, particulate matter, SO_2, H_2S, ammonia, mercaptani, acroleina and COV. After cycle devulcanization opening and autoclaves, hot gases are discharged through a tubing into the atmosphere after passage through scruber. Its role is to drop the gas temperature, the concentration decrease in emissions and to retain the fine particles of dust (pudreta rubber), involved with the gaseous pollutants. For rubber devulcanization, are used in frequently as an agent of regeneration, environmental aromatic oil (type Teleajen). To calculate the actual height of the sources of pollution and dispersion parameters were used formulas developed by Briggs in 1982. Emissions of pollutants SO_2, H_2S , NH_3, and COV acroleina determined to cart exhaust, the entry and exit of the scrubber initial and of the scrubber modernized by decreasing pressure comparison with CMA, are represented graphically.

Keywords: emissions, pollutants, atmosphere, concentration, dispersion

INTRODUCTION

The emission of pollutants in the atmosphere is removing pollutants solid, liquid or gaseous, point source or area (stationary sources fixed or mobile), discharging into the atmosphere, pollutants from different socio-economic activities. S.C. ARTEGO S.A., Rubber and Renewable Department and Power Station, following the processes or different technological operations, removes residual gaseous effluents, which contain pollutants CO, NOx, SO_2, particulate matter (from burning gas to fuel power station, waste gases are discharged through a chimney dispersion with height from the ground 20 m in diameter and 1,4 m peak) and SO_2, H_2S, ammonia, mercaptani, acroleina, COV (Department of Rubber renewable exhaust emissions are routed through a tubing, which takes the waste gases from the scrubber gas washing plant; tubing has a section of 0,196 m² and a ground height of 12 m). Thermal power of the central heating is 34,9 MW/boiler. Since Central operates with a single boiler (the second one is spare), a thermal power plant is less than 50 MW.

EXPERIMENTAL

Power station is equipped with 2 types Teruzzi boilers that produce steam required Rubber of the regeneration. Central heating power of 34,9 MW/boilers, each boiler has a burner, the fuel gas being used. Central functions with a single boiler (the second being the backup boiler) gas discharge being through two metal baskets, one for each boiler.

Were measured concentrations of pollutants discharged into the atmosphere by means of: automatic (burned gas), lab (for dust) and spectrophotometric (for SO_2, H_2S, ammonia, acroleina) [1]. For measurements of gas burned (performed Analyzer Testo 350), if the outcome measurements are expressed in ppm transformation in mg/Nm^3, is done by multiplying by appropriate factors (2,05, 2,93, 1,25 for NOx, SO_2 and CO, respectively), report the conditions of normal temperature and pressure (0°C and 1013 mbar). Because the emission limit values (VLE) are reported at an oxygen content of the reference of 3% (volume), the fuel gas, the measurements should be related to the content using the formulas (eq.1):

$$\mathrm{Noxa}_{[\mathrm{mg/Nm^3}]_{3\%\,O_2}} = \{\frac{(21-3)}{21-[\mathrm{O_2}]}\}\cdot[\mathrm{Noxa}]\ [\mathrm{mg/Nm^3}] \qquad (1)$$

where:

$\mathrm{Noxa}_{[\mathrm{mg/Nm^3}]_{3\%\,O_2}}$ =concentration noxa

21 = volume of oxygen content in air

3 % = volume content of oxygen reference for gas combustibill

O_2 = oxygen content by volume measured in effluent gas

[noxa] = noxa concentration [mg/Nm^3].

Reporting to the volumetric flow is normal using the equation (eq.2):

$$\frac{Q_v}{T} = \frac{Q_{v0}}{T_0} \qquad (2)$$

where:

Q_v, Q_{v0} = volumetric flow corresponding temperatures

T, T_0 = temperature [^{0}K]

Mass concentrations of pollutants associated gas combustion are reported in normal conditions (0°C and 1013 mbar), so are expressed in mg/Nm^3, the oxygen content of specific reference fuel used. After cycle devulcanization opening and autoclaves, hot gases are discharged through a tubing into the atmosphere after passage through scruber. Its role is to drop the gas temperature, the concentration decrease in emissions and to retain the fine particles of dust (pudreta rubber), involved with the gaseous pollutants. Effluent gas samples were taken from tubing entry pollutants in scrubber respectively output to be determined yield install[2]. For rubber devulcanization, are used in frequently as an agent of regeneration, environmental aromatic oil (type Teleajen).Calculating concentrations in the atmosphere were carried out with Gaussian dispersion model, focused on wind, which allows knowledge model concentrations at ground level at distances of different sources and for different weather situations. Equation for calculating the dispersion is (eq.3):

$$C(X,Y)=\left(\frac{Q}{2\pi\cdot\sigma_y\cdot\sigma_x\cdot U}\right)\cdot\exp\left(-0{,}5\cdot\frac{Y^2}{\sigma_{Y^2}}\right)\cdot\exp\left(-0{,}5\cdot\frac{H^2}{\sigma_{X^2}}\right) \quad (3)$$

where:

C (X,Y) = pollutant concentration in the point x, y

Q = mass flow rate;

H = effective height of the source of pollution, according to the basket height, diameter at the top of its speed and temperature of exhaust gas air stratification

σ_X,σ_Y = dispersion parameters depending on source-receiver distance, stratification of air in which instead pollutant dispersion (urban-rural)

U = wind speed at source height.

To calculate the actual height of the sources of pollution and dispersion parameters were used formulas developed by Briggs in 1982. For the calculation was considered an area of 2000 x 2000 m, with step of 200 m, the unit being placed in zone line.Applying the model and climatological dispersion were calculated on the maximum concentrations of environmental mediation (daily - 24 h) for NO_2, SO_2, H_2S, NH_3, acroleina.

RESULTS AND DISCUSSIONS

Determinations of burned gas and powders have been made to cart dispersion of a boiler Teruzzi; the results are presented in table 1:

Table 1. Results of dust and gas burned determinations at Power station

Pollutant	UM	Concentration					Emission limit value
		Det. 1	Det. 2	Det. 3	Det. 4	Media	
CO	ppm	1	0	1	0	-	-
	mg/Nm^3	1,58	0,00	1,52	0,00	0,77	100
NOx	ppm	142	145	149	148	-	-
	mg/Nm^3	367,71	363,73	370,99	367,51	367,48	350
SO_2	ppm	0	0	0	0	-	-
	mg/Nm^3	0	0	0	0	0	35
O_2	%	6,75	6,29	6,18	6,14	6,34	-

From the results presented in the table as shown in the effluent gaseous waste resulting from the power station, NO_2 concentrations exceed the threshold and alert threshold for intervention, which corresponds to a significant pollution of the order I. In consequence, it is recommended to optimize combustion by mounting a burner with low NOx. To determine the level of emissions routed, generated by stationary source of Regenerated Rubber, measurements were made of emissions after devulcanization cycle for each of the four autoclaves of the plant, the results being presented in table 2:

Table 2. Emissions of pollutants, using as a regeneration agent a medium aromatic oil (initial scrubber)

Source emission	Pollutant	UM	Concentration					Emission limit value
			Det.1	Det.2	Det.3	Det. 4	Media	
Exhaust Cart (scrubber before water curtain)	SO_2	mg/Nm^3	493,2	510,02	515,5	543,76	515,62	500
	H_2S	mg/Nm^3	5,98	6,23	7,30	8,33	6,96	5
	NH_3	mg/Nm^3	29,86	30,23	32,25	40,66	33,25	30
	Acroleina	mg/Nm^3	19,7	18,89	22,98	24,83	21,60	20
	COV	mg/Nm^3	6500	6580	6920	6670	6667,5	150
Exhaust Cart (scrubber after water curtain)	SO_2	mg/Nm^3	411,2	420,8	421,06	431,98	421,26	500
	H_2S	mg/Nm^3	4,80	4,96	4,24	5,92	5,23	5
	NH_3	mg/Nm^3	19,8	20,25	20,67	22,56	20,82	30
	Acroleina	mg/Nm^3	16,9	17,25	17,05	17,68	17,22	20
	COV	mg/Nm^3	5820	5850	6030	5910	5902,5	150

Emissions of pollutants SO_2, H_2S , NH_3, and COV acroleina determined to cart exhaust, the entry and exit of the scrubber and initial comparison with CMA, are represented graphically in figures 1, 2, 3, 4 and 5.

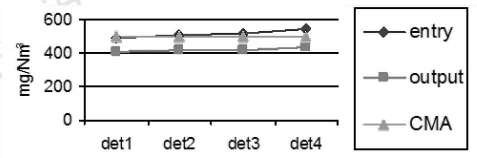

Fig.1. Emissions of SO_2 at entry / exit, scrubber initial

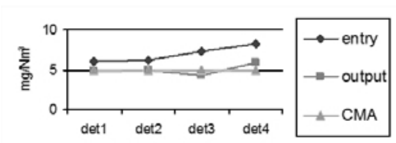

Fig. 2. Emissions of H_2S at entry / exit, scrubber initial

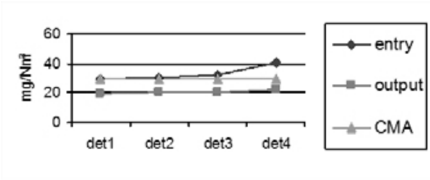

Fig. 3. Emissions of NH_3 at entry/exit, scrubber initial

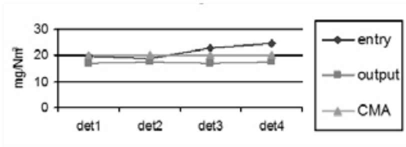

Fig. 4. Emissions of acrolein at entry/exit, scrubber initial

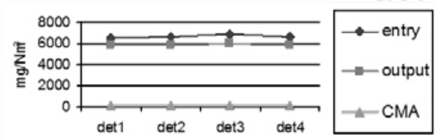

Fig. 5. Emissions of COV at entry/exit, scrubber initial

After passing through the wash, it is found that the emission limit value, the threshold for intervention (PI), the indicators SO_2, NH_3, and overcoming acroleina alert threshold (PA) for SO_2, and ammonia acroleina at one sample analyzed. For H_2S and VOC is exceeded and alert thresholds and thresholds for intervention, which proves the efficiency low scrubber is the recommended replacement. Increasing capacity for retention of existing scrubber and increase its efficiency, has been replaced with other modernized, more efficient. After the cycle devulcanization opening and autoclaves, hot gases are discharged with a pressure of about 30 atm. Since this pressure is relatively low absorption capacity of the plant washing, pressure drop is needed gas before discharge in tubes. The only viable solution is that, after devulcanizare gases to be discharged into a second autoclave not working (empty), the pressure decreasing to half (approximately 15 atm.) After installation of new equipment washing and taking measure to decrease the gas pressure, were again made determinations on the route of the exhaust gas effluent (before and after the scrubber), using in the recipe, as an agent of regeneration, environmental aromatic oil, type Teleajen. Results are presented in table 3:

Table 3. Emissions of pollutants, using as a regeneration agent a medium aromatic oil (imodernized scrubber)

Source emission	Pollutant	UM	Concentration					Emission limit value
			Det.1	Det.2	Det.3	Det 4	Media	
Exhaust Cart (scrubber before water curtain)	SO_2	mg/Nm^3	525,03	522,06	515,33	498,06	515,12	500
	H_2S	mg/Nm^3	78,96	7,65	6,62	6,41	7,16	5
	NH_3	mg/Nm^3	35,63	33,98	31,22	31,09	32,98	30
	Acroleina	mg/Nm^3	22,23	21,96	20,97	20,12	21,32	20
	COV	mg/Nm^3	6420	6410	6380	6350	6390	150
Exhaust Cart (scrubber after water curtain)	SO_2	mg/Nm^3	323,23	315,02	311,32	295,43	311,25	500
	H_2S	mg/Nm^3	3,23	3,01	2,95	2,65	2,96	5
	NH_3	mg/Nm^3	18,56	17,53	16,10	16,01	17,05	30
	Acroleina	mg/Nm^3	9,65	8,36	7,72	7,39	8,28	20
	COV	mg/Nm^3	4850	4830	4690	4700	4767,5	150

Emissions of pollutants SO_2, H_2S, NH_3, and VOC acroleina determined to Cart exhaust, the entry and exit of the scrubber modernized by decreasing pressure and comparing with the CMA, are represented graphically in figures 6, 7, 8, 9 and 10 .

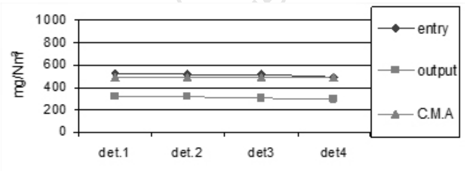

Fig. 6. Emissions of SO_2 at entry/exit, scrubber modernized

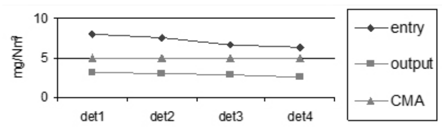

Fig. 7. Emissions of H_2S at entry/exit, scrubber modernized

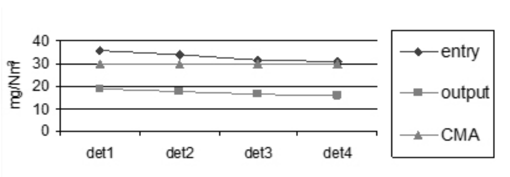

Fig. 8. Emissions of NH_3 at entry/exit, scrubber modernized

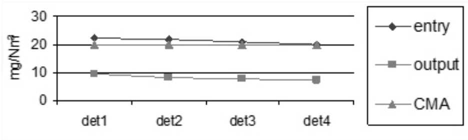

Fig. 9. Emissions of acroleina at entry/exit, scrubber modernized

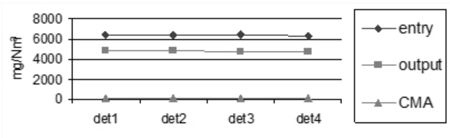

Fig. 10. Emissions of COV at entry/exit, scrubber modernized

Comparing values obtained with the emission limit values, is observed a drastic decrease in concentrations of pollutants after passage through the wash, they are framing in the VLE, and even in the alert threshold, except for volatile organic compounds, whose concentration has major overruns. In conclusion, the new plant is more efficient than the first, but not entirely, considering the large amounts of COV.

CONCLUSIONS

1. SC ARTEGO SA Tg-Jiu, Department Regenerated Rubber and power station, following different processes or technology operations, remove residual gaseous effluents, which contain pollutants CO, NOx, SO_2, dust, H2S, ammonia, mercaptani, acroleina, COV

2. Central heating is fitted with 2 type Teruzzi boilers that produce steam required by Rubber Regeneration Plant, and the thermal power of the power station is 34,9 MW/boiler. Central functions with a single bobiler (the second being the backup boiler), gas discharge being through two metal baskets, one for each boiler.

3. For rubber devulcanization, there has been used the medium aromatic oil as a regeneration agent (type Teleajen)

4. After ending the devulcanization cycle and the autoclave opening, hot gases are discharged through a tubing into the atmosphere, after passing through the scrubber, which is to drop the gas temperature, to decrease the concentration in emissions and to retain the fine particles of dust, together with gaseous pollutants.

5. Effluent gas samples were taken from entry tubing entry of pollutants in scrubber, respectively output, to be determined the yield of washing plant.

6. To determine the level of emissions routed generated stationary source of regenerated rubber, measurements were made of emissions after devulcanizare cycle for

each of the four autoclaves of the plant. After passing through the wash, it is noted that the limit value of pollutant emission of SO_2, NH_3, acroleina. For H_2S and COV is exceeded and alert thresholds and thresholds for intervention, which proves the low efficiency of scrubber, its replacement being recommended. In order to increase capacity for retention of existing scrubber and increase its efficiency, it has been replaced with other modernized, more efficient

7. After installation of new equipment washing and taking measure to decrease the gas pressure, there were again made determinations on the route of the exhaust gas effluent (before and after the scrubber).

8. Comparing values obtained with the emission limit values, it is observed a drastic decrease in concentrations of pollutants after passage through the wash, they are framing in the VLE, and even in the alert threshold, except for volatile organic compounds, whose concentration has major overruns. In conclusion, the new plant is more efficient than the first, but not entirely, considering the large amounts of COV.

REFERENCES

[1] Gămăneci G., Hristov E., Petrova B., Moc A, Şchiopu E.C., Ecology and environment protection, Academica Brâncuşi, Romania, pp 190 – 192, 2008;

[2] Popa R., Racoceanu C, Şchiopu E.C.,Techniques for air monitorization and purification, Sitech, Romania, pp 145-150, 2008;

SULPHATES REMOVAL FROM ACID MINE DRAINAGE

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ABSTRACT

Acid mine drainage (AMD), the highly acidic, dissolved metals and sulphates containing wastewater is a persistent environmental problem related to many active and abandoned mine sites. It is formed by geo-chemical reactions that occur when sulphide-bearing minerals are exposed to oxidizing conditions and water. Untreated AMD pollutes receiving streams and subsurface waters by toxic metals and sulphates and causes destruction of the environment.

Various treatment techniques of AMD have been developed during the recent time to reach neutralization of the waters and elimination of dissolved metals and sulphates. Our work is focused on the biological removal of sulphates from AMD by way of anaerobic reduction to sulphide using sulphate-reducing bacteria (SRB). For cultivation of SRB various growth substrates were used – sodium lactate, ethanol, sweet whey and acid whey. The experiments were performed using real water collected from the site of the AMD outflow at the shaft Pech that receives the mass of waters draining the enclosed and flooded Smolnik sulphidic deposit. Before the process majority of metals (Fe, Al, Mn, Zn, Cu) have been eliminated from AMD by selective sequential precipitation. The sulphates removal with efficiency 83 %, 58 %, 43 % and 11 % from pre-treated AMD has been achieved depend on the growth substrates used for cultivation of SRB.

Keywords: acid mine drainage, sulphates removal, sulphate-reducing bacteria

INTRODUCTION

The sulphates are ubiquitous in freshwater environments. They are not considered to be toxic to aquatic life, unless at very high concentrations due to their lower environmental risks – sulphates emissions are not a direct threat for the environment as they are chemically inert, non-volatile and non-bioaccumulative compounds. In general, organisms have a relatively high tolerance for sulphates. The consumption of drinking water containing sulphates concentration in excess of 600 mg/l commonly results in laxative effects. The taste threshold for the most prevalent sulphates salts ranges from 250 to 500 mg/L [1, 2, 3]. The volume of information related to sulphate toxicity on aquatic organisms within the scientific literature is relatively scarce, compared to other substance. Generally, toxicity of sulphates for most tested aquatic organisms, including fish increases with decreasing water hardness and chloride concentration. [1, 4, 5]. The discharge of sulphate-rich industrial wastewater into surface waters contributes to the increase of the corrosion potential of receiving waters and augments the total dissolved solid contents. Another problem associated with sulphates enrichment at anaerobic condition is the reduction of dissolved sulphates to sulphides and volatilization to air as hydrogen sulphide causative noxious odour [5]. Moreover, high concentration of sulphates induces an unbalance in the natural sulphur cycle [6].

Most jurisdictions have limits set in respect of waters intended for drinking water abstraction and finished drinking water, but not for aquatic life protection [2]. Currently Government Regulation No 269/2010 of Slovak Republic Code includes general requirements for water quality, where the recommended concentration of sulphates is 250 mg/l for surface waters, 150 mg/l (recommended value) or 250 mg/l (marginal value) for waters intended for drinking water abstraction and 250mg/l for irrigation waters.

Waste waters containing enhanced concentration of sulphates are generated by a large spectrum of industrial processes – mining industry, tanneries, paper and pulp production, sea food processing, potato starch production, fertilizers. Acid mine drainage (AMD), water draining active and, in particular, abandoned mines and mine wastes are largely acid with elevated concentrations of metals and sulphates. Sulphates may be present in AMD at concentrations ranging from few hundred to several thousand milligrams per litre and they shouldn't be discharged into water bodies without sulphates removal. Different treatment processes of mine waters have been proposed. The selection of criteria for each of techniques is based on the various technical, economical, environmental factors and enactments. The treatment processes for removing sulphates may be broadly categorized: chemical treatment with mineral precipitation, membrane technologies, ion exchange technologies and biological technologies [3].

The biological removal of sulphates from wastewaters is possible to realize by way of anaerobic reduction to sulphide using sulphate-reducing bacteria (SRB). SRB represent a morphologically and phylogenetically heterogeneous group of microorganisms. SRB are widely distributed in terrestrial, subterrestrial and marine ecosystems and they can also grow in different extream physico-chemical condition of our planet such as the saline, hot and cold environs [7]. For a long time, the accepted view is that SRB prefer surroundings with pH from 6 to 8 and known pure cultures grew only at circumneutral pH [8]. They are generally strict anaerobes that oxidize simple organic compounds or hydrogen using sulphate, thiosulphate or sulphite as a terminal electron acceptor. Lactate is the substrate most widely used in laboratory SRB culture conditions [9], but it is too expensive for a large-scale processes. Several low molecular weight organic compounds have been used as alternative electron donors, such as acetate, propionate, methanol and ethanol. In addition, various types of organic substances have been investigated as electron donors including sewage sludge, leaf mulch, wood chips, animal manure, vegetal compost, sawdust, mushroom compost, whey and other agricultural waste. More complex organics must first undergo hydrolysis and fermentation by acid producing bacteria before utilization by SRB [10]. Researches have shown that using mixtures of substrates rather than a single substrate increases sulphate reduction [11]. Due to the big number of potential substrates the chemical oxygen demand (COD) was introduced to quantify the mass or concentration of organic materials [12]. Sulphate rich wastewaters are usually deficient in electron donors and require their external addition in order to achieve a sulphate reduction [11, 13].

MATERIALS AND METHODS

Acid mine drainage

The investigation was carried out at laboratory scale, utilizing AMD discharged from the shaft Pech situated in Smolnik (abandoned and flooded Slovak sulphidic deposit), with variable concentration of sulphates depending on seasons and weather. In our experiment the water with pH 3.8, containing 3160 mg/L of sulphates was used. Before the process majority of metals (Fe, Cu, Al, Zn, Mn) were eliminated from AMD by selective sequential precipitation process (SSP). Listed metals were removed by precipitation in the form of hydroxides using sodium hydroxide as reagent and sulphides using bacterially produced hydrogen sulphide as reagent at various values of pH [14, 15]. The terminal pH value of AMD after SSP process was 9.5.

Microorganisms

In the experiment the culture of sulphate-reducing bacteria (genera *Desulfovibrio*) has been used, isolated from a mixed culture of SRB obtained from the mineral water Gajdovka (Košice, Slovak Republic). For isolation and cultivation the selective nutrient Postgate`s medium C was used at 30ºC and anaerobic conditions [9].

Analytical procedures

The nefelometric method was used to determine the concentration of sulphates at 490 nm using Spectromom 195 spectrophotometer. The pH of the cultivation mediums was determined by potentiometric method using Radiometer Analytical PHM 210 MeterLab pH meter.

EXPERIMENTS

Batch studies of sulphates removal from pre-treated AMD by way of anaerobic reduction to sulphide using SRB were carried out. Eight reactors containing 200 ml of modified nutrient Postgate`s medium C were used. The modification in each case was removing the sulphate containing salts from the prescribed media and adding 200 ml pre-treated AMD containing the soluble sulphates. Here were also used different growth substrates with value of COD 5g/L: sodium lactate as standard substrate; ethanol; sweet whey, by-product of cheese production and acid whey, by-product of curds production. The pH values of nutrient media was adjusted at about 7.5 using 5 M solution of sodium hydroxide. Four reactors were inoculated with 10% of a 3-day SRB culture at anaerobic condition and incubated at 30ºC (samples marked La-Na, Et, Ws, Wa). Four abiotic controls without SRB culture have been prepared (samples marked La-Na AC, Et AC, Ws AC and Wa AC). The samples were collected daily over a two weeks to monitor the level of sulphates. The pH values all of the samples were measured at the end of the experiment.

RESULTS AND DISCUSSION

In this experiment the anaerobic reduction of sulphates using sulphate-reducing bacteria has been carried out with aim to eliminate of sulphates from real AMD. During experiment the evidence of bacterial sulphate reduction to hydrogen sulphide was obtained by formation of black precipitates of FeS, when sulphide is formed (for diagnostic purposes media contain a ferrous salt), by decreasing of sulphates concentration in the nutrient media and by unpleasant odour of nascent hydrogen sulphide. Figure 1 shows sulphate reduction kinetic when using substrates sodium lactate, ethanol, sweet whey and acid whey respectively compared with abiotic controls.

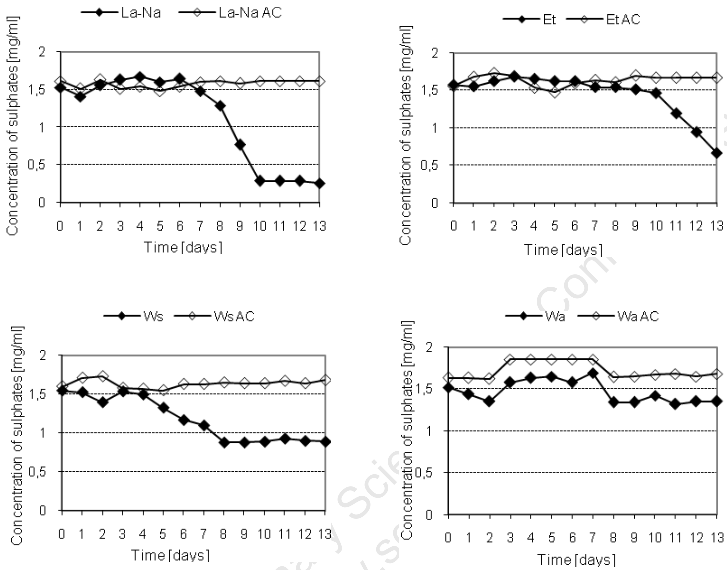

Figure 1: Sulphate-reduction kinetics using natrium lactate, ethanol, sweet whey and acid whey as substrate for cultivation of SRB.

In our experiment the removing of sulphates by dissimilatory sulphate reduction was reached with 83 % (La-Na), 58 % (Et), 43 % (Ws) and 11 % (Wa) efficiency depend on the used growth substrate. In abiotic controls the concentration of sulphates did not decrease. Figure 2 shows the efficiency of sulphates elimination.

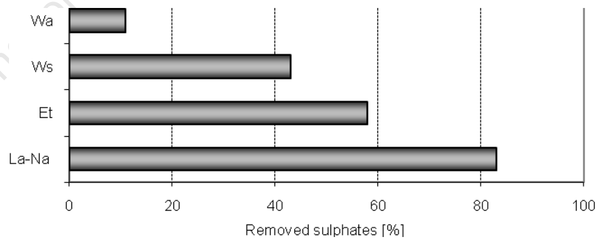

Figure 2: Efficiency of sulphates removal

Comparison of sulphates removal efficiency and pH values of particular nutrient media at the end of the experiment are reported in Table 1. The effectiveness of sulphate reduction depends on the suitability of used substrates as carbon sources for growth of SRB. SRB are sensitive to even mild acidity and several studies showed that acidification of surrounding inhibits the sulphate reduction [8]. Related to this data the drop of the efficiency of sulphate reduction is probably a result of pH value decreasing in the samples. The relevant factor influenced the pH values are the metabolic products of particular substrates.

Table 1: Efficiency of sulphate reduction and pH values of nutrient media at the end of the experiment

growth substrate	sodium lactate	ethanol	sweet whey	acid whey
efficiency	83 %	58 %	43 %	11 %
pH	7.03	6.25	5.77	4.17

Technologies include SRB are promising for AMD treatment because of their ability to reduce soluble sulphates and produce high amount of hydrogen sulphide which has a great affinity to react with most dissolved metals to form insoluble metal sulphides [16]. The potential advantages of metal sulphide precipitation over the usually used hydroxide precipitation in chemical treatment processes include lower effluent metal concentrations, better thickening characteristics of the metal sludge and the possibility to recover valuable metals [17]. Obtained hydrogen sulphide may be also oxidized to elementary sulphur using biological methods. They are divided to direct and indirect. The indirect methods apply the ferric iron for conversion of sulphide to elementary sulphur and the iron-oxidizing bacteria for the regeneration of ferric iron. In the direct processes photoautotrophic or chemolitotrophic bacteria oxidize sulphide to elementary sulphur [18].

CONCLUSION

The use of sulphate-reducing bacteria to remove sulphates from wastewater using different growth substrates was the aim of our experiment. The concentration of sulphates in reactors contained modified nutrient Postgate`s medium C with pre-treated AMD as a source of sulphates was monitored during two weeks. Four reactors were inoculated by SRB cultures and four reactors without inoculation served as abiotic control. Elimination of sulphates with 83 % (using sodium lactate as growth substrate), 58 % (using ethanol as growth substrate), 43 % (using sweet whey as growth substrate) and 11 % (using acid whey as growth substrate) efficiency has been achieved in our research. In batch experiments sodium lactate was superior to ethanol, sweet whey and acid whey as a carbon source for the SRB. However due to the high cost of sodium lactate, its utilization for a large-scale operation would be prohibitive. Other organic substances could be used as alternative substrates to reach satisfactory efficiency of sulphate reduction. Results of our experiment have demonstrated the technical feasibility of the use of sulphate-reducing bacteria to biological sulphate removal from pre-treated real AMD.

ACKNOWLEDGEMENT

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REFERENCES

[1] Davies T.D. & Pickard J.S. & Hall K.J. Sulphate Toxicity To Freshwater Organisms and Molybdenum Toxicity to Rainbow Trout Embryos/Alevins, British Columbia Mine reclamation Symposium, 2003, pp 1-11.

[2] Aquatic Services Unit, UCC. Impact Assessment on River Feale Increased Effluent Sulphate, April 2005.

[3] INAP - International Network for Acid Prevention, Treatment of Sulphate in Mine Effluents, LORAX Environmental, Inc., 2001.

[4] IDNR - Iowa Department of Natural Resources, Consultation Package, Water Quality Standards Review: Chloride, Sulfate and Total Dissolved Solids, 2009a.

[5] IDNR - Iowa Department of Natural Resources, Revising Criteria for Chloride, Sulfate and Total Dissolved Solids, 2009b.

[6] Sarti A. & Silva A.J. & Zaiat M. & Foresti E. The treatment of sulfate-rich wastewater using an anaerobic sequencing batch biofilm pilot-scale reactor, Desalination 249, pp 241-246, 2009.

[7] Barton L.L. & Fauque G.D. Biochemistry, Physiology and Biotechnology of Sulfate-Reducing Bacteria, Advances in Applied Microbiology 68, pp 43-98, 2009.

[8] Koschorreck M. Microbial sulphate reduction at a low pH, FEMS Microbiol Ecol 64, pp 329-342, 2008.

[9] Postgate J.R. The sulphate Reducing Bacteria, 2nd edition, 1984.

[10] Knobel A.N. & Lewis A.E. A mathematical model of a high sulphate wastewater anaerobic treatment system, Water Research 36, pp 257-265, 2002.

[11] Liamleam W. & Annachhatre A.P. Electron donors for biological sulfate reduction, Biotechnology Advances 25, pp 452-463, 2007.

[12] Van Haandel A. & Van der Lubbe J. Handbook Biological Waste Water Treatment, The Netherlands, 2007.

[13] Martins M. & Faleiro M.L. & Barros R.J. & Verissimo A.R. & Costa M.C. Biological sulphate reduction using food industry wastes as carbon souces, Biodegradation 20, pp 559-567, 2009.

[14] Macingova E. Application possibilities of the bioremediation methods for the elimination of the environmental and industrial loads, Slovak Republic, The Technical University of Košice, Ph.D. thesis, 2010.

[15] Macingova E. & Luptakova A. Recovery of metals from acid mine drainage by selective sequential precipitation processes, SGEM 2011 Conference Proceedings, Volume III, pp 573-578, 2011.

[16] Kaksonen A.H. & Puhakka J.A. Sulfate Reduction Based Bioprocesses for the Treatment of Acid Mine Drainage and the Recovery of Metals, Eng. Life Sci., vol. 7, no. 6, pp 541-564, 2007.

[17] Huisman J.L. & Schouten G. & Schultz C. Biologically produced sulphide for purification of process streams, effluent treatment and recovery of metals in the metal and mining industry, Hydrometallurgy 83, pp 106-113, 2006.

[18] Tang K. & Baskaran V. & Mehdi T. Bacteria of the sulphur cycle: An overview of microbiology, biokinetics and their role in petroleum and mining industries, Biochemical Engineering Journal 44, pp 73-94, 2009.

SUSTAINABILITY EVALUATION OF CONSTRUCTION WORKS USING AN ORIGINAL MODEL

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ABSTRACT

Sustainable development has been identified as a top priority problem in construction works. Directives and standards have been developed which are intended to encourage the implementation of sustainable criteria in the life cycle stages of a construction work. The paper presents an evaluation model developed by the authors. The global model is a comprehensive tool, which can be applied mainly on residential buildings. The utility of such model is important in the assessment of a construction work, because it converts sustainability issues into quantifiable goals, which are easier to understand, to use and to apply. The model is used for the sustainability assessment of a new residential dwelling, situated near to Timisoara.

Keywords: sustainability, construction, evaluation model, residential building

INTRODUCTION

The most often quoted definition for sustainable development, is the one presented in the Report of the World Commission on Environment and Development: Our Common Future (WCED 1987), which defines sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs"[1]. Sustainability is represented as a confluence of the three pillars: economic, environment and social, as presented in Figure 1. For this reason a correct assessment of sustainability performances must combine issues of all three dimensions in an equal manner.

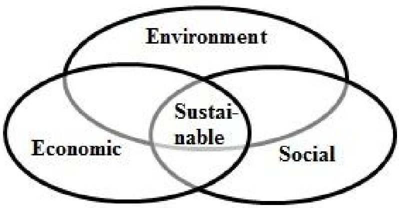

Figure 1. Scheme of sustainable development: at the confluence of three constituent parts [2].

Construction industry has a major determining role on the environment, contributing to economic growth, but having also great social responsibility. It is a major consumer of land and raw materials and generates a great amount of waste [3]. It is also a significant user of non-renewable energy and an emitter of greenhouse gases and other gaseous wastes. Many researches, studies and evaluation tools are available regarding the assessment of the environmental impacts of construction works, offering information on embodied energy, greenhouse gas emissions, waste, etc. Other works are focused on life cycle cost and project management, because most of the people are interested only in the economic part. Neither the social aspects of a construction work are neglected, because they most provide high comfort, safety and adaptability. But in order to address sustainability, all the three parts must be considered equally, in order to respect the definition of sustainability [4].

The paper presents an evaluation model, developed by the authors, which combine environmental, economic and social parameters in an almost equal way. In this way a correct evaluation of the sustainability performances of a construction work can be performed.

GLOBAL MODEL

The evaluation model is developed mainly for the assessment of residential buildings. Because in Romania the residential sector is significant among the construction market, it is a priority to develop a sustainability assessment methodology which can rate buildings and helps to choose sustainable solutions.

The model considers in the assessment the entire building with its components, the construction site and building occupants although some sustainability categories may have an influence on the global or local environment.

The global model defines 13 major sustainability issues with 46 criteria and over 50 qualitative or quantitative key performance indicators, including the three dimensions of sustainability. A short description of the issues and criteria is presented in the next section.

Environment: Energy issue (En) is composed of five parameters: initial embodied energy (En1), operational used for HVAC systems (En2), embodied energy in maintenance and renovations (En3), embodied energy in disposal after end of live (En4) and use of renewable energy sources (En5). The aim of these parameters is to use non-renewable energy efficiently and to encourage the use of renewable energy sources, as solar, geothermal, etc. If the material quantities are known, the initial embodied energy is calculated using either specialized LCA software or free available datasets. The operational energy results from whole building energetic simulations, while the remaining two are based on different scenarios. In general, the maintenance scenario for a residential building includes minor works, as the changes of internal and external decorations, or major replacements as the change of heating system, roof and exterior thermo-system.

The category GHG emissions (G) is composed of five parameters: initial GHG emissions (G1), operational (G2), related to maintenance works (G3), to disposal after end of life (G4) and heat island effect of the roof (G5). The scope of these parameters is to minimize the amount of CO_2-eq. emissions resulting from the burning of fossil fuels. The first four parameters are quantified using the same methods as in case of the energy, while heat island effect is quantified by the average solar reflectance index of the roof.

Materials and Resources (MR) is a sustainability issue, which implies four criteria: Re-use of existing materials, products and structural elements, if available (MR1), material efficiency (MR2), use of materials with recycled content (MR3) and use of local resources (MR4). These criteria has the aim to reduce the depletion of resources, by re-using or recycling parts of existing elements, and meanwhile to reduce other impacts related to manufacturing and transport of virgin materials.

The category Construction Site (CS) focuses on three main problems: Waste from construction and demolition process sent off the site (CS1), Dust produced during construction (CS2) and Noise produced during construction (CS3). CS1 encourages the development and implementation of a construction waste management program, in order to minimize the waste sent off site. CS2 aims to reduce the sources of dust and PM10 emissions arising from construction activities but also from construction equipment's, vehicle exhaust, on-site machinery, etc., applying different protection measures. The scope of CS3 is to minimize the noise arising from construction activities, in order to avoid the disturbance of the neighbourhood and to protect the health of the workers.

Land Use and Water Consumption (LW) is an important category composed of: Construction on contaminated land (LW1), Ground occupancy percentage (LW2), Potable water consumption by building occupants (LW3), Use of grey and rain water (LW3). Land and water are important natural resources which should be carefully used.

Economic: Cost (C), as in the case of energy and GHG emissions, is divided on life cycle stages: Initial cost (C1), operational cost (C2) and maintenance and repair cost (C3). For the evaluation and quantification of these parameters actualization factors have been applied, which takes in consideration escalation and discount rate of future prices.

Construction process (CP) is composed of the parameters: Erection time (CP1), Production rate (CP2) and Construction schedules (CP3). These parameters are intended to shorter the erection time, to raise the production efficiency and to plan the efficient use of resources on site.

Project Management (PM) has the aim to assure a high project quality and to encourage the implementation of sustainability issues during design, construction and operation. It is composed of the criteria: Initial documents (PM1), Documents of maintenance and operation (PM2) and Monitoring of performances (PM3). All parameters are evaluated by checklists.

Efficiency (Ef) implies: Long service life (Ef1), Area efficiency (Ef2) and Controllability (Ef3).

Social: One of the most important aspects of building, from the occupants point of view, is comfort (Cf). The category is divided in: Thermal comfort (Cf1), expressed in Predicted mean vote PMV and Predicted percentage of dissatisfied PPD; Noise and acoustic comfort (Cf2), expressed in reverberation time, airborne sound insulation and impact sound insulation; and visual comfort, expressed in average daylight factor.

Indoor air quality (IAQ) is responsible for the building occupant's health. It is divided in: VOC concentration in indoor air (IAQ1), CO concentration in indoor air (IAQ2) and Effectiveness of ventilation in natural or mechanical ventilated spaces (IAQ3). The aim of these parameters is to create good indoor ambient, eliminating odorous and dangerous gases.

Safety (Sa) includes protection against earthquake (Sa1), against flood (Sa2) and against fire (Sa3). A building must fulfil all design prescription regarding safety protection.

Accessibility and Adaptability (AA) is composed of four criteria: Access to public transport systems and proximity to user specific facilities (AA1), which has the aim to reduce pollution and traffic flow generated by the use of private cars; Lifetime homes (AA2), which intend to encourage the construction of buildings that are accessible and easily adaptable to meet the changing need of current and future occupants; Adaptability constraints imposed by structure (AA3), which intend to ensure a high degree of adaptability for new purposes and Adaptability to future changes in type of energy supply (AA3), ensuring that the building can, in the future, be adapted to run on a different fuel from that originally anticipated, or on renewable energy sources.

The developed model is based on a scoring system. Each parameter is scored between 0 and 5 points. For best practices 5 points are accorded while 0 point for insufficient practices. The points are accorded using different techniques and methods [5]: scaled scoring, comparison with benchmarks or other available options and subjective marking.

In order to underline the importance of each criterion, weighting is needed. The model uses a semi-objective weighting system. It considers if the impact of the parameter is on local or global level, has potential short- or long- term effects and if it's of regional importance [6]. The system has the advantage, that it is very flexible. If some parameters are modified or dis-activated, the system readjusts itself and the weightings are recalculated. But in order to respect the definition of sustainability, the three dimensions have almost an equal importance: environmental 40%, economic 30% and social 30% [7].

The global model results in a Building Sustainability Index BSI in the interval between 0 and 5. Based on the calculated BSI, the building can be ranked as shown in Table 1.

Table 1. Rating benchmarks of the global model.

Global model Rating	**Score BSI**
Very Good	> 4
Good	3.0 -4.0
Acceptable	2.0-3.0
Insufficient	<2.0

CASE STUDY – RESIDENTIAL DWELLING

The first step in the assessment procedure of a construction work using the global model is the presentation of the initial data. The studied construction work is an existing, two storey, residential dwelling, situated near to Timisoara in a rural zone (Figure 2). The structural system is realized of masonry system, with load-bearing walls of vertical hollow ceramic blocks, confined by RC columns and belts. The infrastructure is composed of continues RC foundation under the walls. Both ground floor and slab are made of RC, while the roofing system is made of a timber structure. The usable floor area is 122.2 m^2 gross floor area is 162.88m^2, built area on ground is 80.81m^2, total property area is 300m^2, while the gross volume is 407m^3. Currently no renewable energy sources are available [8].

Figure 2. The studied dwelling, near Timisoara

The second step of the assessment procedure represents the definition of the weightings. Table 2 presents the weightings applied on the dwelling, using the semi-objective weighting system.

Table 2. Weighting used for the residential dwelling.

Environmental	**Weight**	**Economic**	**Weight**	**Social**	**Weight**
Energy	13.82	Cost	13.01	Comfort	7.39
GHG Emissions	8.77	Construction Process	5.96	Indoor Air Quality	4.13
Materials and Resources	5.91	Project Management	5.96	Safety	13.75
Construction Site	3.77	Efficiency	5.07	Accessibility and Adaptability	4.73
Land Use and Water Consumption	7.73				
Total:	**40%**		**30%**		**30%**

The most important part of the model represents the assessment and certification of the construction work, which implies the quantification of each individual criterion. Table 3 presents a summarized version of the results, benchmarks and scores.

Table 3. Results, benchmarks and scoring of the parameters.

Para-meter	Value	Benchmark 0p	5p	Unit	Score	Para-meter	Value	Benchmark 0p	5p	Unit	Score
Environment											
En1	118.1	150	60	$MJ/m^2/y$	1.77	MR2	964	2000	900	Kg/m^3	4.71
En2	671	1048	450	$MJ/m^2/y$	3.15	MR3	1.36	0	30	%	0.23
En3	24.75	60	20	$MJ/m^2/y$	4.41	MR4	15.36	60	5	Km	4.06
En4	13.71	35	10	$MJ/m^2/y$	4.26	CS1	9.63	5	70	%	0.36
En5	0	0	15	%	0	CS2	66.7	20	100	%	2.96
G1	9.52	15.4	6.2	kg CO_2-eq/m^2/y	3.19	CS3	92	105	70	dB	1.92
G2	57.6	93	40	kg CO_2-eq/m^2/y	3.34		65	80	45	dB	2.2
G3	1.04	3.3	1.1	kg CO_2-eq/m^2/y	5	LW1	Checklist				3
G4	0.65	1.9	0.6	kg CO_2-eq/m^2/y	4.66	LW2	26.9	>30	30	%	5
G5	17	29	95	%	0	LW3	174	180	90	l/p/d	0.34
MR1	0	0	50	%	0	LW4	0	0	30	%	0
Economic											
C1	389	650	300	Euro/m^2	3.7	PM1	Document list				2

C2	14.91	40	10	Euro/m^2/y	4.18	PM2	Checklist				0
C3	4.54	25	5	Euro/m^2/y	5	PM3	Checklist				3
CP1	156	300	130	Days	4.2	Ef1	50	25	75	Years	2.5
CP2	6.12	6	15	Euro/hour	0.1	Ef2	75.02	70	95	%	1
CP3	0.83	0.4	0.9	-	4.3	Ef3	Checklist				3
Social											
Cf1	5.05	<15	<6	PPD	5	IAQ3	0.5	0.3	0.8	Ach	2
	0.05	[-7,7]	[-2,2]	PMV	5	Sa1	New building				5
	1.41	>5	[1,2]	Sec.	5	Sa2	Low failure probability				5
Cf2	37	35	47	dB	1.34	Sa3	3	5	1	Class	3
	66	70	58	dB	0.78	AA1	25	30	5	Min	1
Cf3	2.61	0.5	3	%	4.21	AA2	Checklist				4.17
IAQ1	Checklist				3	AA3	Checklist				3
IAQ2	Checklist				4.5	AA4	Checklist				3

The results can be displayed in a radar diagram, which offer a clear visualisation of each category. Weaknesses and strengths of the building are easy to identify as shown in Figure 3. The Building Sustainability Index of the building is 3.1, which correspond to a good practice. A total of 46 criteria were used, with about 80% of quantifiable parameters, which contribute to a high degree of objectivism.

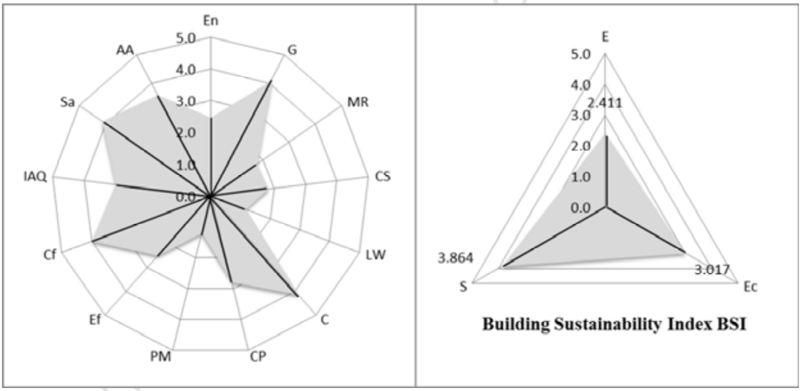

Figure 3. Category and dimension scores displayed in radar diagrams.

CONCLUSION

Sustainability is defined as the confluence of the environmental, economic and social dimensions. For a correct assessment of sustainability performances, all the three dimensions should be treated in equal way. Using evaluation models, sustainability issues can be assessed and quantified, which may help engineers in the decision making regarding different solutions.

The authors developed a comprehensive evaluation model which has been applied on an existing residential dwelling. The quantification and graphical representation of the sustainability parameters offered the possibility to identify the strengths and weaknesses of the building. The strengths of the building are:

- Low life cycle cost, due to good thermal insulation of the envelope, which reduces the costs for heating and cooling;
- High comfort resulting from good indoor environment, large surfaces of windows, which permit the access of daylight, and good sound insulation due to the high mass of the walls and slabs;
- High safety because the building respect all prescriptions regarding the design to exceptional loads;

The weaknesses of the building are:

- No re-use or recycling of existing elements or materials;
- No special protection measures on site to limit dust and sound emissions;
- High water consumption, which can be caused either by impropriate sanitary fixtures or by the occupants usage;
- Only mandatory documents are available, without the implementation of any sustainability issues, or alternative solutions;

ACKNOWLEDGEMENTS

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REFERENCES

[1] World Commission on Environment and Development, 1987. Our Common Future, Chapter 2: Towards Sustainable Development. Report of the World Commission on Environment and Development: Our Common Future.

[2] The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century. Report of the IUCN Renowned Thinkers Meeting, January, 2006.

[3] Dimoudi A, Tompa C. Energy and environmental indicators related to construction of office buildings. Resources, Conservation and Recycling 2008; 53(1-2):86-95.

[4] Bob C., Dencsak T., Bob L. Sustainability of Buildings, Proceedings of the 4th WSEAS International Conference on Renewable Energy Sources, 2010, pp. 69-74.

[5] Ugwua O.O., Haupt T.C. Key performance indicators and assessment methods for infrastructure sustainability—a South African construction industry perspective, Building and Environment 42 (2007) 665–680.

[6] Larsson, N. 2007. Rating system and SBTool. From: http://www.iisbe.org/iisbe/.

[7] Bob C., Dencsak T. Building Sustainability. Civil Engineer Approach, Lambert Academic Publishing, Saarbrucken, 2010, 65pp.

[8] S.C. Vertikal Project.S.R.L. Casa tip duplex in regim P+M si imprejmuire. Project no. 2/2011. Project documentation.

SUSTAINABLE MEASURES IN REBUILDING AFTER DISASTERPAPER

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ABSTRACT

Management of natural disasters has always been a hot issue throughout the history of mankind. Nowadays, strategic plans of counter measures and recovery are developed worldwide. International organizations, non-profit organizations, government institutions and volunteers collaborate in this direction.

In these situations, the media is the first to react and to focus on disasters like earthquakes, hurricanes and floods. The second to react is the government and after that the local authorities.

Another important aspect to be considered is the impact of the reconstruction process on the environment, the people and the local communities.

Training of local population for improving the reaction to possible future disasters is an important issue.

This is why this article will make a comparative analysis on how emergency architecture is applied in the disaster management process in different parts of the world.

Keywords: emergency architecture, sustainability, reconstruction, disaster management

INTRODUCTION

The problem of natural catastrophes and the issues of repairing the damages afterwards is a very debated issue today.

The media is the first to focus on catastrophes like earthquakes, hurricanes, floods. The second to respond is the government.

There are also local authorities which intervene during a situation of crisis.

But the category this paper analyses is that of non-profit organisations and volunteers , particularly architects.

Apart from that it is very important how the whole infrastructure is being rebuilt and how it affects the environment and the residents. A good rebuilding strategy can be observed in non-profit organisations like Architecture for Humanity, founded in 1973 in London by Cameron Sinclair.

Cameron Sinclair has had the drive to unite dozens of architects, constructors and volunteers in order redesign and rebuild communities affected by disasters in a sustainable manner.[4]

In numerous conferences held around the world one can see that the projects *Architecture for humanity* develops are based on the principles of sustainability.

The projects are economically based on local materials and technologies and involve the community. They are conceived to last and work throughout many generations. Emergency architecture is a new design and building process which lasts many years.

This is why small steps have to be taken into rebuilding an area.

Every year in Romania there are different natural disasters that affect entire villages, that's why the rebuilding process is a constant problem.

The main threats are floods which mainly occur in spring along with the melting of the snow.Usually villages and areas situated in valleys mainly at the bottom of mountains and hills are the first to be affected. Also villages close to river beds have lately suffered from floods.

Counties like :Arges, Buzau , Vrancea, Valcea are usually affected.

The measures taken in order to rebuild the affected areas are:

-the measures for repairing the infrastructure;

-measures in order to diminish the effects of floods;

-measures for the reconstruction of temporary buildings;

Usually houses are being repaired using masonry and timber structures for the roof, the same building solutions being used in almost every case of damage.

In Romania, the measures provided for reconstruction after disaster don't focus on rebuilding or on having a sustainable step by step strategy of reconstruction. The needs of the community aren't taken into account and the impact of the decision making is ignored.

This is why it is very important for Romanian architects to study this phenomenon from a social and economic point of view in order to provide long term solutions for refugees.

A good strategy would be involving the community and choosing the materials wisely according to the area and using a green building design .Also it is important to raise awareness about using temporary housing in a sustainable way.

All the pillars of sustainability have to be taken into account in these situations: the social factor, the economical and the environmental factors.

Because of the financial situation of Romania, the most important factors to be taken into account are *the costs* and the *speed of construction*.

The easiest and most efficient way to accomplish such a building is to use a modular structure. The most suitable framework would be a steel framework.

Mainly because of the high-precision factory prefabrication, steel frames have both practical and economic advantages. However, the main advantage is the speed of the construction process. A steel frame can be built in half the time of building any other type of framework (for example wood or steel). If walls, roof and windows are prefabricated too, the construction time can be reduced even more. Using renewable energy for these types of shelter also reduces construction time and lowers maintenance costs. It is also a measure which helps protect the environment.

This is why it is important to analyse different typologies of emergency architecture all over the world. One of the best known campaign is that of rebuilding Haiti after the earthquake in 2010.

Many projects have been design in order to answer the desperate call for help of the authorities of Haiti. Even though a lot of money has been donated and a lot of non-profit organisations lend a helping hand, the reconstruction process is slow and difficult.

A few projects have emerged showing a new and ingenious approach .

Le Cabanon, the Haitian Cabin is a simple yet ergonomic shelter for a two bedroom home contained in only 160 square feet.[1] The architect Andrés Duany who designed this emergency home proposed a lightweight modular home using fiberglass and resin.

(fig1, fig2).

Le Cabanon

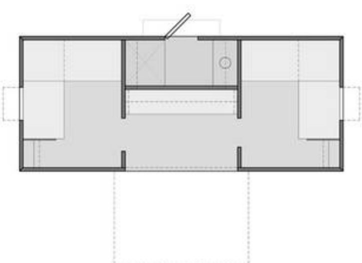


Fig.1 Fig.2

Another sustainable project built on light gague steel structure is that od NC-Office-Haiti Mountain House.

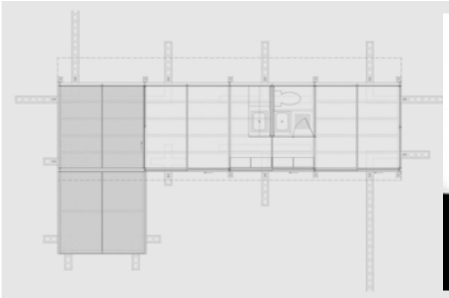


Fig.3. Fig.4

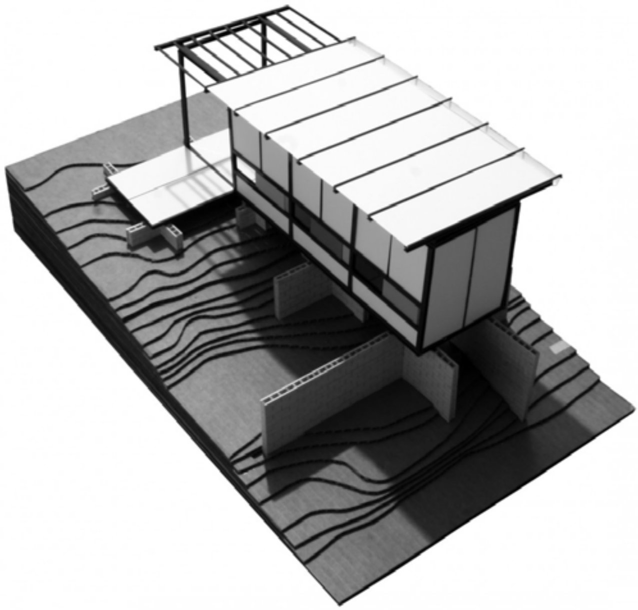


Fig.5

There's also GCIA , which has a container city pilot project under construction in Jacmel in southern Haiti. Containers which are being donated are integrated into shelter buildings.[3]

GCIA stands for Greencontainer International Aid which is an NGO providing long term planning for disaster victims.

This is how shelters made from recycled containers look like :(Fig 6)

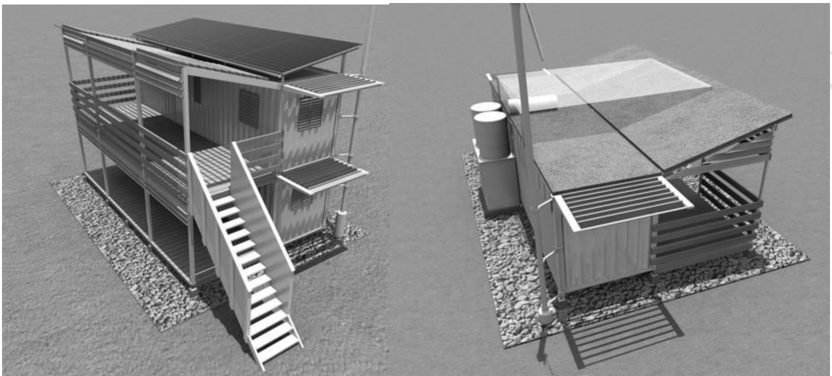
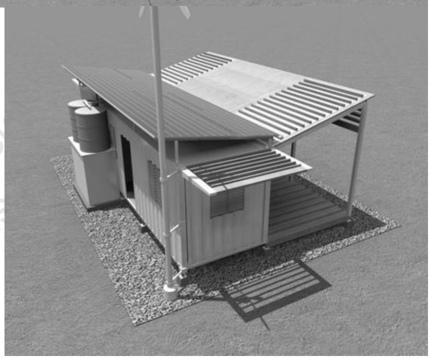


Fig 6.



Emergency architecture must be easy to build, time efficient, energy efficient and cost efficient.

In order to create such buildings there is a necessity for a technology which implies

-easy confection

-easy assembly

-the transportation should be carried out on small distances

-the reduction of labour costs through the automatisation of the factory production.

Light gauge steel has numerous structural advantages, one of them being that of the employment of modular units.

Modular units which are being manufactured and fully fitted in the factory , furthermore being transported and assembled on site. Cold formed steel is well-known for carrying lateral and vertical loads. Light gauge steel modules are prefabricated in factories and delivered on site.

The main advantages of panel or sub-frame constructions are:

-speed of erection

-factory standards of quality control during fabrication of the units

-reduction of site labour costs

-scope for automation in factory production.[5]

The structural benefits of panel construction and the experience that structural engineers and construction workers have with these technologies should make the implementing of such buildings easier in emergency cases. In the future it is very possible that Romania should start using recycled containers in order to solve the shelter problem in case of disaster.

REFERENCES

[1] Andres Duany, project for "Le Cabanon",Haiti

, http://architecture.about.com/od/housetypes/ss/HaitiHomes_2.htm

[2] NC Office- Self-sustaing home for Haiti

http://worldgreen.org/living/eco-products-for-the-home/6726-nc-office-designs-charming-l-shaped-self-sustaining-homes-for-haiti.html

[3] http://green-container-intl-aid.com/

[4] Cameron Sinclair, Architecture for Humanity, http://architectureforhumanity.org/

[5] D Dubina, I Vayas, V ungureanu New technologies and structures in civil engineering.Case studies on Remarkable Constructions ISBN 973-9400-40-x, Editura Orizonturi Universale ,pp 104

TECHNICAL AND ENVIRONMENTAL SOLUTIONS FOR SLUDGE RESULTED FROM SEWER SYSTEM MAINTENANCE (CLEANING)

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ABSTRACT

Environmental investments are an important contribution to solving economical and social development in Romania: protection of health, life quality and stimulating economic development. To contribute to regional development, Romanian authorities had to make significant investments in environmental infrastructure, particularly in water, waste and air quality. Currently, S.C. AQUATIM S.A. Timisoara has the status of regional operator; one of the key sectors is represented by the waste water treatment plant. One of the S.C.Aquatim S.A problems is sludge storage resulted from maintenance (cleaning) sewerage network. This sludge is discharged into a dump inside the waste water treatment plant. The water derived from sedimentation is sent to water line from waste water treatment plant and the sludge is transported to a waste landfill. The amount of sludge resulted after one day is about 50 mc, which is a high quantity. This paper presents the technical and ecological solutions for this issue. Taking into account the existing situation regarding improper sludge discharge it is necessary to achieve a coarse material separation plant guaranteeing well sorted materials framing and a discharged water quality respecting Romanian Standards HG 352/2005 - NTPA 001/2005 at the wastewater discharge point. Also in the paper are shown the advantages of using this solution.

Keywords: environment, pollution, waste water treatment plant, sludge, sewerage network, environmental impact, sewer system maintenance

INTRODUCTION

Environmental degradation or pollution includes alteration of the environment quality, until the state of incompatibility with life of the living organisms. Each material or substance introduced artificially in biosphere, or that exists in natural conditions and causes negative changes in environmental quality is a pollutant. A major source of water contamination is the landfill, or other solid residues, located on the ground in the open dumps irrationally located and organized. Contamination from these deposits may be produced by direct leaking of residues in rivers when raining or by infiltration in soil. The most common deposits of this type are those of urban waste and industrial solid waste, especially ash from coal burning power plants, etc. It can also be classified in the same category of sources of contamination sludge deposits from wastewater treatment plants or other chemical industries, as well as from sugar factories. Since February 1st, 2010, S.C. Aquatim S.A. is the regional operator of water services and sewerage systems, and currently provides these services in the city of Timisoara and other 64 municipalities, in the county - 8 towns, 23 large villages and 33 small villages [7]. In Timisoara, waste water and storm water are collected and conveyed through the combined sewerage system. The sewer maintenance programs are designed to improve operation efficiency and prolong the life of the assets. One of the S.C. Aquatim S.A problems is the sludge storage resulted from maintenance (cleaning) sewerage network. This sludge is discharged into a dump inside the waste water treatment plant. Water derived from sedimentation is sent to water line from waste water treatment plant and the sludge is transported to a waste landfill. Taking into account the existing situation regarding improper discharge of sludge and also environmental pollution caused by this sludge it is necessary to achieve a coarse material separation plant guaranteeing a well sorted materials framing and a discharged water quality respecting Romanian Standards [4], [6], [7].

STUDY CASE

Before starting the study case, it has been realized a sludge granulation analyze as can be seen below (Fig.1) from which results that 60 % of the quantity analyzed is grit (gravel) having the diameter of the particles between 2 and 70 mm. Starting from the idea that the sludge has 60% grit and also that the S.C. Aquatim S.A has high costs to purchase grit for sewer repairing, it was chosen a coarse material separation plant.

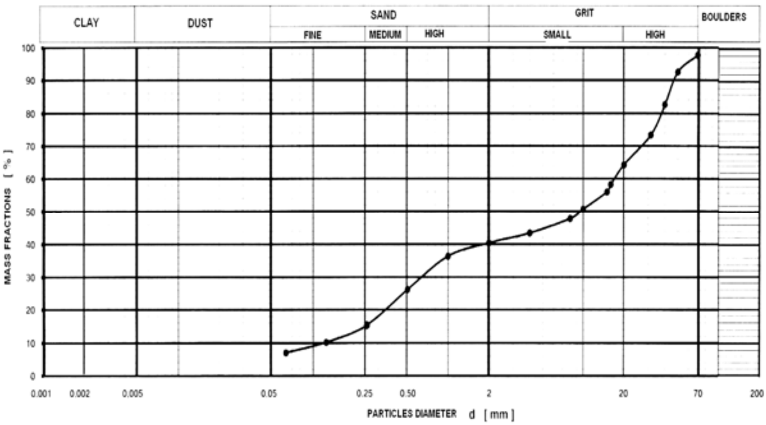

Fig.1. Granulation curve

In figure 2 it is presented the coarse material separation plant from which results the washed and sorted grit. The water needed for grit wash is taken from a well and also from water supply system. Four vacuum trucks could unload the sludge, in the same time, in a concrete underground tank [1]. The tank is covered by grate which stops the grit with the particle bigger than 40 mm. The quantity of grit which remains on the grate is 9 mc/day. From this tank the sludge is carried out, using 3 screws and a monorail with clamshell bucket, in the first grit separation installation (ROTAMAT) [8]. This installation is equipped with a rotating drum. With the rotating drum started and the wash water being added, the material supplied is first of all homogenized i.e. larger agglomerates are split up. At the same time the components < 10 mm are washed out by means of a spray bar. After that they are transported to the sump situated below the rotating drum. The coarse material > 10 mm is kept back by the rotating perforated plate and discharged into a container provided at the end of the washing drum [8]. The screen area is cleaned by means of a spray bar fixed at the outside of the washing drum.

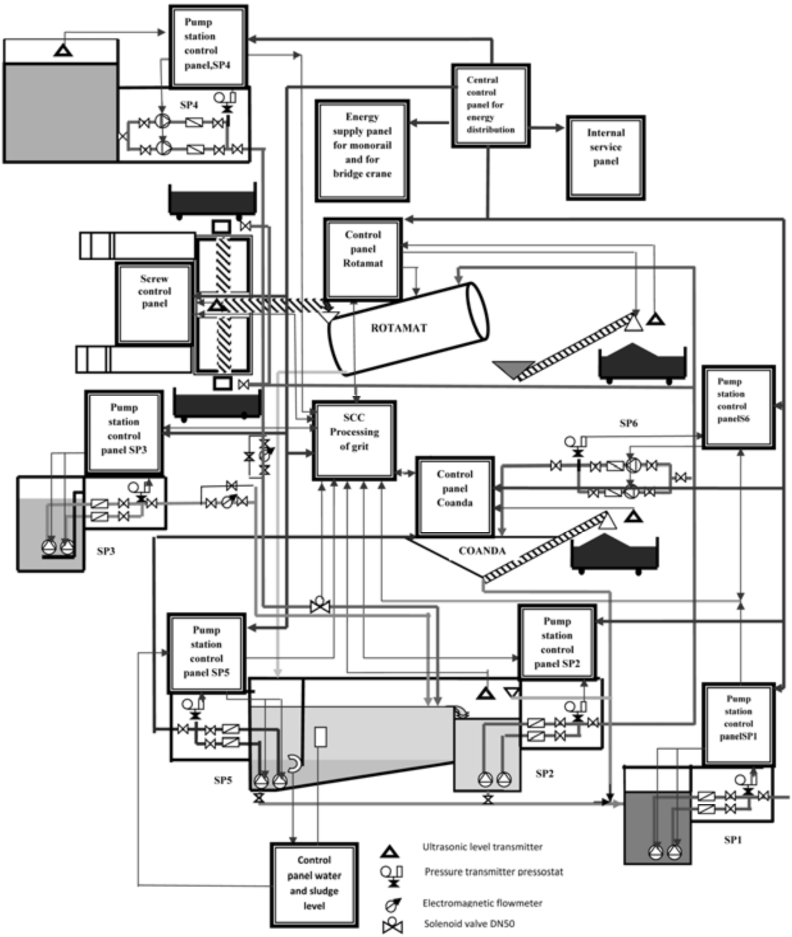

Fig.2. Coarse material separation plant

The particles having the diameter smaller than 10 mm are sent to another installation (COANDA) [8]. The grit / water mixture flows either by means of a pump or by gravity into the vortex chamber where a rotary motion is induced. The grit particles sorted and washed by this installation is between 1-10 mm. The washing water from ROTAMAT is sent to a settling tank and will be reused. The washing water from the COANDA and from settling tank is sent to the water line from waste water treatment plant. For the water disinfection and also for these two installations is used chlorine. The quantity of grit sorted and washed by Rotamat is 18 mc/day and by Coanda 5 mc/day, grit which can be used for sewer reparation or could be sold.

EVALUATION IMPACT BEFORE AND AFTER INVESTMENT

To evaluate the environmental impact produced by the sludge deposits a comparative evaluation method was used between the ideal state of the environment, the actual state of environment and the state of environment after investments, taking into discussion four environmental factors: air, water, soil and human habitation [2], [3], [5].

To evaluate the general state of environmental factors and also to correlate these factors in a graphical method synthetic appreciation was used based on quality indicators. Each of the environmental factors analyzed is characterized by representative quality indicators for assessing the grade pollution. In this sense, in a first stage, environmental factors relate to the limits allowed by national standards, achieving the pollution index Ip. For Ip = 0-1, the environment is affected in permissible limits and if the Ip > 1, the environment is affected more than the permissible limits.

Graphical representation is done using the Rojanschi illustrative method. The ideal state is represented graphically by a regular geometric form, (depending on the environmental factors taken into consideration: water, air, soil, and human habitation) with sides equal to 10 units of good standing [2]. Through union points an irregular geometric chart is obtained with a smaller surface, inscribed in the ideal state which is regular geometric chart. Global pollution index of ecosystem (IPG) consists of the rapport between ideal surface and real surface. According to the specialty literature there have been made assessments on global environmental pollution index for different situations, from which it was established a rating scale for IPG values from 1-6, the resulting environmental impact.

When there are no changes in the quality environmental factors, so there is no pollution, the global pollution index IPG has the value 1.

When there are changes in the quality environmental factors, the global pollution index IPG will get progressively the values between 2 and 6.

Graphical representation of values led to the determination of the ratio between the two surfaces from which results that IPG = 1.11.

As it can be seen in the figure 3 global pollution index (IPG =1.11) estimated that the activities that will take place in the investment objective will produce a global contamination of the environment (water, air, soil, human habitation) that will stay in admissible limits. For the actual state the IPG=6.66 meaning that the environment is degraded and is improper for life form.

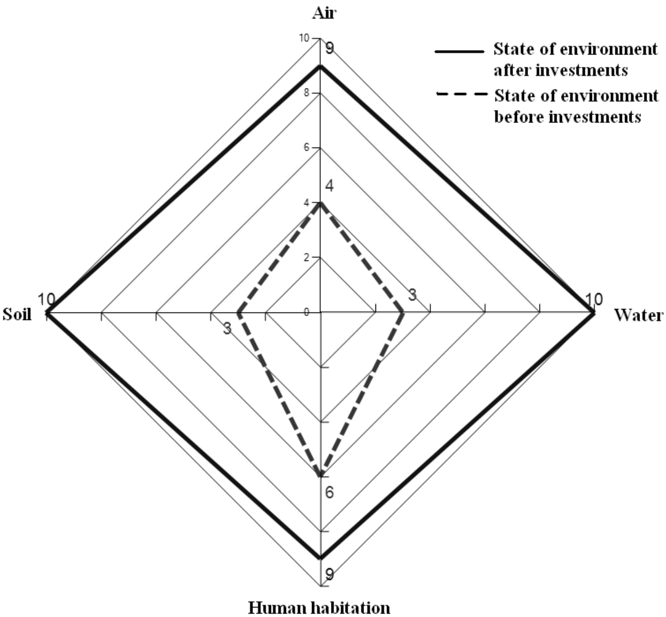

Fig.3. Global pollution index using Rojanschi method

CONCLUSIONS

By building the “Coarse material separation plant” grounds will not be disturbed as a result of construction works because the plant will be built inside the waste water treatment plant and will not affect flora species in this area.

The plant construction will affect a small land area (about 1000 square meters) from the existing surface of the waste water treatment plant which is about 200 000 square meters. It is estimated a potential contamination with construction waste, until the project finalization. After putting into operation the plant and by assuming a proper functionality, there will be no changes in the adjacent soil fertility. The main risk is the possibility of wastewater infiltration due to improper operation or waterproof of buildings that have waste water and sludge. According to Romanian law, wastewater treatment plant should be located more than 250m far from residential area. It is estimated that additional measures are not necessary to protect air quality.

The plant construction will decrease the IPG=6.66 for the actual state to IPG =1.11. This is a really important change from the environmental point of view and is made for people to be aware that the construction of the plant is an important investment for environment.

Acknowledgment

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REFERENCES

[1] Alina Girbaciu, Platform and installations for processing wastes coming out from sewer maintenance, Feasibility Study ordered by S.C. Aquatim. S.A, Romania, 2011.

[2] Octavian Liviu Munteanu, Evaluation of human impact on the environment, House Book of Science Editor, Romania, vol.1/issue 1, 2005.

[3] Vladimir Rojanschi & Florina Bran & Gheorghita Diaconu. Protection and Environmental Engineering, Economical Editor, Romania, vol. 1/issue 2, 2002.

[4]*** HG 352/2005, Norms of discharge wastewater into the aquatic environment.

[5]*** HG 445/2009, for framework procedure for environmental impact assessment for specific public and private projects.

[6]*** NTPA 001/2002, Pollutant loading limits for industrial and municipal wastewater to discharge into natural receivers.

[7] www.aquatim.ro

[8] www.huber.de

THE ADAPTATION OF ACIDITHIOBACILLUS FERROOXIDANS FOR THE TREATMENT OF HAZARDOUS WASTE

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ABSTRACT

This study presents the adaptation of *Acidithiobacillus ferrooxidans* tolerating high concentration of heavy metals for bioleaching of Ni-Cd batteries. The influence of Ni^{2+} and Cd^{2+} on the growth and activity of *Acidithiobacillus ferrooxidans* strain was investigated. Oxidation of Fe^{2+} is possible in the presence of 0.85 M nickel (Ni), 0.17 M of cobalt (Co) and cadmium (Cd) concentration above 0.08 M by non-adaptation *Acidithiobacillus ferrooxidans* strain. Adaptation was investigated in a 9K medium with sulfur as the sole energy source with increasing concentrations of nickel (from 2.0 $g \cdot l^{-1}$ up to 18 $g \cdot l^{-1}$) added as $NiSO_4$ and cadmium (from 0.50 $g \cdot l^{-1}$ up to 10 $g \cdot l^{-1}$) as $CdSO_4$. The efficiency of Cd solubilization in the adaptation process was higher than Ni solubilization. All experiments were carried out in 250 ml Erlenmeyer flasks containing 100 ml of media at 30 °C. Adaptation was successfully ended after 5 weeks when bacteria population reached $5x10^8$ cells ml^{-1}.

Keywords: *Acidithiobacillus ferrooxidans*, adaptation, heavy metals

INTRODUCTION

Nowadays, nickel–cadmium batteries have been used widely in mobile phones, as in other varieties of applications. Nickel–cadmium batteries are defined as hazardous waste because of heavy metals and carcinogenic substances. That is why it is important to find an economic and environmental solution to recycle them without loss of valuable elements. There are basically two methods for treatment of used batteries, pyrometallurgical and hydrometallurgical techniques. Pyrolisis are fast and effective but costly and emissive. On the contrary, the hydrometallurgical methods are cheaper with less pollution but not so much efficient. Practically biohydrometallurgical methods have been used in industrial field due to their higher efficiency, lower costs and simple operation. It can be applied for the recycling of valuable elements in nickel–cadmium batteries [4].

Biohydrometallurgical technology has been studied in the 1940s. In 1947, Colmer and Hinck. First isolated *Acidithiobacillus ferrooxidans* from the acid mine water. And then Temple, Leathen studied this autotrophic bacteria, they found out it can oxidize Fe^{2+} to Fe^{3+}, and oxidize sulfide in minerals to H_2SO_4. In 1954, Bryner systematically studied the microbial leaching of various sulfide and reported the role of *Acidithiobacillus ferrooxidans* in the leaching of sulfide ore. After that bioleaching is continuously expanding applied in the field of desulfurization of coal, flue gas desulphurization, heavy metal removal from rain, fly ash, river sediment and sludge [1, 17].

Leaching of sulphide ores by *Acidithiobacillus ferrooxidans* may process in two ways: direct and indirect. The indirect mechanism (Eqs. 1 and 2) entails the oxidation of the sulphides by the Fe^{3+}, produced by bacterial oxidation of $Fe^{2+}$and the direct mechanism (Eq. 3) is produced by a frontal attack on the sulphide by the bacteria [2].

$$MS + 8Fe^{3+} + 4H_2O \rightarrow 8Fe^{2+} + M^{2+} + 8H^+ + SO_4^{2-} \quad (1)$$

$$4\ Fe^{2+} + O_2 + 4\ H^+ \xrightarrow{A.F.} 4Fe^{3+} + 2\ H_2O \quad (2)$$

$$MS + 2O_2 \xrightarrow{A.F.} M^{2+} + SO_4^{2-} \quad (3)$$

Most by *Acidithiobacillus ferrooxidans* temperature tolerance is at 25–35°C. The large amount of sulphuric acid make the environment in which *A. ferrooxidans* grows inhospitable to most other organisms. Itself is well adapted to high concentrations of sulphuric acid and grows optimally in the pH range 1.5 – 2.5 [15]. Below pH 4.5, microbial populations that derive their energy from the oxidation of Fe^{2+} are more efficient than other agents supplying Fe^{3+} which is a key oxidizing agent for degradation of most sulphide minerals and also microbial metabolism of Fe^{2+} generates heat energy which favours purely chemical reactions involving sulphides [3].

MATERIAL AND METHODS

Experimental work was aimed at adapting *A. ferrooxidans* to growing on both the Ni and Cd sulphides at a pH of 2 and temperature of 30 °C. All experiments were performed using optimum conditions for the growth of *A. ferrooxidans* from the literature [9, 13].

Microorganism

A sample of unadapted *A. ferrooxidans* strain was used in this work. Pure culture was isolated from the acid mine water, the mine site Zlaté Hory, the Czech Republic. The best conditions for *A. ferrooxidans* growth are at 28 – 30 °C and pH = 2. After isolation was a bacteria cultivated in 9K medium.

Media

Cultivation of bacteria took place in 9K medium, according to Silverman and Lundgren (1959). The composition of 9K medium proposed by Silverman and Lundgren is as follows: 2 g/L $(NH_4)_2SO_4$, 0.1 g/L KCl, 0.5 g/L K_2HPO_4, 0.5 g/L $MgSO_4{\cdot}7H_2O$, 0.01 g/L $Ca(NO_3)_2$, 40 g/L $FeSO_4{\cdot}7H_2O$. The medium without $FeSO_4{\cdot}7H_2O$ was autoclaved at 121 °C for 20 min. $FeSO_4{\cdot}7H_2O$ was separately autoclaved at the same condition. The initial pH was adjusted to 1.8 – 2.0 using 1N H_2SO_4 (5 mol/L).

Experiment procedure

All experiments were carried out in 250 mL Erlenmayer flasks containing 100 mL solution. The adaptation was started by inoculating 10 ml of bacteria into 100 mL 9K medium that contained Ni^{2+} and Cd^{2+} sulphides in different concentration (Fig. 1). Adpatation of *A. ferrooxidans* was performed at 30 °C on rotary shaker at 150 min^{-1} and pH 2.

Fig. 1. Metals concentration used for adaptation *Acidithiobacillus ferrooxidans*

Time [weeks]	1	2	3	4	5
Elements	Concentration [$g.L^{-1}$]				
Nickel	2,0	6,0	10,0	14,0	18,0
Cadmium	1,0	3,0	6,0	9,0	10,0

As the source of metals were used $NiSO_4.7H_2O$ (M = 280.86 $g.mol^{-1}$) and $3CdSO_4.8H_2O$ (M = 769.53 $g.mol^{-1}$). Concentration was slightly increasing as shown at Fig. 1 and bacteria was subsequently taken from solution every week. The process of adaptation is shown at Fig. 2. Three sets of adaptation experiment were used for all elements. After a week sample of adapted bacteria was taken from solution and inoculated to media with higher concentration of Ni^{2+} (Cd^{2+}). This procedure was repeated when concentration bacteria in solution reached $5x10^8$ ml^{-1}.

For rotary shaked was used Infors multitron 2. The ferrous iron and ferric iron concentration were determined spectrophotometrically using Spekol 2.

RESULTS AND DISCUSSION

Adaptation of *A. ferrooxidans* to Ni^{2+} and Cd^{2+} ions

In the first week of experiment, *A. ferrooxidans* was adapted in solution with the lowest concentration of Ni^{2+} ions (Fig. 1). Tolerance to metal ions is acquired by *A. ferrooxidans* cells during the long lag phase [9]. The results of Fig. 2 show that concentration of Ni^{2+} at higher concentration has inhibitory effect on ferrous oxidation rate. Subculturing of *A. ferrooxidans* to solution with higher concentration of Ni^{2+} ions leads to adaptation [5]. The effect of cadmium ions is much higher than nickel ions. The result is slower bacterial growth in the presence of cadmium [10] and faster increase in bacterial population for nickel ions.

Fig. 2 Influence on Ni^{2+} and Cd^{2+} ions on ferrous oxidation according to Eqs. 1 and 2

Time [weeks]	1	2	3	4	5
Elements			Concentration [g.L^{-1}]		
Ferric (Ni^{2+})	22,5	16,4	12,4	10,3	9,1
Ferric (Cd^{2+})	20,5	14,8	11,0	9,8	8,8

Influence of ferrous and ferric ions

As *A. ferrooxidans* became increasingly tolerant to higher concentration the % Ni extraction is increasing [9]. Same situation is in case of Cd^{2+} ions. There are two proposed explanations this. At first the time required to develop membrane-associated enzyme protecting systems which enable the cells to secure energy provision through ferrous iron oxidation. And the second one due to the time required for those bacterial cells that survived in the presence of the metal cation, to replace the bacterial population [13].

The results showed that Fe^{3+} ions had an obvious effect on the leaching rate of Ni. With the prolongation of leaching time, the leaching rate of Ni increased slowly which can be attributed to the depletion of Fe^{3+}. Xiaojuan (2008) study leaching solutions containing 9 g/L Fe^{3+} declare, that higher concentration of Fe^{3+} increase leaching rate of Ni over the leaching period, which could justify the indirect mechanism of bioleaching for the metal sulfides [16].

The specific oxidation rate of ferrous ions decreased with increasing ferric ion concentration [6, 7, 11]. Some of batch experiments carried out at 34 °C and 200rpm showed, that concentrations of Fe(III) up to 5 g.L^{-1} do not affect the bacterial population in the batch reactor [12]. Leaching process is obviously due to chemical oxidation of MS by the Fe^{3+} previously formed by microbial oxidation of Fe^{2+} in the medium [8].

CONCLUSION

A. Ferrooxidans was successfully adapted over 5 weeks to leaching material containing nickel and cadmium, such as Ni-Cd batteries and other electro waste. Adapted *A. ferrooxidans* is able to tolerant higher concentration of Cd and Ni than unadapted strains. Mechanism of oxidation Fe^{2+} to Fe^{3+}, that was used as indicator at this work is very important in the leaching process. The Fe^{3+} ions have a main effect on the leaching process of electronic waste. Non-adapted *A. ferrooxidans* is not able to oxidize large amount of Fe^{2+} to Fe^{3+} in presence of high metal concentration and leaching process is much slower. That's why adaptation is so important and research is still needed.

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REFERENCES

[1.] Cerruti C. & Curutchet G. & Donati E. Bio-dissolution of spent nickel–cadmium batteries using Thiobacillus ferrooxidans, Journal of Biotechnology, vol. 62/issue 3, pp. 209-219, 1998.

[2.] Donati E. & Curutchet G. & Pogliani C. & Tedesco P. Bioleaching of covellite using pure and mixed cultures of Thiobacillus ferrooxidans and Thiobacillus thiooxidans, Process Biochemistry, vol 31/issue 2, pp. 129–134, 1996.

[3.] Ehrlich H.L. & Brierley C.L.1990. Microbial Mineral Recovery, McGraw-Hill, New York, pp. 55–73, 1990.

[4.] Jablonka R. Získávání niklu z Ni-Cd baterií pomocí biooužení, Engineer Thesis, Czech Republic, 2011.

[5.] Kai T. & Nishi M. & Takahashi T. Adaptation of Thiobacillus ferrooxidans to nickel ion and bacterial oxidation of nickel sulfide, Biotechnology Letters, vol. 17/issue 2, pp. 229-232, 1995.

[6.] Kawabe Y. & Inoue Ch. & Suto K. & Chida T. Inhibitory effect of high concentrations of ferric ions on the activity of Acidithiobacillus ferrooxidans, Journal of Bioscience and Bioengineering, vol. 96/issue 4, pp. 375-379, 2003.

[7.] Kelly D. P. & Jones C. A. Factors affecting metabolism and ferrous iron oxidation in suspensions and batch cultures of Thiobacillus ferrooxidans: relevance to ferric iron leach solution regeneration, Metallurgical applications of bacterial leaching and related microbiological phenomena, New York, pp. 19-44, 1978.

[8.] Kim S. D. & Bae J. E. & Park H. S. & Cha D. K. Bioleaching of cadmium and nickel from synthetic sediments by Acidithiobacillus ferrooxidans, Environmental Geochemistry and Health, vol. 27/issue 3, pp. 229-235, 2005.

[9.] Mason L. J. & Rice N. M. The adaptation of Thiobacillus ferrooxidans for the treatment of nickel–iron sulphide concentrates, Minerals Engineering, vol. 15/issue 11, pp. 795-808, 2002.

[10.] Medírcio N. M. & Versiane A. L. & Teixeira C. M. Specific growth rate of sulfate reducing bacteria in the presence of manganese and cadmium, Journal of Hazardous Materials, vol. 143/issues 1–2, pp 593-596, 2007.

[11.] Nyavor K. & Egiebor N. O. & Fedorah P. M. The effect of ferric ion on the rate of ferrous oxidation by Thiobacillus ferrooxidans, Applied Microbial Biotechnology, vol. 45, pp. 688-691, 1996.

[12.] Pina P. S. & Leão V. A. & Silva C. A. & Daman D. & Frenay J. The effect of ferrous and ferric iron on sphalerite bioleaching with Acidithiobacillus sp., Minerals Engineering, vol. 18/issue 5, pp. 549-551, 2005.

[13.] Rossi G. Biohydrometallurgy. McGraw-Hill, UK, pp. 137–142, 1990

[14.] Tuovinen O. H. & Niemelä S. I. & Gyllenberg H. G. Tolerance of Thiobacillus ferrooxidans to some metals. Antonie van Leeuwenhoek, vol. 37/issue 1, pp. 489-496, 1971.

[15.] Tuttle J. H. & Dugan P. R. & Apel W. A. Leakage of cellular material from Thiobacillus ferrooxidans in the presence of organic acids, Applied and Environmental Microbiology, vol. 33, pp. 459-469, 1977.

[16.] Yang X. & Zhang X. & Fan Y & Hongyu L.I. The leaching of pentlandite by Acidithiobacillus ferrooxidans with a biological and chemical process, Biochemical Engineering Journal, vol. 42/issue 2, pp. 166-171, 2008.

[17.] Zhao L. & Wang L. & Yang D. & Zhu N.. Bioleaching of spent Ni-Cd batteries and phylogenetic analysis of an acidophilic strain in acidified sludge. Frontiers of Environmental Science, vol. 1/issue 4, pp. 459-465, 2007.

THE COMPLAINTS ABOUT CEBECİ QUARRIES THAT HAVE BEEN NOTIFIED TO İSTANBUL METROPOLİTAN MUNICIPALITY

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ABSTRACT

In the district of Sultangazi Borough Cebeci Quarries, 16agregate quarries are in service. It has been detected that the areas, in which the quarries of Cebeci district are operating, are getting closer to each other in general, some of them are nested, production actions of the quarries are usually taking place in vertical axis, in the majority of the quarries stair,bench system's can not be formed, in terms of slope stability some kind of risks occured and because licensed areas are small, there are not enough or no quarry area, areas where excess earths and stones from excavations are dumped and storage for pruducts , and also with the rise of settlement in the area, quarries are placed in Cebeci village and Cebeci neighborhood and these causes local people to complain about noise because of the irregular blasting. All the complaints that have been notified to Istanbul Municipality since 2008 were compiled and the result of statistics revealed that nearly %50 of complainers have been negatively effected by quarries close to settlement areas , without neccesary permissions, illegal and not working suitable to mining ethics. That the noise and ground vibration complaints caused by blasting are increased in summer months (April-October) and that this was caused by dense operations of the sites in these months were also observed. Observations are conducted as on-field researches in Cebeci region.Negative effects on local people and damages to environment created by blasting operationsin quarries were examined through a survey research.

With the changes in explosive material and blasting system and measuring the blastings with 2 ground vibration measuring device and reporting, noise and vibration complaints caused by blasting were overcome to a large extent.

Keywords: Blasting, Ground Vibrations,Dust, Complaints

1.INTRODUCTION

Nowadays, by reason of disturbances caused by environmental effects of mining operations, there happen to be kind of problems in relationships between society and mining industry in time. These problems sometimes bring on disputes which are not very friendly, and sometimes result in such different consequences like judicial authorities' stopping mining operations because of social oppresion. [8] Therefore, contemporary mining industry must eliminate this kind of real, psychological orexploitation oriented complaints and find solutions to these problems scientifically. Only these scientific approaches can prove mining industry's interest and respect to environment and make longlasting and realistic solutions to be put forward. [3]

Quarries in Cebeci district, that is today completely placed among settlement areas as a result of unplanned urbanization, is now a place where we see environmental problems at the highest rate, when compared with all other quarry areas throughout Istanbul.The biggest stone quarries and sand casting areas which are placed right next to Sultangazi Borough Cebeci neighborhood, have become the worst nightmare of local people due to their excessive use of explosive materials, and the dust, noise and ground vibrations resulted from this. In Cebeci neighborhood, to where dustclouds reach, the number of lung ilness sufferer's are rising day by day. Local people state that authorities are insensitive about the case and they are desperate. Agregate quarries which are in service since 1960s, are effecting the life in district negatively with the dust, noise and ground vibrations they created in parallel with the settlement style which occured as a result of unplanned urbanization in last 15 years. Due to the actions of agregate quarries, there is constant accumulation of dust in windows and balconies of the houses especially during summer time. First of all, living in Marmara Region with these ground vibrations caused by quarry blastings,where they wait for a possible earthquake in any time, is damaging the mental health of the people. [11] Especially children are effected to a great extent by the ground vibrations of night time. In these ground vibrations by blastings which are even scary for adults, children's psychology are considerably damaged. Datas are gathered through survey researchabout environmental effects of excavation operations in the vicinity of quarries in Cebeci basin.

Figure1: CebeciBasin ,Quarries in İstanbul

2.FINDINGS

In our country, the environmental damages of vibrations which especially stem from open quarry blasting and the rise of complaints in parallel to this, is a longly disputed subject. It is thought that there are different kinds of reasons for the complaints resulting from vibrations created by blasting. Local people's complaints about ground vibrations created by blasting can be divided into 3 group in terms of reason:

Complaints related to real causes

Complaints related to worry and lack of knowledge

Benefit oriented, malicious intended complaints [10]

Our observations show us that complaints related to real causes compose a very little percent. Complaints related to worry and lack of knowledge have the biggest share. The most disturbing ones of these are benefit oriented, malicious intended complaints, doubtlessly.

When we examine the complaints we get to our municipality, we can categorize the complaints of people in this way:

-Quakes are happening in the same way as real earthquakes

-Quakes create fear and panic

-Quakes couse windows to break, buildings to be damaged

-During quakes, stones hit to roofs and even the inside of houses

-Because of the quakes , LPG tubes and objects fall in the house and mirrors on walls break into pieces. [5]

In order to examine the environmental effects of explosions in Cebeci district, in the survey research with locals of quarry region, participants were asked different questions about the effects of quarries to environment, buildings and and local people. There were 100 participants of the survey between the ages of 24-73. 41% was women, 59% was men. Survey researchwas conducted in an area 150-1000 metres away from stone quarries and the problems caused by excavations with blastings were evaluated regarding the distance.

3.CONDUCTED STUDIES

In this research, the vibration of blasting that are conducted in Cebeci Quarries, which operates in order to quarry for constructional and asphalting processes, are examined in their very place. In the first part, the neccesary literature informations are given; and in the qualitative part, survey method is used. The survey in the area was conducted in the time interval between 03.02.2010 and 06.02.2010. Throughout the survey, 100 participants, all of whom are settled in the area around stone quarries in Cebeci District, were asked 29 questions. Every one of these questions are scrutinized under titles. By giving the aims of the questions and the answers of the participants, the consistency of survey datas' with concerned literature researches and the findings of scienrific studies in the area.

Local people were asked to what extent they feel the air shock, gas, dust, noise and ground vibration and how much they are disturbed by these. The results were inquiredin the light of scientific knowledge.

Also, in the moments of blasting which took place while carrying out the survey, local people were asked about their disturbance level at that moment and the answers were compared with the very same explosions' recordings which were noted in the yard of a 700m away mosque's and a building of a 900m distance by Istanbul Municipality and Istanbul University. The consistency of the reactions of the people to the ground vibrations and scientific datas were examined.

In the meetings held under the chairmanship of the chairman of Department of Environment Protection, with the managers of agregate quarries and concerned institutions; in order to stop problems which stem from stone quarries, following precautions were decided to be taken:

Noise and Vibration Originated by Quarry Blasting

Suggestions were:

Using delayed, non-electrical capsule in order to prevent noise and vibration originated by blasting

Shifting to stair system

Conducting blasting in a controlled way and according to a schedule which has no conflicting blasting

Measuring the impact of blasting by taking a Vibration Measuring Device.[2]

In addition, our chairmanship cooperated with Police Department and provided blasting with security officers.

Primary 5 mostly complained negativity of rock excavation by blasting can be said to be:

Flying rock

Gas Emission

Air shock and noise

Dust Emission

Ground vibration.[1]

4.BLASTING MATERIAL'S ENERGY

4.1BLASTING

Decomposition – Transfer(transformation)- Vibration- Air Cannon

Image 2.1: Environmental effects of exploding mines

Blastings in quarries are conducted as a part of Blasting Project with Vibration Control which is carried out with the cooperation of Istanbul Municipality Environmental Protection Chairmanship, Agregate Quarries Cooperative and Okan University.

Blastings are recorded 24 hours a day with 2 vibration measuring device(brought from canada as a part of project). There are 2 vibration devices, one is in Veysel Karani Mosque and the other is in the Factory of Community Bread.

Blasting are conducted using a delayed and controlled firing system and reported. [7]

The reporting, in order to predict and compare the impacts levels of the results of ground vibrations measurements belonging to the incidents which were recorded by the evaluation crew, on local institutions and buildings; was assessed according to the regulationgs of T.R Environment and Forest Ministry, the Control and Management of Environmental Noise Regulations with taking particle velocity components and constitution frequency into consideration. [9]

T.R Environment and Forest Ministry, the Control and Management of Environmental Noise Regulations were became valid by being published in official journal dated 06.04.2010 and numbered 27601. In the 5th part of this regulation, named Environmental Vibration Basics and Criteria, under the title of Vibration Criteria in Buildings and in the 25-a entry, the basics about controlling environmental vibrations caused by a variety of vibration sources were given. According to this entry, the ground vibration levels in sensitive usages which explosions in mines and agregate quarries and also the areas which operates in the similar way create, can not exceed the limit values in the highest permitted values of ground vibrations originated by blasting in mines, agregate quarries and similar areas, outside the closest, very sensitive usage areas

Vibration Frequency(Hz) The velocity of highest permitted vibration

(Peak Value-mm/s)

Vibration Frequency(Hz)	**Peak Particle Velocity (Maximum point -mm/s)**
1	**5**
4-10	**19**
30-100	**50**

Table 1: T.C. Ministry of Environment and Forest's Regulation of Management and Evaluation of Noise Norms.

(Between 1 Hz- 4Hz, from 5mm/s to 19 mm/s; between 10Hz-30 Hz, from 19mm/s to 50 mm/s, it rises linear in a logarithmic graphic) [13]

Most of the measurements are found to be less than "The highest permitted values of ground vibrations originated by blastings in mines, agregate quarries and similar areas, outside the closest, very sensitive usage areas ". After an assesment of high vibration measurement values, it was observed that high values was due to the mirror and explosive material. And the companies were asked a report about the 12-15m height of mirror, using exel type non-electrical capsule and conducting explosions untill 4pm. In USA, (USBM and OSM regulations) with law regulations 140 decibel air shock level was defined as damage set out level and noise upper limit. It's known that the effect of air shock declines with distance. This decline factor scaled distance concept is represented with (SD=R/Q). With the researches encouraged by USA Mining Chamber, [4] the relationship between air shockpresure and scaled distance was proved. [9]

Real air shock and noise levels in anywhere, with topographical conditions, is related toblasting geometry. [6]

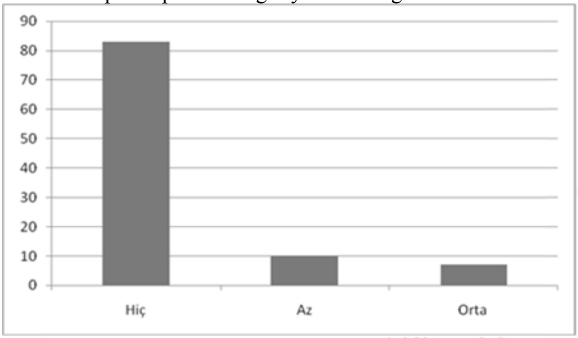
5.RESULTS

As the results of studies conducted by our chairmanship about rehabilitation of agregate quarries in cebeci district;

With the changes in explosive material and blasting system and measuring the blastings with 2 vibration measuring device and reporting, noise and vibration complaints caused by blasting were partially overcome.

83 % of the participants: “Never” feel the ground vibrationand not disturbed.

10% of the participants: “Slightly” feel the ground vibrationand disturbed.



7% of the participants: “Moderately” feels the ground vibration and disturbed.

Figure 2: Never Slightly Moderately

And;

90% of the participants: “Never” hear the noise (air shock) and not disturbed

4% of the participants: “Slightly” hear the noise (air shock) and disturbed.

6% of the participants: “Moderately” hear the noise (air shock) and disturbed. [14]

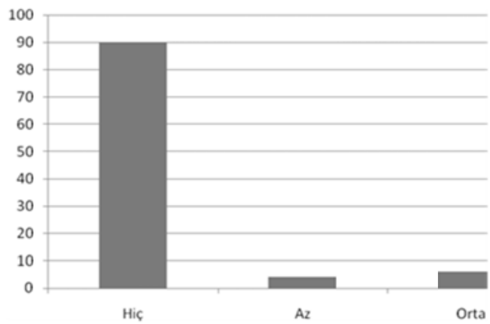


Figure 3: Never Slightly Moderately

REFERENCES

[1] Dowding, C.H. 1985. Blast Vibration Monitoring and Control. Prentice-Hall Inc., Englewood Cliffs, NJ, pp. 119-126.

[2] Dowding, C.H., Blast Vibration Monitoring and Control, Prentice-Hall, 1985, 297p

[3] KONYA C.J., WALTER, E.J., 1990, Surface Ballast Design, New Jersey, USA,

[4] OSMRE, Federal Regulations, 2004, Code of Federal Regılations 30 CFR Part 700, http: /www.osmre.gov/regindex.htm (03 Tem. 2007)

[5] LANGEFORS, U., Kihlström, B., 1979, The modern technique of rock blasting, 3rd edition, John, Willey & Sons, New York, 437 p

[6] Johnston, G.J. Durucan, S. 1994. The Numerical Prediction, Analysis and Modelling of Ground Vibration Induced by Blasting. Third International Symposium on Mine Planning and Equipment Selection, Istanbul, 18-20 October 1994.

[7] RICHARD H., 2005, Associates pty Ltd., North South Bypass Tunnel Environmental Impact Statement Working Paper No.8 Construction Noise and Vibration, SKM Connell Wagner Joint Venture, Australia,

[8] RAINA, A.K., Chakraborty, Choudhury, P.R, Ramulu, M., Bandyopadhyay, C., 2004, Human Response to Blast-Induced Vibration and Air-Overpressure:An Indıan Scenario, Bulletin ofEngineering Geology and The Environment, 63, , 209-214.

[9] Kahriman, A. Ozer, U. Karadoğan, A. Aksoy, M. Adıgüzel, D. Özdemir, K. 2007. Evaluation and Measurement of Ground Vibrations Induced by Blasting Excavation at Cebeci Quarries. Project Report.Engineering Faculty, Istanbul University, Istanbul.

[10] Kahriman, A. Ozer, U. Aksoy, M. Karadogan, A. Tuncer, G. 2006. Environmental impacts of bench blasting at Hisarcik Boron open pit mine in Turkey. International Journal of Geosciences Environmental Geology, Springer Press, DOI 10.1007/s00254-006-0274-5, pp.1015–1023.

[11] Kahriman, A. 2004. Analysis of parameters of ground vibrations produced from bench blasting at A Limestone Quarry. Soil Dynamics and Eartquake Engineering, 24, Elsevier, London, U.K, pp. 887-892.

[12] Ozer, U. Kahriman, A. Aksoy, M. Adıguzel, D. Karadogan, A. 2008. The Analysis of Ground Vibrations Induced by Bench Blasting at Akyol Quarry and Practical Blasting Charts. Environment Geology, Springer Press, DOI 10.1007/s00254-007-0859-7, 54:737–743.

[13] Ozer, U. Kahriman, A. Adiguzel, D. Aksoy, M. Karadogan, A. 2007. The Investigation of Ground Vibrations Induced by Bench Blasting at Different Quarries at Çatalca District in Turkey, The Thirty-Three Annual Conference on Explosives andBlasting Technique, January 28 -31, 2007 Nashville, Tennessee, USA. Volume I. pp 241-253.

[14] SPSS, Statistical Software, SPSS 13.0 for Windows.

THE DEVELOPMENT OF CULTURAL LANDSCAPES IN THE POLISH CARPATHIANS

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ABSTRACT

The paper presents the evolution of cultural landscapes in the Polish Carpathian Mountains. The study has determined that the greatest change in natural Carpathian landscapes was caused by agricultural activity. In many areas natural boundaries between adjacent vegetation belts have been replaced by field-forest boundaries and the proportion of forests in the total area was 40% as recently as in the 1970s. Subsequently, the structure of land use began to change as the proportion of arable land started to shrink giving way to grassland, newly planted forests, spontaneously reforested abandoned land and to land developed primarily for tourist purposes. The study shows that much of the development in the cultural landscapes in the Polish Carpathian Mts. did not demonstrate a good balance with regard to their environmental interest.

Keywords: Carpathians, environmental conditions, land development, agricultural activity, cultural landscape

INTRODUCTION

The Carpathian Mountains form the largest mountain range in Central Europe. They arc over 1300 kilometres and are between 60 and 350 kilometres in width covering an area of 190 thousand square kilometres, of which 19.67 thousand square kilometres is within the Polish national border.

Human intervention in the natural Carpathian landscape was gradual. Initially, it involved forest clearance for settlement (at lower altitudes) or herding purposes (at higher altitudes). Crop farming developed later accompanied by the expansion of land development, mining, smelting, hydropower and other economic activities. Many Carpathian areas became leisure and tourist destinations leading to the development of tourist infrastructure. Cultural landscapes in different Carpathian regions and countries differ from one another.

The study objective was to identify patterns in the development of cultural landscapes in the Polish Carpathian Mountains with a particular focus on the period of dynamic economic and political change that has occurred in Poland over the last two decades. The vast scope of the study required both field and study work, including a review of the literature about the region, an analysis of historic and modern cartographic materials, interpretation of socioeconomic statistics, interviews with local communities and monitoring of the vegetation in selected and delimited plots in the field.

POLISH CARPATHIAN ENVIRONMENT

The Polish Carpathian Mountains (which range from 300 to 2500 m in altitude) are divided into the following geomorphological units (fig. 1): high mountains (Tatras), medium-height mountains (Beskids and Bieszczady), a foothill upland belt (Carpathian Foothills) and a vast depression known as Podhale. These units are further subdivided into many physical geography regions [1]. Due to the large altitude range the mountains involve a range of biotic zones arranged vertically [2] and including: foothills (moderately warm) with deciduous forests as natural vegetation, lower montane belt (moderately cool) originally covered by mixed beech and fir forests, montane belt (cool) with spruce, subalpine belt (very cool) with krumholz, alpine belt (moderately cold) with sparse grass and flowering plant vegetation, and subnival belt (cold) with naked rocks. The Polish section of the Carpathian Mountains remains entirely below the snow line.

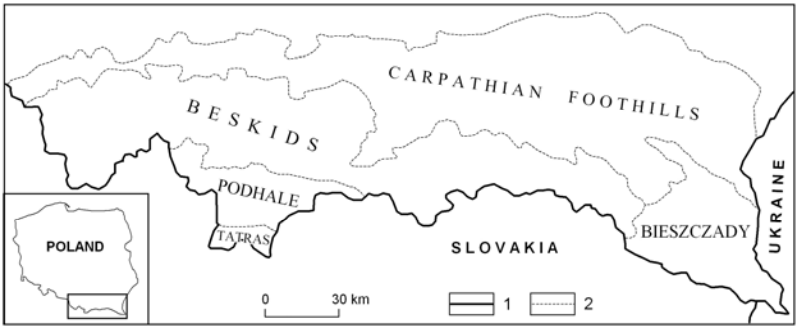

Fig. 1. Geomorphological regions in the Polish Carpathian Mts. [3]: 1 – national borders, 2 – regional boundaries.

The Tatra Mts., the highest range of the Polish Carpathian Mountains, are typically Alpine in character with biotic belts ranging from lower montane to subnival. A southern part of the range consists of an outcropping crystalline core made of Carbonaceous granitic rocks and older metamorphic rocks. To the north the core is covered by Mesozoic sedimentary rocks. The Tatras were folded between the Upper Cretaceous and Palaeocenic, but their current landscape developed during the Neogene and was then transformed during the Pleistocene ice age. Hence numerous glacial landforms (including glacial cirques, U-shaped valleys and moraines) are found alongside sharp crags, stone runs and landslides [4].

The lower Beskids and Bieszczady ranges run along a general EW axis and feature multiple depressions and gates. Geologically both ranges consist of thick Cretaceous and Tertiary complexes of fleisch formations that were folded in the early Neogene and middle Miocene and then evolved into a typically erosional-denudational land relief [4]. In the Beskids range the natural character of the biotic belt system is preserved solely in the topmost Alpine belt, but in the Bieszczady the belt system has been transformed entirely by human activity. Indeed, meadow ecosystems replaced natural spruce forest and krumholz above the lower montane belt.

The Carpathian Foothills, upland in character, rise to 300-550 m in the form of broad ridges carved by deep valleys running from the adjacent Beskids and Bieszczady mountains, with several depressions of mainly erosional-denudational and sometimes tectonic origin. The region's geology is dominated by fleisch formations, just as in the Beskids and Bieszczady ranges, with fold and nappe tectonics. In terms of vegetation belts the area represents the premontane belt covered by deciduous forests with some fir mixed in.

The Podhale region, highly diverse in relief, slopes northwards from approximately 1200 m to 500 m filling a gap between the Tatra and Beskids Mountains. The depression's geology is dominated by a horizontal layer of Paleogenic fleisch rocks up to 3000 m in thickness [5] with only a narrow outcropping of the limestone Pieniny Mountains. The entire area remains within the lower montane belt, but uncharacteristically also contains pine and spruce forests and raised peat bogs in its northern section.

AGRICULTURAL LANDSCAPES

The advent of agricultural activity in the Polish section of the Carpathian Mountains is linked to an influx of nomadic herding populations migrating alongside the Carpathian arc from the Balkans. Known as Vlachs, these people reached the eastern Polish borders in the 14th c. Vlachs burned forests along mountain ridges clearing the area for summer pastures, from which they descended into forested valleys to feed their animals on the forest floor in winter. Gradually, Vlachs joined in with permanent settlers (Ruthenians, Poles, Hungarians, Germans and Slovaks) who started farming the land in the lower parts of the Polish Carpathian Mts. This brought animal husbandry and crop farming together and they existed side by side for several centuries. In many Carpathian areas the boundaries between biotic belts were replaced by artificial field-forest boundaries, often at excessively high altitudes.

The 19th c. marked an accelerated development of crop farming at the expense of herding, which went into decline and was limited to sheep herding on high pastures. As the need for arable land increased farmers took their ploughs to altitudes of 900 m and above. This development, as well as the expansion of mining and smelting, led to further deforestation. The beech and fir forests of the lower montane belt were destroyed first and were replaced by quickly growing single-species spruce forests planted for mass logging. In the 1970s, arable land covered 38.2% of the Polish Carpathian Mts. and forests only accounted for 39.7% [6]. Many Carpathian catchment basins had just 20% forests. The domination of farmland was particularly strong below 500 m altitude (table 1).

This land use structure had its serious drawbacks. Indeed, crop farming in the mountains is more expensive and less productive than in lowlands [7, 8]. Cereal and potato crops at an altitude of 600-700 m yield ca. 50% less than at 250-300 m. Altitude also affects the growth of grass biomass in meadows and pastures and it is estimated that above 600 m the productivity of meadows and pastures drops by 10% every 100 m. Alongside these adverse economic effects the intensification of Carpathian farming contributed to the degradation of the natural environment [9]. For these reasons it was suggested that the land use structure should be modified to favour meadows, pastures and forests and that crop farming should meanwhile be eliminated above an altitude of 700 m.

Table 1. Land use structure in the Polish Carpathian Mts. in the 1970s [6].

Altitude [m a.s.l.]	Form of use [%]				
	Arable lands	Meadows and pastures	Orchards	Forests	Others
< 500	50.5	13.5	2.0	26.5	7.5
500–700	23.9	13.8	0.9	54.6	6.8
700–1000	14.5	14.1	0.0	67.7	3.7
> 1000	0.0	0.0	0.0	74.2	25.8
Total	38.2	13.4	1.4	39.7	7.3

In the late 1980s, farming went into decline across the Polish Carpathian Mts. This was linked to the political and economic transformation in Poland accompanied by the restriction of financial and organisational support to mountain farming. Crop production and the animal count dropped. According to the Agricultural Census, between 1996 and 2002, the area of arable land shrank dramatically in some Carpathian municipalities, including in Łapsze Niżne by 40%, in Czorsztyn by 48% and in Krościenko by 55% (all three municipalities in the Podhale region). Much of that land became overgrown by rough grassland and only some was used for meadows and pastures. This change in the proportions of arable land and grassland [10] marked the emergence of post-agricultural landscapes in the Carpathian Mts.

POST-AGRICULTURAL LANDSCAPES

The change in the landscape resulting from the decline in farming is manifested by the disappearance of the mosaic structure of fields and grasslands in particular. As arable fields, meadows and pastures are abandoned they are overgrown by grassy or forest vegetation. These spontaneous vegetation successions do not lead to the development of natural climax communities and only feature a high degree of biodiversity in an initial phase. Ultimately, they develop into communities of low biological and economic value.

On uncultivated arable fields the succession depends on the original crop [11]. The succession after root vegetables has two phases. In phase one, lasting for up to three years, the field is taken over by various herbaceous plants, including *Hieracium pilosella*, *Gnaphalium sylvaticum*, *Senecio sylvaticus*, *Crepis hiennis*, *Taraxacum officinale*, *Leontodon hispidus*, *Lapsana communis*, *Erigeron acer*, *Cirsium arvense*, *Thymus pulegioides*, etc. Phase two involves the expansion of Fabaceae (legumes) and grasses, including typically *Agrostis vulgaris*, *Holcus mollis*, *Festuca rubra* and

Cynosurus cristatus. The succession after cereals involves only the said grass species. Finally, the succession after clover involves *Phleum pratense* and *Agropyron repens*.

The abandonment of meadows also causes adverse biological effects. For example, in an abandoned meadow known as Stolarzówka in the Pieniny Mountain range (Podhale region) [12] certain species of Orchidaceae disappeared, including *Coeloglossum viride*, and the proportion of thermophilic plants (*Anthyllis vulneraria*, *Sanquisorba minor*, *Trifolium dubium*, *Euphrasia rostkoviana*) decreased. Kurnikówka meadow, originally inhabited by patches of *Anthylli-Trifolietum*, was taken over by a lush grass community dominated by *Dactylis glomerata*. The cessation of mowing of Trzy Korony meadow led to the transformation of a community consisting of *Veratrum lobelianum and Laserpitium latifolium* into a community with *Hypericum maculatum*. On many occasions, it was observed that a mixture of meadow species would become dominated by *Phleum pratense* and *Agropyron repens* joined at a late stage by *Conium maculatum*, which caused a degradation of these communities. Adverse successions were also observed in abandoned pastures. It was commonly found that a pasture complex of *Lolio-Cynosuretum* was replaced by communities dominated by *Nardus stricta* and *Carduus crispus*, which are inferior both in terms of their biological and economic value as source of feed.

When abandoned for a sufficiently long time, arable land, meadows and pastures tend to undergo a vegetation succession leading to the development of forest ecosystems. Pioneer species of herbs and subshrubs (e.g. *Hypericum maculatum*, *Vaccinium myrtillus*), begin to encroach followed by more expansive shrub and tree species (e.g. *Rubus idaeus, Juniperus communis*, *Alnus incana*, *Corylus avellana*). While the fact that spontaneous succession leading to a recovery of forests in the Polish Carpathian Mountains must be seen as a positive development, it does not develop communities with climax species. For this reason planned afforestation is preferable and some current activities in this area include the planting of beech, fir, larch and pine trees. As a result of all these processes the forest coverage is growing. For example, the proportion of forests in the total area of two monitored catchment basins in the Pieniny Mountains increased from 20.9% (Biała Woda) and 21.2% (Potok Skalski) in the 1960s to 56.2% and 53.8% today [13]. Forest ecosystems are seen to expand in glades formerly used for agricultural purposes. In control patches in the Pieniny Mts., forests reclaimed up to 42% of the glade area [14].

LANDSCAPES OF THE MODERN ECONOMY

For centuries, economic activities in the Polish Carpathian Mts. were largely limited to agriculture, forestry and mining with a minor presence of other land uses (e.g. transport, industry and tourism). The 20th c., and especially its second half, saw a strong development in two other forms of activity, water management and tourism.

The area is a large source of water that generates approximately 13% of Poland's resources [15]. For this reason local water management focuses primarily on retention. Numerous reservoirs include: Solina (472 mn m^3 capacity), Czorsztyn (231.9 mn m^3), Rożnów (193 mn m^3), Dobczyce (127 mn m^3), Tresna (94.6 mn m^3), Klimkówka (42.6 mn m^3) and Porąbka (26.6 mn m^3). Their multiple roles include flood control, hydropower, water abstraction, leisure and water sports. Landscape changes linked to the creation of reservoirs follow certain patterns [16]. They typically involve: 1) clearing forests or eliminating farm fields, 2) modifications in settlement structures and transport and utility networks, 3) large-scale physical change to land, 4) flooding of areas, 5) development around the reservoir. As a result of this process a water body is added to the landscape with its infrastructure (dam, embankments) and other developments, typically leisure and tourist infrastructure (fig. 2).

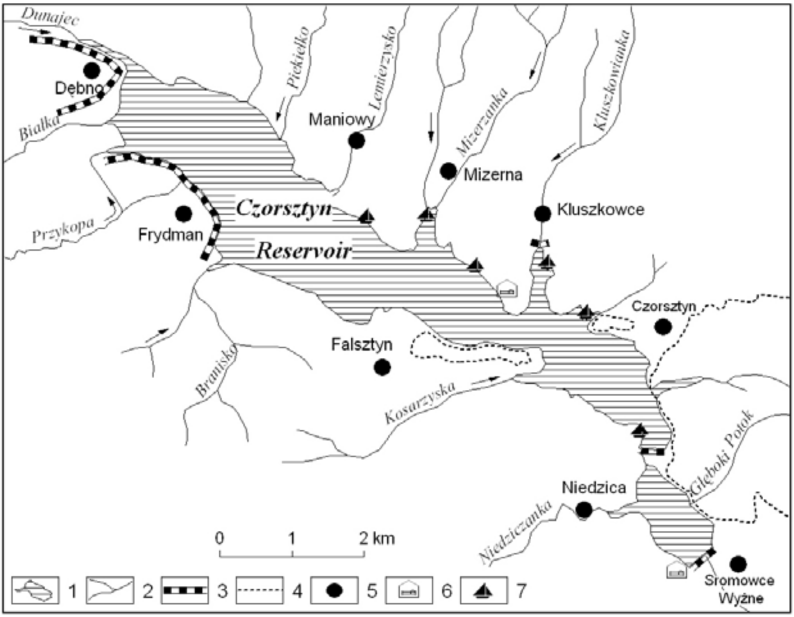

Fig. 2. Typical components of a Polish Carpathian landscape with reservoirs at the Czorsztyn dam: 1 – reservoir, 2 – rivers and streams, 3 – dams and embankments, 4 – boundaries of formally protected nature, 5 – towns and villages, 6 – tourist facilities, 7 – marinas.

Rivers are typically used as a source of water for household and commercial purposes, but also for leisure and tourism. The latter uses include angling, kayaking, rafting and involve the development of suitable infrastructure. From the commercial perspective, the once dominant role of rivers as transport routes (e.g. for timber) was replaced by small-scale hydropower.

Landscape components associated with tourism are present across the area's altitude profile. Accommodation and catering infrastructure supporting outdoor activities dominates. PTTK (Polish Tourist Country-Lovers' Society) has about 4300-4400 beds available and private operators (registered with the Polish Main Statistical Office) have 53648 beds (2006) [17]. Tourists use foot and cycling paths, ski lifts and pistes, cable cars, visit historic monuments and visitor centres, and practice angling, sailing, kayaking, paragliding and mountain climbing. Tourism has become a major source of income for the local communities and changed an employment structure traditionally dominated by agriculture. The growth of tourism also has its negative side affecting Carpathian nature, including through the large amount of waste produced in the process [18].

CONCLUSIONS

Over the last few centuries, humans have considerably altered the natural Carpathian landscapes creating cultural landscapes across the region's whole altitude range.

The development of cultural landscapes has involved excessive pressure on the productive functions (including food and timber) of Carpathian nature and negated the need to maintain its natural functions (e.g. biodiversity and water resources).

Initially, cultural landscapes evolved in relation to the immediate needs of the local communities. During recent decades, however, larger socio-economic transformations drove the development of landscapes in general and the shrinking agricultural landscapes in particular.

The development of cultural landscapes ought to follow principles of sustainable development. This would ensure the creation of an environment conducive to environmentally-friendly commercial activity, and also tourism and leisure.

REFERENCES

[1] Kondracki J. Regional geography of Poland, Polish Scientific Publishers, Poland, pp 314-371, 1998 [in Polish].

[2] Hess M. Climatic zones in the Polish Western Carpathians, Geographical Works of the Jagiellonian University, Poland, vol. 11, pp 1-255, 1965 [in Polish].

[3] Starkel L. Characteristic of Polish Carpathians relief and its role for human activity, Problems of Developing Mountain Regions, Poland, vol. 10, pp 75-150, 1972 [in Polish].

[4] Starkel L. (ed.) Geography of Poland – natural environment, Polish Scientific Publishers, Poland, pp 1-690, 1991 [in Polish].

[5] Stupnicka E. Regional geology of Poland, Geological Publishers, Poland, pp 1-286, 1989 [in Polish].

[6] Kurek S., Głuszecki K., Jagła S., Kostuch R. & Pawlik-Dobrowolski J. Natural basics of land use in the Carpathians. Institute for Land Reclamation and Grassland Farming, Poland, pp 1-44, 1978 [in Polish].

[7] Twardy S. & Hamnett R.G. Low input ways of sheep grazing in the Polish Carpathians, Institute for Land Reclamation and Grassland Farming, Poland, pp 1-32, 2000 [in Polish].

[8] Twardy S., Kuźniar A. & Kopacz M. The characterization of agriculture in the Polish Carpathians, Proceedings of the Conference in Jaworki (ed. by Twardy S.), October 9-11, 2001 – Institute for Land Reclamation and Grassland Farming, Poland, pp 230-237, 2001.

[9] Jagła S. & Twardy S. Mountainous areas meadow and pasture farming and its influence on the natural environment, Proceedings of the Conference in Jaworki (ed. by Curzydło J.), October 21-22, 1999 – University of Agriculture in Krakow, Poland, pp 117-128, 1999 [in Polish].

[10] Twardy S. Carpathian agricultural lands as less favoured areas (LFA), Water-Environment-Rural Areas, Poland, vol. 8/issue 2b, pp 191-202, 2008 [in Polish].

[11] Kostuch R. & Jagła S. Spontaneous plant growth on the unused arable pasture land in Jaworki, Problems of Developing Mountain Regions, Poland, vol. 19, pp 91-111, 1978 [in Polish].

[12] Kaźmierczakowa R. Floral composition and plant biomass of non-utilized meadows in the Pieniny Mountains and changes caused by single mowing, Pieniny – Nature and Man, Poland, vol. 2, pp 13-24, 1992 [in Polish].

[13] Kopacz M. Surface waters of carpathian streams with reference to structural-environmental changes, Institute for Land Reclamation and Grassland Farming, Poland, pp 1-88, 2003 [in Polish].

[14] Zarzycki J. The dynamics of vegetation on chosen glades in the Pieniny National park at the end of the XX century, Pieniny – Nature and Man, Poland, vol. 9, pp 87-90, 2006 [in Polish].

[15] Starkel L. Spatial diversification of carpathian environment and necessary improvements in land use, Problems of Developing Mountain Regions, Poland, vol. 30, pp 11-29, 1990 [in Polish].

[16] Jaguś A., Rahmonov O., Rzętała M. & Rzętała M.A. The essence of cultural landscape transformation in the neighbourhood of selected artificial water reservoirs in southern Poland, Cultural Landscapes (ed. by Kirchner K. & Wojtanowicz J.) – Regiograph, Czech Republic, pp 37-55, 2004.

[17] Szpara K. Agritourism in the Polish Carpathians, Geographical Works of the Jagiellonian University, Poland, vol. 125, pp 161-178, 2011 [in Polish].

[18] Smoroń S., Twardy S. & Kowalczyk A. Surface water quality in tourist areas of the Western Carpathians, Water-Environment-Rural Areas, Poland, vol. 7/issue 2b, pp 155-166, 2007 [in Polish].

THE EVALUATION OF THE WATER ENVIRONMENT FACTOR, AFFECTED BY THE OIL EXPLOITATION WITHIN THE TICLENI-ROMANIA LEASE

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ABSTRACT

The hydrographic network of the studied area belongs to the Jiu River (Zlastu, Cioiana, Gilort, Amaradia) and to the Olt inferior basin (the Oltet). The surface waters that cross over the territory where the Ticleni Lease develops its activity are the Şuţa brook, Cioiana brook, Brătuia brook, Moroaia brook, Valea Mare brook, Romanaţi brook, Cîlnic brook, Giovria brook, Cioieniţa brook, Cornăţelu brook, Negreni brook, Poieniţa brook, Totea brook, Vladimiri brook and Blahniţa brook [1].

The exploitation system and the circuit of the fluids from the floaters is conceived as a closed system, so the contact with the environment factors cannot happen without control excepting the case of abnormal running conditions caused by accidents, negligence, aging phenomena, running conditions and ground or fluid attack. The main possible polluting agents for the water environment factor are the base crude oil, salted water, formation water, silts. The maximum permitted content of petroleum products in the receiver is of 0,1 mg/l.

In order to investigate the surface waters and the groud water sheet from the lease perimeter in order of a possible contamination, evidence was taken from rivers and fountains. The investigations carried out in order to establish the pollution degree and the impact upon the water, fallowed the physical and chemical characteristics of sufface waters and the evidence from the ground water (NH_4^+, NO_2^-, Ca^{2+}, Cl^-, Fe^{2+}, S^{2-}, Mg^{2+}, SO_4^{2-}, petroleum products, filterable residues dried at 105 Celsius, Na^+, organic substances for the surface waters also Al^{3+}, NH_4^+, NO_2^-, Ca^{2+}, Cl^+, distillable phenic compounds, Cu^{2+}, syntetic anionic detergents for ground waters).

From the analysis of surface waters that cross over the petroleum exploitation divisions it has been deduced that the most affected course of water is Cioiana brook with its affluents Brătuia and Cioieniţa (the analyses results reveal a passing of the Cl^- indicator and petroleum products, as a consequence of the frequent failures of the transport pipes and the least affected course of water is the Gilort river).

Keywords: water, evolution, indicators, exploitation, oil

INTRODUCTION

The hydrographic network of the studied area belongs to Jiu river, as well as to the Olt inferior pond. In this area, the most important streams are: Zlastu, Cioiana, Gilort, Amaradia that belongs to Jiu's river hydrographic pond, as well as Oltetu which belong to Olt's river hydrographic pond [2]. Among the surface waters that pass through the territory of the Schela Ticleni activity area, we name also: the Şuţa brook, Cioioniţa Valley, Brătuia brook, Moroaia brook, Valea Mare brook, Romanaţi brook, Câlnic brook, Giovria brook, Cioieniţa brook, Cornăţelu brook, Negreni brook, Poieniţa brook, Totea brook, Vladimiri brook, and Blahniţa brook (fig.1).

- **Zlastu** – this stream is completely adapted to the subsidence area (S=103 km^2, L= 20 km)
- **Cioiana** – (S= 177 km^2, L= 21 km) is a stream adapted to the Southern contact of the Bran Hill with the Getic Elevated Plane. As a subsequent stream, it receives affluent only from the right side, namely: Brătuia, Lumedie, Valea Mare and Romana. The entire hydrographic pond is composed of a series of hills whose peaks represent also the cut-waters and the surface included between these peaks has a subsidence aspect known as Depresiunea Cioianei. The earth oil exploitations from Ţicleni have powerfully polluted its waters.
- **Gilort** – is the most important left affluent of Jiu. In the interest area, new affluents converge towards Gilort, of which the Câlnicul arrives from the subcarpatic hills. (S= 103 km^2, L= 21 km) and the right affluent Blahniţa.
- **Amaradia** – is the biggest discontinuous flow river from the Getic Elevated Plane. Within the studied area, a small dimension hydrographic organism is made and it is framed in the elevated plane type, having a thermal and high mineralization regime whose quality is modified in a bigger or a smaller range by the polluting agents from the earth oil exploitations from the Bustuchin area.
- **Olteţ** – is the main collector of the Olt-Jiu inter-river, its pond developing in the studied area and losing its flow, a phenomenon that can be observed especially during small waters period, when its flow rate is of 1 m^3/s.

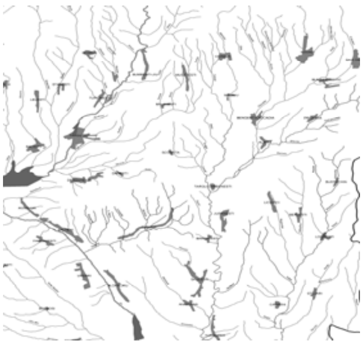

Fig. 1 Surface waters that pass through the hydrocarbons exploitation area

2. THE CAUSES FOR POLLUTING SURFACE WATERS

The exploitation system and the circuit of the bore fluids is conceived as a closed system. The contact with the environment factors cannot happen uncontrolled except for the case of abnormal functioning conditions caused by: accidents, negligence, aging phenomena, ground or fluid aggression [3]. For the Schela Ţicleni, the following causes and potential water pollution sources have been identified:

- pipe breaking
- pipe cracking and hoping
- accidental crude oil discharge from plants during different technological operations, bore interventions, pipes coupling
- reservoir breaking, technological pipes breaking, joint packing breaking
- joint wear of the moving pieces, especially the packing from the back of the columns (which makes contact between the bore and the environment factors), causing drainages, emissions, bore heads fountainheads apparition
- leakages in the transport and storage system of the bore fluids (crude oil, water, gas)
- increasing the extracted pool water volume and its use for the treatment and injection treatments
- using reservoirs, sludge boxes, storage pits for collecting the fluid without capturing the gaseous phase
- contacting the bore columns with the atmosphere
- executing technological operations, negligence, errors, disobeying and neglecting the rules and regulations at work

For the cement grounded plants (storage pits, catch pits, reservoirs) cracks, blanks or dislocations may appear, and they are often difficult to detect, localize and repaired, but they have unfavourable effects because they allow bore fluid leakage into the ground and ground waters.

3. THE EFFECTS OF POLLUTING AGENTS ON WATERS

Hydrocarbons act, in the first place bacteriostatically, with little antibacterial due to the low water solubility. Being resistant to bacteria action, they live long in the infected areas, forming a superficial strip (because they have a density lower than that of water) which prevents the oxygen diffusion in water. Chlorophyll assimilation and organism breathing are prevented and therefore the phytoplankton photosynthesis becomes more difficult, and it produces approximately 70% of the atmospheric oxygen. The main food element of the aquatic life, the algae and plankton, stops being useful.

Many bacteria adapt to the presence of hydrocarbons and metabolize them. Upon protozoa, the aliphatic hydrocarbons in saturated solution initially act by paralyzing them, after one hour, they become deadly. Olefins and cyclic hydrocarbons act as toxics of the nervous system. Aromatic hydrocarbons reveal high toxicity, in concentration of 1-10 mg/l regarding the organisms they act upon. The maximum admitted content of earth oil products into the receptor is of 0,1mg/l.

Organic compounds lead to the increasing of the receptor salinity. Chlorides over a certain range make water inadequate for industrial and drinking water, reaching the receptor, cover its bed. In the calm areas of the country they cause flora and aquatic micro fauna degrading [4].

Fenolic and aromatic compounds have a toxic action upon the aquatic beings. Cancerous hydrocarbons (3-4 benzopiren), concentrated in the eatable aquatic animals organism, reach man's feeding. Therefore, earth oil pollution strikes not only the marine equilibrium but also man's health.

The main possible polluting agents for water environment factor are:

- crude oil
- salty water (pool water)
- slimes

Gross earth oil is immiscible with water, and it can exist in the subterranean environment as a separated phase. This polluting agent floats at the water surface. The crude oil extracted from the pool is mainly accompanied by salty water and only rarely by some mechanic impurities. The water percentage increases during exploitation from an initial 0,1 -4% to 60-90% and more, until the bore is flooded at the end (over the profitable limits of exploitation). The mechanic impurities often present in crude oil (together with water) are sand particles engaged from the layer when crude oil flows towards the bore.

Crude oil water is (with many exceptions) salty water with different concentrations. The following substances can be met in water composition in variable proportion: sodium chloride, magnesium chloride, calcium carbonate and calcium bicarbonate, sulphate of lime, chert, magnesium and aluminum silicate, ferric sulphide and iron rust, as well as other metallic oxides.In crude oil, water may have the following three forms:

a. *Free water* **-** this is easily gravitationally separated from the crude oil when it passes through a horizontal separator, triphasic separator, or by storing it into a tank.
b. *Suspension water* **-** it is under the form of drops having the dimensions over 100 μ. They are maintained in this state because of the crude oil clinginess. Its separation from crude oil is done by heating (the crude oil clinginess is decreased).
c. *Emulsions* **-** they are formed small dimensions water particles between 0,2-100μ. Their separation from crude oil is done by demulsification of the crude oil within its treatment processes.

Slimes or mud that settle on the tanks bottom in which the crude oil is stored are formed from mechanic impurities of crude oil (solid substances of organic or anorganic nature – mineral substances).

In order to investigate surface water and water bearing bed from the lease in order of a possible contamination, tests were taken from rivers and fountains [5]. The investigations made in order to establish the pollution degree and its impact on the water environment factor have mainly focused on the physical – chemical features of surface waters and ground water tests. The results of the analyses made are displayed in table 1.

The admitted values for the quality of surface waters, the analyses methods for STAS and the regulations are displayed in table 2.

Table 1.The results of the analyses of the tetst from the emmisary (surface water)

river/brook	*Cl^- (mg/l)*	*oil products*	*dry filterable waste at 105^0 C (mg/l)*	*aspect*	*quality categories of water*
Cioiana brook, in the Ticleni area, upstream with the Şuţa brook	**1031,60**	**2,20**	**2294,40**	Relatively clear, redish sediment, petroleum product irizations	II
Cioiana brook, downstream from Parcul Mare Ţicleni	**1019,60**	**2,70**	**1870,0**	Relatively clear, redish sediment, petroleum product irizations	II
Cioiana brook, downstream oli zone Ţicleni	202,33	**3,4**	**4300**	Limous, powerful pp smell, with suspensions	II
Zlastu brook	25,78	**1,79**	350	Relatively clear, weak smell of pp, with fine suspensions	II
Gilort river Upstream from the Colibaşi oil zone	19,60	**7,00**	100,000	Clear with sand sediments	II
Gilort river Downstream from the Colibaşi oil zone and Albeni mine zone	20,34	**1,00**	20,34	Relatively clear, fine sand sediment	II
Gilort river Upstream the Bărbăteşti compressor station	24,45	**2,7**	52	Relatively clear	I
Gilort river Downstream the Bărbăteşti compressor station	26,67	**1,6**	20	Relatively clear	I
Amaradia river outside Hurezani	125,29	**1,8**	**2950**	Relatively clear, weak smell of pp, with fine suspensions	II
Amaradia river Outside Bustuchini	**837,25**	**3,2**	**1605**	Relatively clear, weak smell of pp, with fine suspensions	II
Amaradia river Downstream oil zone Totea	112,84	**1,6**	**2570**	Relatively clear, weak smell of pp, with fine suspensions	II
Olteţ river Upstream P1 Alunu	193,34	**0**	**760**	Relatively clear	I
Olteţ river, Downstream A1 Alunu	193,34	**1,28**	**780**	Clear	I

Şuţa brook P807 downstream Ţicleni	114,76	**3,0**	368,0	Relatively clear, redish sediment, petroleum product irizations	III
Şuţa brook in the area of the 802 bore	**323,30**	**2,40**	**7539,0**	Relatively clear, redish sediment, petroleum product irizations	III
Cioieniţa brook, P13 upstream	**676,89**	**2,00**	**1790,0**	Opalescent, sand sediment, fine petroleum irizations	III
Cioieniţa brook, P13 downstream	**230,33**	**2,60**	870,50	Opalescent, sand sediment, fine petroleum irizations	III
Brătuia brook, Upstream confluence Cioiana	212,40	**1,60**	**4140,30**	Relatively clear, redish sediment	III
Brătuia brook P6 Upstream	193,39	**1,60**	650,60	Relatively clear, redish sediment	III
Moroaia brook, P16 upstream	612,30	**3,60**	**1383,20**	Opalescent, sand sediment, fine petroleum irizations	III
Valae Mare brook Oil zone downstream	38,67	**1,40**	250,20	Relatively clear, redish sediment	III
Romanaţi brook Bâlteni P3 downstream	370,70	**1,11**	**780,20**	Relatively clear, redish sediment	III
Câlnic brook Călugăreasca village, oil zone upstream	64,46	**1,20**	380,10	Opalescent, sand sediment, fine petroleum irizations	III
Câlnic brook, discharge in the Gilort river	69,60	**1,20**	390,50	Opalescent, sand sediment, fine petroleum irizations	III
Giovria brook Câlnic confluence, Călugăreasca village	51,57	**1,60**	470,00	Relatively clear, sand sediment	III
Cornăţelul brook	25,78	**0**	340	Relatively clear, no smell	II
Negreni brook Upstream in the Totea oil zone	64,65	**2,8**	500	Limous, powerful pp smell, with suspensions	III
Poieniţa brook Amaradia river confluence, Buştuchin locality	141,86	**1,6**	**3560**	Relatively clear, weak pp smell, with suspensions	III
Totea brook Totea exploitation area upstream	96,67	**1,3**	720	Relatively clear, weak pp smell, with suspensions	III
Vladimiri brook Valea Deşului locality	257,79	**1,4**	810	Clear, weak pp smell, with suspensions	III
Blahniţa brook Colibaşi oil zone downstream	489,8	**1,4**	1320	Relatively clear, weak pp smell, with suspensions	II

Table 2. Admitted values of the indicators for the surface water quality

Indicators (mg/dm^3, max)	Admitted values Quality categories		
	I	II	III
ammonium (NH_4)	1	3	10
nitrites (NO_2)	1	3	it does not form
calcium (Ca^{2+})	150	200	300
chlorides (Cl^-)	250	300	300
total iron (Fe^{2+})	0,3	1	1
sulphuretted hydrogen and suplhures (S^{2-})	-	-	0,1
magnesium (Mg^{2+})	50	100	200
oil products	0,1	0,1	0,1
dry filterable waste at 105^0C	750	1000	1200
sodium (Na)	100	200	200
organic substances (O_2) – for potassium dichromate	10	20	30
sulphurs (SO_4)	200	400	400

4. RESULTS AND CONCLUSIONS

The conclusions that may be drawn from the surface waters analysis (table 1), that pass through the crude oil exploitation stations are:

- the most affected water flow is the Cioiana brook with the affluents Bratuia and Cioienita, the analyses results highlighting an overcome of the Cl indicators and petrol products, as a consequence of the frequent damages of the transportation pipes and ground water.
- the less affected water flow is the Gilort river, this fact being highlighted by the analyses.

REFERENCES

[1] Campina ICPT, Medium reviews at hydrocarbon deposits exploitation at Bâlteni, Bâlteni-east, Bustuchin, Colţeşti-Hurezani, Ticleni-vechi, Romania, pp. 5-7, 2010

[2] S.C.Geopetrol S.A.Ploiesti, The report of medium reviews second level-Ticleni scaffholding, Romania, pp. 9-10, 2010

[3] Campina ICPT, The exploitation study and evolution of alternative technologies, potential for exploitation and comercial deposit (the structure) Colibaşi-east-Călugăreasa, Romania, pp. 12, 2011

[4] Jamie B., Water quality monitoring, E.Fn.Spoon, London, pp.24-25, 1996

[5] Chapman D., Water quality assessments. Guide to use of biota, sediments and water in environmental monitoring, Chapman Hall, Lanodon, pp.28, 1996

THE *FRICHE*S` TYPOLOGIES AS THE ECONOMIC CYCLES EFFECTS ON LANDSCAPE IN THE NORTHERN PART OF THE EASTERN CARPATHIANS (ROMANIA)

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ABSTRACT
The article deals with one of the major problems from Northern Carpathians of Romania: *friche's landscape/brownfiled*[1]. The territorial typological analysis, from these point of view is needed as sustainable development trend and understanding in the Northern Carpathian area and is a subject to inventory typological, cultural landscape (sense Claval, 2003) as *friche* type - fr.: *friche*, engl: *fallow land*, fr.: *friche industrielle*, engl., *former industrial site*, fr.: *terre en friche;* engl.: *uncultivated*, *waste land, brownfield,* as adj. <*out of cultivation* or *en friche* (Brunet, 1993[1], Claval, 2003, 2007[5], Chiriţă, Puşcaşu, 2009[3], Matei, 2011, Chirita 2011[2], Matei 2010), and *resilience* (so Cocean et al., 2010, 2011). Geographers, environmentalists, economists and planners tried to decrypting mechanisms of evolution especially for urban friche, as support for functional reconversion. For unitary speech, our discourse we prefer to use the French term for *brownfield*, as *friche*.

On the other hand, the resilience of a geographical area[6], generate a certain residual landscape caused by the presence *friches,* is confirmed by sequencing, sometimes very rapid of stages of economics and functional changes, specific to habitats, identified as major economic cycles, Chiriţă, Puşcaşu, 2009[4] with reverberations in territorial physiognomy. The friche involves many types: of industrial, agricultural, urban, tourist or as the whole planning mixt typologies in Northern Eastern Carpathians, corresponding of economic restructuring events amplitude and shape different of each economic cycle identified as well a certain typology of spaces and facilities abandoned territory cohorts for planning, for other future stages ([6] Cocean,2007). In this manner, the article aims to identify ways of environmental analysis of relational typologies of territories taken by certain communities and their evolutionary trend as functional areas.

Taking for a community, the existing geographical area, as geographical space of territory, a certain areas from North-Eastern Carpathians landscapes, generated structural and functional dynamics specific spatial sense, attribute specific human and economic land use and making the culture, identifying the following types:

1. industrial and mining friche of mineral resources specific to old mining areas;
2. social friche;
3. agricol and forestry friche;
4. human habitat friche, urban or rural-friche;
5. tourism and services friche;

[1] We prefer to use the French sense for *friche,* and the word for *unused area*, for its meaning relevance in Romanian.

6. socio-economic complex friche .

Genetically related to economic cycles followed, ie. Bukovina, is evidence of the dynamics of economic restructuring, supported by the region, as both sources of disruption landscape or pollution, and more or less as rural for reconversion opportunities. The quality of structural dynamics of rural mountain countryside means to current cultural re-functionalization and ***re-conversion of rural space (CRSp),*** (Chirita, Matei, 2011 [14]) which requires identify and framing nowadays friches.

Monitoring system in rural areas represented by a matrix, identifying abandoned territories and their typological classification as friche offers an integrated analytical perspective, a European component of the current projected sustainability.

Key words: *friches / brownfield, Northern Carpathians, cultural landscape, typology, environmental sustainability, tourism*

CARPATHIAN TERRITORIAL RECONVERSION AND REFUNCTIONALIZATION RURAL SPACE

Resize the structural and functional territorial planning promotes favors not only the evolution of certain areas, in terms of functionality but non-functional areas, abandoned, unclaimed subspaces hard to classify the terminology you use: *fallow, unused or abandoned.*

Westland or brownfield terms/ concepts bring forward not only not used field but the temporary nature useless territory of the type of environment that develops those not only urban but also rural spaces. *Friche* term (fr.) replaces this empty, unfulfilled specialty Romanian literature (Chirita, Puşcaşu, 2009, [3]), and generated by non-use type space left (the land of anyone) who builds a viable functional destiny.

Friche term used for others than urban areas, as those of rural spaces in the mountain areas or simply rooted in mountain area, rural, even outside villages, outside of the rural- hearth, brings the idea of a reconsideration, followed by an act of functional re-conversion

Re-converting rural as the urban ones, due to economic dynamicity, that brings a new dimension not only of an area / territory abandoned but addition of actions-trends in cultural landscape, recalling spatial attributes: docks - port, forts, etc. or for mountain regions the *friches* as components of cultural landscapes in villages or in country-outside, as in the mining exploitation and so on.

The economic evolutions and developments, anchored to those of planning, generating more and more such location as *friche/* brownfiled here, as meaning in the rural areas, who is located in unfriendly areas, uninteresting, at least, in the current stage of evolution, of the territory with mainly functional attribute for economic tertiary sector areas of those who mainly are before 1990-1997 in Carpathians areas as industrial and agricultural economic activity.

The *forestry and agricultural friches* introduce new dimensions of landscape-cvasi cultural (Claval, 2003[5], Brunet, 1993[1], Cocean, 2009), trough the substantial resilience of landscape and especially by regional disparities, functional - dysfunctional.

The friches typology from the Carpathian regions is a difficult endeavor and a process that should be based on a rigorous inventory, started with old headquarters units of forestry-agricultural products to architectural ensembles, some of cultural heritage, functional and in a position to be abandoned or groomed.

THE SPECIFICITY OF CARPATHIAN TERRITORIAL SYSTEMS

The territorial development differentiated, ([7] Duncan, 2008) in different historical stages, in different social- productive systems, generated new territorial structures, with some degree of complexity allowed, often reshaping meanings at different development levels, regional or local. Interpretation of the meaning of economic and social development, through the subsequent transformations old territorial structures previously created, caused or reconsiderations of previous regional arrangements /territorial planning either the abandonment of the old and creating new ones, without "*brownfield-ing"/ "friching"* [2]internal structures.

A. In the Carpathians, decipher the organization of territorial systems, through the role and geosystem function features, grafted on the man-caused territorial organization, were and are conditioned by the manner of disposition of orographic lines: a dominant Northern to Southern orientation. Territorial systems analyzed correspond to areas of intense activity of human communities, cvasi-permanent succeeded in those areas, the average density of population -over the Carpathians, mainly rural: in depressions, valleys, across major regional assemblies known as corridor transfer, the areas of spatial discontinuity. Sequences are found between the northern, central and southern discontinuities of The Eastern Carpathians: Bârgău - Dorna - Câmpulung, Pays Bârsa - Brasov, Breţcu – Oituz. Rucăr - Bran. Also, appear as longitudinal discontinuity corridor areas, the extension or perpendicular to the cross ones: Depression-Country of Maramures, The Land- Countryside of Giugeu - Ciuc, respectively corridor of Gheorghieni – Ciuc - Tuşnad, Predeal - Azuga, or those smaller extensions as: Ciumârna-Săcrieş, Moldoviţei corridor, Moldova Superior basins depression of those depressions from the flysch Carpathian mountains, etc. .

We analyze the territorial system of the Eastern Carpathians, corresponding valley corridors as areas of territorial discontinuity, generated elements by their shape, the orientation of the valleys, the scale depressions, etc., territorial analysis includes those the countries/lands/*pays* in the Eastern Carpathian, and extended research from northern part to south, who had an important role in the economic and social development, with major effects of polarization: Oas, Maramureş, Dorna, Neamt, Székely, Barsa etc.

The territorial systems analyzes are geosystemic determined, in terms of functionality and landscape dynamics, the specific morphological features Carpathians area, namely:

- ⇒ high degree of horizontal fragmentation;
- ⇒ large hypsometric accessible surfaces, such as the plateaus of the erosion surfaces or depressions-country;
- ⇒ density of passes and passages- passes connections as corridors.

A second very important dimension on which we stop for explain the capacity of economic cycles in influences of the cultural landscapes and friches, is the specificity of the Carpathian area, visible through the scope of human pressures on it, due to different territorial systems evolution, evolution due to successive administrative organizations associated cultural landscape as: habitation of the built space, areas of use and exploitation mineral and forestry resources, accessibility and communication, planning and organization of forest and others.

[2] Create a new internal area of friche

The landscape differentiation and the mainly economic cycles were not only links to belonging and administrative management shape in recent territorial administrative structures, but also were generated by geopolitical and the historically role of the administrative organization, in different administrations, which that have divided the Carpathian territory as the internal boundaries of national unitary state, until 1918. Although there were historical provinces and here we refer particularly to those whose borders, internal subsequently separated Moldova Moldovan kingdom of Transylvania and Bucovina - the Duchy of Bukovina (Bucovina, Austro-Hungarian Empire province, from 1775 to 1918).

The manner they organized in Carpathians also, the local administrative structures and territorial systems work differently then bring the structures of differentiated spatial organization structural, functional and dynamic (Ianoş, 2000 [13]). All that shall charge caused a reflection of the developments in history, reported the moments of their genesis and formation or development of social productive systems. So, the specificity of the Carpathian Mountains is not anchored strictly in physical-geographical conditions imposed, undoubtedly the most important, and the rhythms that have followed different spatial organization and those economic cycles.

Relevance of regional differences in spatial systems with specific human activity territorial palnning and reflection, is related mainly to the moments of progress, start and then the evolution of major economic cycles, which we have reconstituted the Carpathians (Matei, Chiriţă, 2011[14]).

Here were considered historical stages of economic exploitation of mineral resources and forestry, each marked by social and economic booms, for a period of maximum expansion and then a slight decline to extinction. For example, the historical moment of the Peace of Adrianople, 1829, fixed for Romanian principality, favorable terms of trade and wood grain, ie a stimulus for the expansion of the Carpathian area of cleared forest areas, massiv deforestation. Wood was necessary in mountain and extr-acarpthians or subcarpathians areas and / or for shipyard in Danube ports or seashore. These events have been perceived differently, in different times or triggered.

The same situation of increasing the economic capcity occurred in the Eastern Carpathians and the need for iron, manganese and coal, which was different for areas belonging to the United Moldovan Kingdome or Austro-Hungarian administration. Of course, the big economic cycles remain important as present, in most regions Carpathians, only the amplitude varies during actual events and their succession.

Is important to note, that the *friches: industrial, mining, social,* etc.., emerging and established territorial effect, after the peaks activity of economic cycles mentioned, also had different contributions to the organization / reorganization of geographical space.

DIFFERENTIATION TERRITORIAL SYSTEMS FRICHE IN EASTERN CARPATHIAN AND THEIR TYPOLOGY

Regional differences or physical-geographical organization of the Carpathians, due to factors mentioned have allowed different rates of release of major economic cycles that have succeeded. Carpathian Resources generated by operating these economic cycles and were at and subsequent formation of mining areas, industrial, agricultural or forestry later abandoned, generated friches / brownfield / waste land.

As, in the same space resumption of economic activities by exploiting resources that became more interesting, more attractive to new socio-productive systems evolved, and status of abandoned sites, and have found new functional destinations.

Throughout the countries of the Carpathians, including friches caused by logging mention: former log loading ramps, facilities for narrow rail, for the transport of forest exploitation and the remnants of former dams for floating conducted logs (*haituri* =dams with locks that temporarily store water from rivers to facilitate, by dumping, logging in rafts) or other items that were once the premises with concrete platforms or logs as in the Dornas Bassin: Negrei Şarului Valley, Dornişoara, Dorna, in Maramureşului Land as Viseu, Vaser, etc. .

Their recovery for tourism may be a prerequisite for mountain tourism and rural development, both as targets and as points, locations for future facilities such tourist board (concrete platforms, valuation of forest access roads).

The same type railway transport systems, narrow gauge, mostly abandoned in the decades 6 and 7 of the last century, have created new tourist attraction elements that, generally, the old narrow gauge railway -terminus have at Moldovita, Obcinile Bucovina. In the basins of Vaser and Viseu in Maramures Depression, or in Baraolt, basins Trotus and Asău, etc..

Photo: Tourist train transportation on narrow gauge, railway, Moldovita valley, Bucovina, 2011

Also friche of territorial planning /arrangements as road for forestry ang log transport are among the most important directions of Carpathian area that further developments.

Access roads in protected areas are mainly those who once had a role in forestry. In the old forest roads and forest districts cable transport systems are often capitalized in respect to accessibility to tourist areas or isolated areas.

Although mostly they have Friche status as abandoned industrial level, restoring some of the equipment (steam engines, trolleys and vintage cars or even stops and railway stations), is a very important functional retraining with for tourism.

Another dimension of friches/brownfiled with possible tourist accessibility and attraction is the abandoned *mines*. They form usual a desolate, abandoned mine through holes, mine developed in full chaotic forest areas, quarries sometimes suspended at altitudes above 1300 - 1400 m and very large areas or primary ore processing plants, floating plants, concentration of ores and their treatment (Leşu Bear in Bistrita basin, basin Ostra Suha, Fundu Moldova Moldova or upper basin of Balan in Harghita Mountains).

Desolate landscape caused by this adds harmful role that have dumps over the dam and determine infiltration and surface water and pollute the river.

Quarry - friche of former sulphur mining exploitation in Negoiu Romanesc Mountains, in National Park of Calimani Mountain, Eastern Carpthians, Photo: Viorel Chirita, 2010

CONCLUSIONS

In the context of agricultural and forestry territorial mountain space, in the study area, persistent different types of friches/brownfiled elements contribute to reconsider the role of non-agricultural activities in rural-mountain that can be located within them (Matei, [15]). As urban areas by successive retraining, are found in new functionality (including social, commercial and cultural service sector) and Romanian mountain village and may be associated items such friche, landscape, cultural features or complementary agricultural activities .

Perspective of reconversion cultural landscape of friches:

One perspective is that of a potential cultural tourism such as facilities as roasting ovens manganese (rodocrozitul - black shale ore exploited), the first industrial installation in the manganese operation, fixed in the late 19th century by Austrian administration, at Iacobeni of Mainz or processing ovens Tuşnad kaolin near the 18th century, up to large scale mining and destructive potential of the environment such as the Baia Borsa Massif Calimani Pietricelu-Negoiul Romanian who worked until the early 2000s.

All these could be targets of niche tourism, little known that, with minimal facilities, would get a major tourist resource. In this respect were built the old salt mines of sub Carpathian hills area Praid and Cacica former friche mining, nowadays main tourist attraction of reconversion of mining friche.

Another perspective is that of **social friches** in Carpathian area. In their case should be noted that they are generated by the change of use of temporary housing sites or not, to the barracks to true mining villages or cities ranked as a city during the lifetime of industrial activity.

Unfortunately, the buildings in various stages of degradation are difficult to rehabilitation in view not only the physical destruction due to idle status and poor management and administration when were functional (e.g. : Leşu Ursului on Valley of Bistrita River, Balan in Harghita Mountains, partially Baia Borsa in Maramures Mt., etc or the typical friche set of apartment service buildings in Calimani Mt.

Photo: *Social Friches in Calimani Mt, 1550m alt., former buildings for service*

**Photo, Viorel Chirita, 2010*

Therefore, just as rural territory optimization strategies take into account ecological governed by the European Charter for rural areas (Division 12), anything that is traditional, rustic and sustainable rural development should not be disregarded - so have seen these items landscape, rural friches - as possible to convert territorial spaces associated non-agricultural activities: tourism, production based on conventional energy resources, minerals or the products of organic farming or small units for organic products.

Deciphering the mechanisms by which these may be targets for portfolio retraining developers, it is necessary to achieve practical and pragmatic approach to development not only theoretical concept.

REFERENCES

[1] BRUNET, R., FERRAS, R., THERY, H., 1993, Les Mots de la Geographie, dictionnaire critique, Reclus- La Documentation Francaise, Paris

[2] CHIRIȚĂ, V., 2011, Environmental Relationships in Dornas Region and The Călimani National Park (Eastern Carpathians) The 11th International Multidisciplinary Scientific Geo-Conference & EXPO - SGEM 2011, procedings, Albena, Bulgaria, www.sgem.org

[3] CHIRIȚĂ, V, 2009, Frişă, brownfiled sau paragină-dileme şi argumente pentru un concept sintetic, Analele Universităţii „Ştefan cel Mare", Suceava, Sect. Geografie, Anul XVIII, 2009

[4] CHIRIȚĂ, V., Violeta PUŞCAŞU, 2009, Constructive and Destructive Relationships in The Călimani Protected Area, Conferinţa Internaţională Management

and Sustainable Protection of Environment BenA (Balkan Environmental Association) , Universitatea 1Decembrie, Alba Iulia, 6-7mai, 2009

[5] CLAVAL, P., 2003, Geographie Cuturelle, Armand Colin, /VUEF, Paris, France

[6] COCEAN, P. (2007), Dissolution Processes of the Mental Spaces afferent to the Romanian Lands" Revista de Geografie Politică, 1, pg. 5-10, Oradea.

[7] DUNCAN, J. JOHNSON, C. NUALA, SCHEIN, R., 2008, A Companion to Cultural Geography, Blackwell Publishing, UK

[8] DUNCAN, James, 1992, Re-representing the Landscapes: problems of reading the intertextual, in vol Paysage et crise de la lisisibilite, , coord, La Mondanda et colab, France

[9] GROZA, O. , 2003, De re- geographiae sau lungul drum al spaţiului către teritoriu, « Teritorii (scrieri, dez-scrieri) », Paideea, Bucureşti

[10] GROZA, O. 1999 - La Moldavie : les structures territoriales des espaces ruraux en difficulté – un modèle d'analyse territoriale, in V. Surd (coord.) – « Rural Space and Regional Development », Ed. Studia, Cluj,

[11]GROZA, O., 2002, Teritorii (scrieri, dez-scrieri), Paideea, Bucureşti

[12] GROZA, Octavian – Redescoperirea teritoriului sau reapropierea spaţiului, in Revista Ştiinţifică, « Vasile Adamachi », Ed. Universităţii « Al.I.Cuza » Iaşi, vol.5, no.1-4 (serie nouă), ianuarie-decembrie

[13] IANOŞ, I., 2000, Sisteme teritoriale. O abordare geografică, Editura Tehnică, Bucureşti

[14] MATEI, Daniela, Viorel CHIRIŢĂ, 2011, The Local Development Options in the Dornas Region, Between the Economic, The 54th International Scientific Conference, Durable Agriculture development strategy, University of Agricultural Sciences and Veterinary Medicine /UASMV, Iasi

[15] MATEI DANIELA, Economie rurala neagricola. Traditie si perspective in Moldova, Editura Terra Nostra, Iasi, 2011

THE IDENTIFICATION AND RISK ASSESSMENT OF THE POLLUTANTS GENERATED BY CONTINUOUS EMISSIONS

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ABSTRACT

The continuous emissions generally lead to the emergence of long-term chronic risks, but in certain conditions they can cause acute effects. Identification and characterization of physico-chemical pollutants emitted from a source are necessary to evaluate the risk that can produce negative effects on human health and the environment. For risk assessment it is necessary to determine the exposure time, to assess the dose to which the body is exposed and the response to this dose. The most important aspect of the current interpretation of the dose-response function and the risk estimation based on it refers to the uncertainty and risk levels of individual risk assessment in the final phase.

The analysis and evaluation of the continuous emission requires the completion of three phases. The first phase is to identify sources stating the amount and physico-chemical characteristics of the emissions. Phase 2 involves the identification and characterization of recipient movement of pollutants from source to receiver (using mathematical modelling in general), the location of a recipient (individuals, communities and sensitive ecosystems). Modelling the transport of pollutants from sources provides information about the exposure. Phase 3 is the identification of the relationship between exposure and effect so that the effects or risks should be determined.

To determine the exposure of the continuous emissions, the use of mathematical models is necessary. Those models simulate the transport and transformation of substances in the environment, and which can be used to calculate risk-generating incidental consequences. The model takes into account several factors such as conditions of release and features of continuous emissions, transport and geophysical characteristics of the route, as well as environmental risk parameters. At the same time, the models solve some of the key issues related to assessing the rate and effects of the accident, the establishment of relations between local effects in the short term and long-term and simultaneous assessment of multiple sources of risk.

Keywords: risk assessment, pollutant emissions, modelling pollutant transfer

1. INTRODUCTION

Clean water is absolutely essential for healthy living and adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth. Nevertheless, it has been observed that millions of people worldwide are deprived of this. Freshwater resources all over the world are threatened not only by over exploitation and poor management but also by ecological degradation.

Soil and water pollution with nitrogen compounds as a result of wasteful agricultural practices affect human health especially in rural areas. However, the aquatic ecosystems are affected by the eutrophication process due to intensification of high concentrations of nitrogen. Many areas of groundwater and surface water are now contaminated with nutrients that have an adverse effect on human health. In this context, legislative measures have been taken. The most important is the Directive 91/676/EEC related to water protection against pollution caused by nitrate from agricultural sources. According to this Directive, the maximum allowable concentration of nitrate in water is set up to 50 mg / L.

In this context, a study was developed in the meadow of the Danube, in a rural area, represented by the agricultural enclosure Gostinu-Greaca-Arges. The results have shown that the nitrate values have higher concentrations comparing to the maximum allowable concentration value for all the area studied.

2. DATA AND METHODS

The research activities were focused on more villages located in the Southern part of Romania, in the vicinity of the agricultural enclosure Gostinu-Greaca-Arges, from Giurgiu county (figure 1).

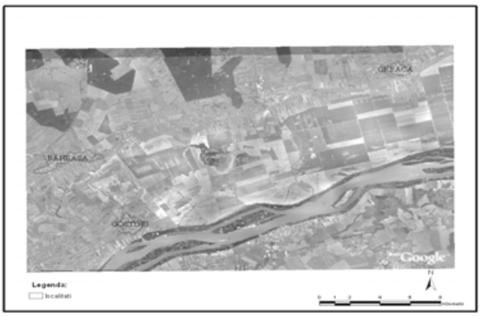

Fig. 1. Location of sampling sites

The relief of analyzed perimeter is represented by the Burnas Plain and the Danube Meadow and the climatic conditions are similar to those indicated by the meteorological station Giurgiu, with some differences due to meadow topo-climate. The average annual temperature is between 10,8 ^{0}C and 18.5 ^{0}C for the vegetation period, total amount of annual precipitation is 535 mm, out of which 350 mm is recorded in the vegetation period. The hydrographic network is represented by the Danube river. The groundwater is stuck in the sand layers and gravel of Fratesti. The hydraulic permeability of layers varies from 1,5 to 3 m/day in loess at 0, 001 to 0,01 m/day in the layers with clay texture. The recharge of unconfined aquifer comes from the Danube (at middle and high levels), rainfall and losses from irrigation.

Currently, the population of analysed localities has no centralized water supply consisting in abstraction of raw water from aquifers, raw water treatment, water transport, storage and distribution of drinking water to all users within localities. Water used by locals for daily consumption comes from underground water sources through individual catchements. In most cases, rural wells are improperly located, being situated in the vicinity of sources of groundwater pollution (cesspools, septic tanks).

The main problem in the analysed area, is the lack of sewage collection and wastewater treatment system before discharging in the emissary.

3. RESULTS AND DISCUSSION

Identification and risk assessment

Identification and risk assessment on human health and environmental quality caused by the leaching of nitrate in the groundwater was performed in three steps, as is shown below.

Step 1. Identifying sources and pollutant emissions

Identified pollution sources in the rural areas analysed are represented by: septic tank systems from which effluents are discharged directly into the soil, improperly completed animal landfills and unreasonable application of organic and chemical fertilizers containing nitrogen. It is well known that septic tanks systems are important point sources (historical and current state), for pollution of groundwater with nitrate [1, 2], by discharging effluent directly into the soil. The effect of these systems is felt especially in rural areas where septic tanks number is higher, exceeding the capacity of soil retention and purification of the effluent before it enters in the groundwater layer.
Resulting effluent from a septic tank system has typically a nitrogen concentration amount from 25 to 60 mg/L. From this, 20 to 55 mg/L is in ammonia form (NH_3, NH_4^+) and less than 1 mg/l as nitrate (NO_3^-). Although the amount of nitrate is not high, this may increase under the process of nitrification (biological oxidation of $N\text{-}NH_4$ to $N\text{-}NO_3$), [3].

Step 2. Transfer of the pollutant from the source to the emissary

Temporal and special variation of the pollutants depends on the groundwater flow in the aquifer and the type of substance dispersed. The flow in the aquifer is influenced by initial and boundary conditions. For the flow regime analysis, first the velocity field in the area of interest is calculated. Determination of velocity field is based on the calculation of the same level curves of hydraulic head (compared to a reference level), using Darcy's law:

$$Q = AK\left|\frac{\Delta h}{L}\right| \tag{3.1}$$

where:

Q = volumetric flow rate;

A = flow area perpendicular to L;

K = hydraulic conductivity;

L = flow path length;

H = hydraulic head.

Hydraulic calculation of flow regime in an aquifer requires drawing of the equipotential lines, flow lines and velocity fields. Hydraulic head value at any point in the aquifer is determined by integrating groundwater flow equation in terms of initial and boundary conditions. With these values, lines of equal level of water table can be drawn for unconfined aquifer and at the same time, lines of equal piezometric surface for confined aquifer. Knowing these curves, the direction of flow at any point in the area can be determined and also the flow lines can be drawn to find out the values of velocity field. The velocity values are determined using Darcy's equation and taking into account the hydraulic conductivity of the aquifer. Concluding, solving the problem of pollution in an aquifer requires integration of groundwater flow and pollutant dispersion equations, taking into account the flow velocities in the aquifer. Generally, for integrating the mentioned equations numerical methods are used, such as finite difference method or finite element method.

MODFLOW (three-dimensional block-centred finite-difference groundwater flow model), a computer program, has been developed by [4] in the form of modular three dimensional groundwater flow model for US Geological Survey. MODFLOW is able to simulate a wide range of flow in porous media with wide varieties of systems and standards including groundwater flow and transport of contamination [5].

MT3DMS is a three dimensional multi-species contaminant transport model for simulating the solute transport processes [6]. It is based on the advection-dispersion formulation for modelling of saturated and unsaturated zone and also interaction between surface water and subsurface water. MT3DMS contains different techniques including the third–order Total Variation Diminishing (TVD), fully implicit Finite-Difference Method (FDM), and particle tracking based Method of Characteristics (MOC). There has been a wide development in MT3DMS since the first released in

1990 which was known as MT3D. It supports simulation of different species mass transport. Nevertheless, in first edition it used for simulating of single species.

Visual MODFLOW combines MT3DMS and MODFLOW to flow and transport modelling under different conditions. The program can be readily understood and modified, it is simple to use and maintain, easily executed on a variety of computers with minimal changes, and is efficient with respect to computer memory and execution time [5]. Study of transport and dispersion of nitrate in the aquifer can be done using Visual MODFLOW (figure no. 2).

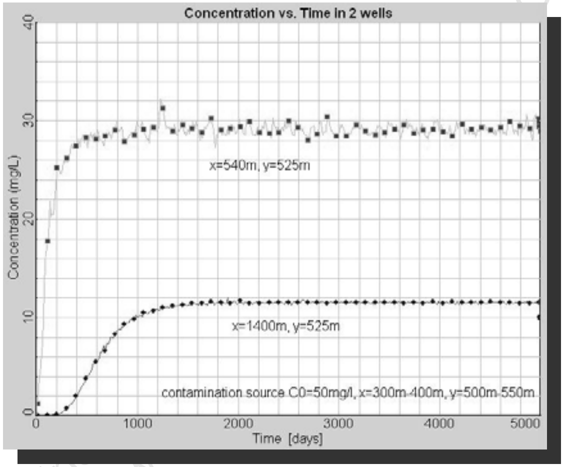

Fig. 2 – Example of visualisation of nitrate concentrations in two observations wells simulated with Visual MODFLOW

Step 3. The effects of pollutants on biotic and abiotic environments

Research and quality field studies were conducted in the rural areas in the Danube valley. Analytical results of groundwater samples taken in May of 2009 indicate that the values exceed maximum of concentration allowable by the 458/2002 Law, amended and supplemented by the 311/2004 Law for nitrate parameter, but also for other parameters analyzed such as conductivity, total hardness and chlorides (Tables 1, 2, 3).

Table 1 – The results of analytical determinations for Gostinu well

No	Parameter	Units	Value	Method used	**311/2004 Law** Max. allowable concentration value
1.	pH	unit. pH	6,84	SR ISO 10523/97	6,5÷9,5
2.	Conductivity	µS/cm	2870	SR EN 27888/97	2500
3.	Calcium (Ca^{2+})	mg/L	179,6	SR ISO 6058/08	-
4.	Magnesium (Mg^{2+})	mg/L	87,6	SR ISO 6058/08	-
5.	Total hardness, minimum value	^{0}G	45,3	SR ISO 6059/08	5
6.	Sodium (Na^+)	mg/L	123	ISO 9964/1-93	200
7.	Nitrate (NO_3^-)	mg/L	420	SR ISO 7890/1/98	50
8.	Chlorides (Cl^-)	mg/L	313,8	SR ISO 9297/01	250

Table no. 2 – The results of analytical determinations for Baneasa well

No	Parameter	Units	Value	Method used	**311/2004 Law** Max. allowable concentration value
1.	pH	unit. pH	6,94	SR ISO 10523/97	6,5÷9,5
2.	Conductivity	µS/cm	924	SR EN 27888/97	2500
3.	Calcium (Ca^{2+})	mg/L	53,7	SR ISO 6058/08	-
4.	Magnesium (Mg^{2+})	mg/L	48,4	SR ISO 6058/08	-
5.	Total hardness, minimum value	^{0}G	18,7	SR ISO 6059/08	5
6.	Sodium (Na^+)	mg/L	83,2	ISO 9964/1-93	200
7.	Nitrate (NO_3^-)	mg/L	65	SR ISO 7890/1/98	50
8.	Chlorides (Cl^-)	mg/L	49,6	SR ISO 9297/01	250

Table no. 3 – The results of analytical determinations for Greaca well

No	Parameter	Units	Value	Method used	**311/2004 Law** Max. allowable concentration value
1.	pH	unit. pH	6,86	SR ISO 10523/97	6,5÷9,5
2.	Conductivity	µS/cm	1453	SR EN 27888/97	2500
3.	Calcium (Ca^{2+})	mg/L	96,2	SR ISO 6058/08	-
4.	Magnesium (Mg^{2+})	mg/L	98,3	SR ISO 6058/08	-
5.	Total hardness, minimum value	^{0}G	36,1	SR ISO 6059/08	5
6.	Sodium (Na^+)	mg/L	84,4	ISO 9964/1-93	200
7.	Nitrate (NO_3^-)	mg/L	140	SR ISO 7890/1/98	50
8.	Chlorides (Cl^-)	mg/L	113,5	SR ISO 9297/01	250

The most dangerous human health risk that can occur as a result of water pollution by nitrate is methemoglobinemia, well known in the literature as “blue baby syndrome”. In human body, the nitrate (NO_3^-) is rapidly converted to nitrite (NO_2^-) and the major biological effect of the nitrite is due to their involvement in the oxidation of normal hemoglobin into methemoglobin (MHb), which is unable to carry oxygen to tissues. Methemoglobinemia clinically manifests itself when methemoglobin concentration reaches 10 % of normal hemoglobin. Hemoglobin for one year children is more probable to become MHb, and in addition, they are more exposed to the disease risk comparing to the adults. The most vulnerable group on the nitrate pollution are new born babies, infants, pregnant women and the elderly.

It is known that ground and surface water are in connection, so increasing the concentration of nitrate in groundwater affects the aquatic ecosystems through eutrophication phenomenon (figure 3).

Fig. 3. Body of water situated in the area of interest and affected by eutrophication

CONCLUSION

Taking into consideration the Romanian situation regarding risk assessment of the pollutants generated by continuous emissions, it is concluded that the rural areas are most affected by the leaching of the nitrate into the aquifers. Two main solutions to be implemented for reduction or elimination of nitrate pollution are proposed:

- The development of centralised sewerage, including wastewater treatment plants;
- The use of the best agricultural practices

In the future, the best solutions should be taken in order to reduce the number of diseases caused by nitrate pollution.

REFERENCES

[1] Robertson, W.D, Cherry J.A, & Sudicky E.A. Ground-water contamination from two small septic systems on sand aquifers, Ground-water. vol. 29, pp. 82-92. 1991;

[2] Robertson, W.D. & Cherry J.A. Hydrology of an unconfined sand aquifer and its effect on the behaviour of nitrogen from large – flux septic system, Applied Hydrology, vol. 1, pp. 32 – 44, 1992;

[3] Reddy, K.R. & Patrick, W.H. Effect of alternate aerobic and anaerobic conditions on redox potential, organic matter decomposition and nitrogen loss in a flooded soil, Soil Biol. Biochem. 7, pp. 87-94, 1975;

[4] McDonald, M.G. & Harbaugh A.W. A Modular Three-Dimension Finite-Difference Groundwater Flow Model, US Geological Survey, Washington DC, USA, Book 6,. Chapter A1, pp. 586, 1988;

[5] Harbaugh, A.W. MODFLOW-2005, the US geological survey modular ground-water model. The groundwater flow process, US Geological Survey, Reston, Virginia, USA, variously pp. 253, 2005;

[6] Zheng, C. Recent development and future directions for MT3DMS and related transport codes, Groundwater, 47, DOI: 10.1111/j.1745-6584.2009.00602.x, pp. 620-625, 2009.

THE IMPACT HIGHLIGHT AND EVALUATION PRODUCED BY THE HEAP BRANCH II COROIEȘTI - E.P.C.V.J. VULCAN

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ABSTRACT

The purpose of this study was to provide an assessment of the environmental impact that the heap Coroieşti Branch II has on the environment.

Using the impact array and impact network long-term negative effects on the environment have been marked out. Assessment of the impact generated by the heap dumps on environmental factors highlighted the most important manifestations of the impact on soil, water, air, vegetation and local community.

The result of this study showed that the average subject to anthropical activity is in the acceptable limits.

Keywords: heap, arrays, network impact, global impact index

GENERAL CONSIDERATIONS

The evaluation phase is the time passing from an estimate of the expected impacts on the various ambiental components, quantitatively measured depending on the physical nature, quality estimate to assess the importance of these impacts.[1]

Evaluation of environmental quality in an area at one time is made possible by the assessment of the quality of the air, water, soil, state of the fauna and flora of the area and the health status of the population in the area. These factors can be characterized by representative quality indicators for assessing the degree of pollution factors that have determined admissible limits.[3]

HIGHLIGHTING THE GENERATED IMPACT

Impact assessment is the main method in the measurement of environmental deterioration as a result of anthropogenic activities.

The matrix method is the most widely used instrument of the methodology of impact assessment.

In the case of the environmental balance this method may be applied in assessing the evolution in over time of the relationship between the analyzed activity and the environment, after introducing the environmental protection equipment and appliances.

The arrays of impact have been improved in order to be able to represent the impact process through several related logical connected arrays. The whole assemble is defined as a coaxial array that highlights the mutual roles of different categories of items involved in a process of impact: actions, interfaces, etc.[2]

Using this method makes it possible to analyze all possible relationships, making the total assessment more objective. It should be noted that this method allows evaluation of both the direct and indirect impact. Usually in arrays of impact assessment scales and reliability grids are used for differentiating the roles of different types of activities and ecological factors, which give a complex character to the method.

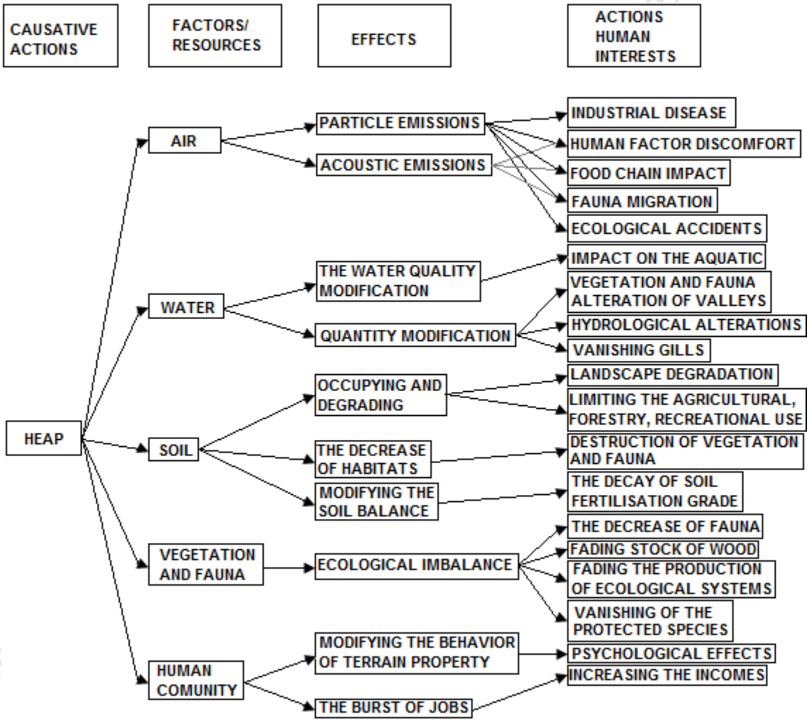

Fig.nr. 1. *Impact network for dumping of sterile - heap*

The advantages of the method include: the possibility to compare different types of impacts based on common judgments, transparency, flexibility, easy and economic character. The main disadvantages of the method are: its own subjectivity, because it involves the judgment of the evaluator or the judgment of an evaluation team and the fact that the evaluation is qualitative, although quantitative grades are given.

The stiffness of the matrices can be overcome by using networks where nodes sequentially layout the items in a process of impact.

Networks are reminiscent in many respects with arrays, but they are recommended to study the cause-and-effect relations that underlie the impacts. A network of impact identifies chains of direct and indirect impacts, primary and secondary generated by an action or the determination of actions which generates a specific impact.[2]

Networks used for highlighting the impacts are made up of flowcharts or chains of multiple relationships, which show the correspondence between the actions of the project and ambient components that these actions could change. These allow the highlight of the secondary or indirect effects, the presence of multiple interactions and the cumulating effects in a more systematic way than the arrays actions-cause-and-effect. They also have the ability to locate the impacts in a temporary dimension.[2]

In order to identify the impacts generated by a project, the networks reconstruct the chain of events or the potential effects induced by the project-specific actions on the initial state of the environment, the potential changes of the environmental conditions, the multiple effects of the impact and the possible minimization measures.

ASSESS THE ACHIEVED IMPACT

A simple method of assessing the degree of environmental pollution for a location is the global pollution index. The way of integration in the environment of the activities made on site can be assessed in synthetic evaluation based on these indicators of quality. According to the inclusion within the normal limits reliability grades are granted.

Global impact index method makes it possible to express the state of the environment based on the ratio between the ideal value and value at a time of the quality indicators specific to the targeted environment.

In assessing the state of the environment in both the ideal situation and the situation in which it is affected by anthropical activities, stairs of reliability are used for the environmental factors and ambient components that contain grades from 1 to 10; 1 corresponds to a serious damage situation to environmental factors analyzed; and 10 to natural status, not affected by anthropical activities. According to the grades of reliability that define the environment in the initial state (environment, not affected by anthropical activities) and the carrying out of a project, two polygons are constructed (with three, four or more sides, depending on the number of ambiental analyzed components), one of which shows the ideal state and the other the state affected by the impacts generated by the project.[2]

The global impact index is calculated by the ratio between the two areas of the polygons. Depending on the value obtained for the global impact index (I_G), the environment can be defined as follows:

I_G = 1 environment not affected by anthropical activities;

I_G = 1-2 environment subjected to anthropical activity - within admissible limits;

I_G = 2-3 environment subjected to anthropical activity, causing discomfort to life forms;

I_G = 3-4 environment subjected to anthropical activity, causing disturbance to life forms;

I_G = 4-6 environment seriously affected by anthropical activities, dangerous to life forms;

I_G > 6 degraded environment, unsuitable to life forms.

Global impact index method has several advantages, among which stated:

- provides a global picture of the state of the environment;

- allows the comparison of different areas by analyzing them on the basis of the same indicators;

- allows the dynamics in time analyze of a zone.

The disadvantage of this method is the subjectivity that appears in granting the grades of reliability.

The estimation of the quality indexes of the environment is made by their reliability scale.

The environmental factor soil will be affected by dirt dumping and the modification of pedogenesis processes. The impact of this factor falls within admissible limits, which corresponds to a quality index $I_{C\ SOIL}$ = 0.50-1.00 resulting in a reliability grade Nb = 7

Water infiltration in the heap can produce pollution of surface waters and groundwater and could affect the stability of construction. Infiltration water from the heap arrives in main gill: Priboi and Piscu changing their quality into worst, therefore environmental factor water will be affected within admissible limits, resulting in a water quality index: $I_{C\ WATER}$ = 0,25-0,50 ⇒ Nb = 8.

Considering that dust particles involved do not exceed maximum permissible concentration of 6 mg\/m3, just in the periods of drought and high winds, the impact on this environmental factor is within acceptable limits, which corresponds to an index of air quality $I_{C\ AIR}$ = 0 – 0.25 ⇒ Nb = 9

Due to the fact that the objective of this review would not bring prejudice to human settlements because they are located at a great distance of the target, the impact on human settlements will not have negative effects, only on the employees. Because there is a risk of water and air pollution in the area in the event of extreme weather phenomena, then quality index ICUm = 0.25-0.50 ⇒ Nb = 8.

Because the heap is an example of anthropic impact on the area where it is located, it creates changes in landscape, its presence reduces the biodiversity, and simplifies the structure of the ecosystem, the quality index for these two factors is IVF = 0.50-1.00 resulting in a reliability grade Nb = 7.

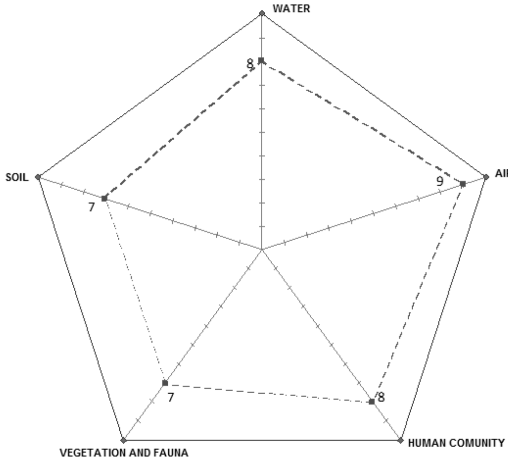

Fig.nr. 2. Determining the global impact index

Analyzing the reliability grades the following conclusions are made:

- Environmental factor SOIL will be affected in the admissible limits, level 3;
- Environmental factors VEGETATION, FAUNA, will be affected in the admissible limits, level 3;
- Environmental factor WATER will be affected in the admissible limits, level 2;
- Environmental factor AIR will be affected in the admissible limits, level 1;
- Environmental factor HUMAN COMMUNITY will be affected in the admissible limits, level 2.

After calculations these resulted S_i=237,764 and S_r=145,034

$$I_G = S_i/S_r$$

$$I_G = 237{,}764/145{,}034 = 1{,}639$$

Therefore, it appears that I_G falls between 1-2: environment subjected to anthropical activity within admissible limits.

CONCLUSIONS

Assessment of the impact generated by the heap U.P. Coroieşti RII branch on environmental factors highlighted the most important manifestations of the impact on soil degradation by changing the forms of relief and landscapes, taking over portions of the land forever, hydrological changes; regarding the consequences on the human element they are negative anatomical, physiological and psychological, as well as positive regarding the economic condition; regarding the consequences on water the phenomena of water infiltration may cause pollution of surface waters and groundwater; impact of air is determined by the sources of dust, dust in suspension, the phenomena of spontaneous combustion; and on wildlife and vegetation the impact is created by the landscape changes, leading to the reduction of biodiversity, especially the simplification of the structure of the ecosystem.

REFERENCES

[1] Fodor D. & Baican, G. The environmental impact of mining industry, Editura Infomin, Deva, România, 2001, p.183-200

[2] Lazăr, M., & Dumitrescu I. Anthropic impacts on the environment, Editura Universitas, Petroşani, 2006, p.190-234

[3] Negulescu, M., Vaicum L. ş.a. Protection of the environment, Editura Tehnică, Bucureşti, 1995, p.124-138

THE IMPACT OF ALTERNATIVE SEWAGE SYSTEMS ON THE ENVIRONMENT

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ABSTRACT

This paper will analyze the effects of alternative sewage systems on groundwater flow and surface water, on soil, underground and human beings.Through comparative analysis of gravity, gravity and pumping and vacuum sewage systems, we highlight the opportunities for their use or their application as wastewater collectors, depending on the configuration of land, groundwater levels and economic issues.

The case studies outlined in this paper highlight the technical and scientific aspects, coupled with the related impact on the environment.

Keywords: gravity system, pumping system, vacuum, impact study

1. INTRODUCTION

Sewer system means all buildings and facilities which provide collection, transportation and wastewater treatment, from population centers on the hearth. These types of works with a positive impact on the environment are designed to ensure environmental protection, hygiene and human health. Wastewater collection from the hearth population centers can be achieved by gravity drainage networks with free level or pressure, with pumping or vacuum systems. [3], [5], [6]

Choosing the appropriate sewerage system is determined by the size of the locality, slope, nature of the soil, groundwater level, position and size of the emissary. The choice is made based on technical, economic and environmental considerations. Technical documentation for waste water collecting sewage from populated centers, are followed by feasibility studies, through which technical solutions are confirmed by impact studies on the environment. The impact assessment highlight the effects of the activities in the framework of the project on the environment: water, air, soil, human settlements, flora and fauna, etc. The impact of these factors may be permanent, temporary or accidental.

Permanent effects are generally long term effects, occurring during operation and they may have insignificant environmental effects. Temporary effects are short term effects, occurring during execution, with significant effects on the environment, but without exceeding the permissible limits of rules and standards. Accidental effects are caused by damage to the sewer system components, heavy traffic, earthquakes, landslides, floods,they are long, medium or short lasting harmful effects, in which the environment is more or less degraded. Measures taken to reduce negative impacts and enhance positive impacts are requirements to ensure a clean and healthy environment. [3]

2. ALTERNATIVE SEWERAGE SYSTEMS

Sewage systems are systems that change following the development or expansion of urban population centers. Residential areas are communities that grow near population centers. Collection and discharge of wastewater must ensure comfort and hygiene conditions in the communities.

Drainage waters collected and transported through sewage systems must fit into the requirements of the technical norm NTPA 002/2005, so that: temperature < 40 C; pH < 6,5 – 8,5; suspended solids < 350 mg/dmc; biochemical oxygen consumption CBO_5 < 300 mg O_2/dmc; sulfates SO_4^{2-} < 600 mg/dmc; sulfites SO_3^{2-}< 2 mg/dmc; ammonium NH_4^+ < 30 mg/dmc. [10]

Collection of domestic wastewater and rainwater may be made through separation, combined or unitary systems.

The gravity sewer system ensures free flow of collected water p = pat. It is the most common, being recommended in areas with high slopes of the land. Gravity sewage system with pump is a combined network between the gravity system and the pressure pipe from the pumping station. In the sewage pumping system it will be ensured the flow of pressurized water collected by a pumping station p > pat. This system is used where a gravitational flow of wastewater is possible. These systems are recommended for areas with sloping land. Vacuum sewer system, ensure the transport of domestic wastewater at lower pressures than atmospheric pressure p < pat. This system is recommended in the lowland areas and developped residential neighborhoods near urban population centers. [3], [4], [5], [6], [7]

Gravity sewer system has a much higher vulnerability than other systems due to the leakage from sewage pipes joining manholes, causes leakage of domestic wastewater with increased risk of groundwater dilution effect , with negative effects on treatment. Low speeds because of large section of sewer pipe favors increased deposits, fermentation of organic materials spills of toxic gases and combustible gas, with negative effects on operating personnel and the environment. [3], [8]

Pumped sewage system has a low vulnerability. The tightness of sewage pipes causes no difficulty. Pumping stations are expensive works with high investment and running costs. Pumped sewage systems require previous separation and retention of coarse bodies: sand, gravel, textiles.

Vacuum sewer system is a sealed system and it corresponds from an ecologically point of view. Because it is a sealed sewage pipes, infiltration and exfiltration are eliminated. Additional facilities are about the collection manholes, equipped with vacuum valve. It would be taken measures to retain coarse bodies. The vacuum has a high energy consumption. Because of the small diameter pipe, reduced width of the excavation and laying depth of the high pipe the investment costs are reduced.

3. CASE STUDY

For the case study it was chosen a sewage network of a human settelment, located in a lowland area with a population of 450, presented in Fig. 1. [7]

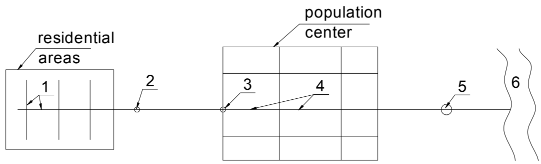

Fig. 1. Situation plan
1-gravity sewer / vacuum; 2-pumping station / vacuum; 3-inspection manholes; 4-principal collector; 5-treatment plant; 6-emissary

Gravity sewer network system (G), will be made of PVC pipes with a length L = 2335m and a diameter of Dn 250 or Dn 300. The average depth at which network laid in this case is h = 1.8 m. The chosen slope in this case is i = 0.003 ÷ 0.024 which ensure optimum operation of the sewerage system, in order to ensure a selve-cleaning of the pipe. Fig. 2 shows the longitudinal profile of this sewer system. [4], [7]

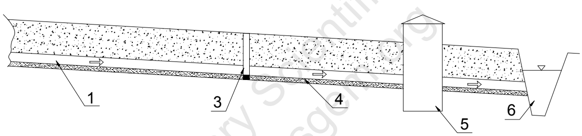

Fig.2. Longitudinal profile of gravity sewerage system
1- secondary gravitational collector; 3-inspection manholes; 4-principal gravitational collector; 5-treatment plant; 6-emissary

In gravity sewer systems with pumping (P) the domestic wastewater is collected by connecting manholes and transported to pumping station by gravity through PVC pipes (in this case study two pumping stations are provided). The pressure pipe will be made of high density polyethylene pipe with a diameter Ø110 and a length L = 2335m. The average depth at which the network laid in this case is h = 1.5 m, the slope is chosen in this system by i = 0.003 ÷ 0.024 which ensure optimum operation of the sewerage system in order to ensure a self-cleaning of the pipe. Fig. 3 shows the longitudinal profile of this sewer system. [4], [7], [9]

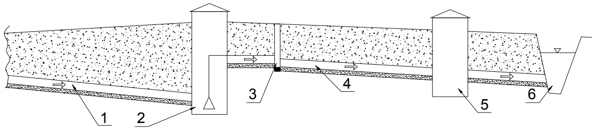

Fig.3. Longitudinal profile of the pumping sewer system
1- gravitational collector with free level; 2-pumping station; 3-inspection manholes; 4-principal gravitational collector; 5-treatment plant; 6-emissary

Vacuum sewerage network (V), will be made of high density polyethylene tubing PE-HD PE 100 SDR 13.5 with a diameter Ø 110 and Ø 125 and a length L = 1965m. The average depth at which the network laid in this case is h = 1.2 m, slope chosen is Ic = 0.002, maximum depression allowed in vacuum sewer Δpv = -0.6 to - 0.7 bar minimum allowable negative depression for valve opening Δpv = -0.25 bar fig.4. [4], [7], [9]

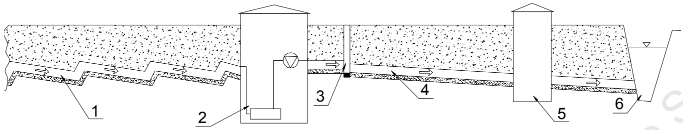

Fig.4. Longitudinal profile of vacuum sewerage system
1- vacuum pipeline; 2- vacuum station; 3-inspection manholes; 4-principal gravitational collector; 5-treatment plant; 6-emissary

Currently there are over 50 environmental impact assessment methodologies (Barrow, 1997; Goudie, 1983, 1993). The method used to assess the impact is the analysis of the environmental impact size. The method is based on environmental quality estimation indices based on a scale of their creditworthiness. For each of the environmental factors (water, air, soil, flora - fauna and human settlements) is calculated a quality index for which we obtain a mark of evaluation (Nb) granted by the outcome samples and environmental analysis. [1], [2]

In relation to the effects size we have quality indexes Ic, which are defined by the relation:

$$I_c = 1/ \pm E \quad (1)$$

where: $\pm E$ - effect size determined by the evaluation matrix

From the analysis of the granted credit notes results a number of conclusions which allow classification of environmental factors mentioned in the admisible limits established in accordance with the law. The method allows the calculation of the global pollution index (I_{PG}). Thus, with evaluation marks for quality indices assign environmental factors construct a diagram in which the ideal environment is represented graphically by a regular geometric figure inscribed in a circle with a radius of 10 units of worthiness, where the geometric shape depends on environmental factors analyzed. Graphical representation is made with the Rojanschi illustrative method. Ideal condition (S_i) is represented graphically by a regular geometric shape enclosed in a circle with a radius of 10 units of worthiness. Actual condition (S_r) is plotted by irregular geometric shape obtained by joining points, which represents the equivalent value of the quality index in the worthiness scale, shape enclosed in the regular geometric shape of the ideal condition. It results a ratio between the ideal surface (Si) and the actual surface representing the real condition (S_r). [1], [2]

$$I_{PG} = S_i / S_r \quad (2)$$

$$S_i = N_{b\ apa} \times N_{b\ aer} \times \sin 72° /2 \quad (3)$$

if: $I_{PG} = 1$, pollution doesn't exist;

$I_{PG} > 1$, there are changes in environmental quality.

Table 1 - Impact Assessment Matrix

Action or generating sources	Water			Air			Soil			Human settelments			Flora and fauna		
	G	P	V	G	P	V	G	P	V	G	P	V	G	P	V
Construction stage															
Spatial organization of building site	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
Access road developing	0	0	0	0	0	0	0	0	0	+	+	+	0	0	0
Construction	-	-	-	0	0	0	-	-	-	+	+	+	-	-	-
Network tracing	0	0	0	0	0	0	0	0	0	+	+	+	0	0	0
Plugging ditches and restore landscape	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Transport of materials	0	0	0	-	-	-	0	0	0	0	0	0	0	0	0
Operational stage															
Maintenance operation	-	0	0	-	+	+	0	+	+	+	+	+	0	0	+
Risk of accidents and injuries	-	0	0	-	0	0	-	-	0	-	+	+	-	0	0
Social effect	0	0	0	0	0	0	0	0	0	+	+	+	0	0	0
Effects size	-2	0	0	-3	0	0	-2	-1	0	4	6	6	-2	-1	0

G- gravitational; P-pumping; V-vacuum

For each of the environmental factors (water, air, soil, flora - fauna and human settlements) is calculated a quality index for which we obtain a mark of evaluation (Nb) granted by the outcome samples and environmental analysis. The graphical representation is made with te Rojanschi method. The ideal plant (Si = 237.8) is represented graphically by a regular geometric shape enclosed in a circle with a radius of 10 units of credit worthiness.

Gravity system (G) - $N_{b\ water} = 5$; $N_{b\ air} = 4$; $N_{b\ soil} = 5$;.$N_{b\ h.s.} = 9$; $N_{b\ f.f} = 5$. Actual condition (S_r) is plotted in Fig. 5.

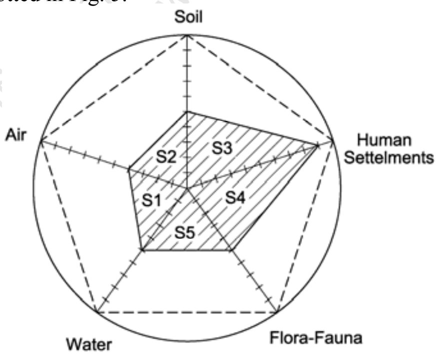

Fig. 5. Graphic presentation of impact assessment - gravity system

$S_1 = 9{,}51$; $S_2 = 9{,}51$; $S_3 = 21{,}40$; $S_4 = 21{,}40$; $S_5 = 11{,}89$; $Sr=73{,}71$ (3)

$I_{PG} = 3{,}22$ - Environment is affected by human activity, causing disorders the forms of life.

Pumping system (P) - $N_{b\ water} = 10$; $N_{b\ air} = 10$; $N_{b\ soil} = 6$; $N_{b\ h.s} = 9$; $N_{b\ f.f} = 6$. Actual condition (S_r) is plotted in Fig. 6.

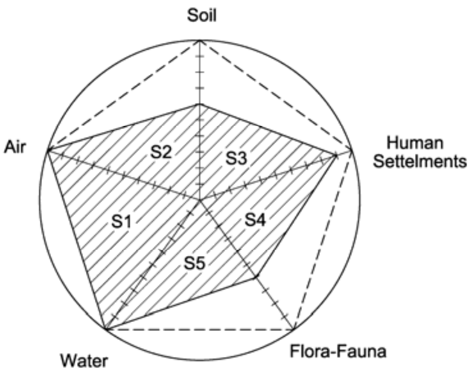

Fig. 6. Graphic presentation of impact assessment - pumping system

$S_1 = 47{,}55$; $S_2 = 28{,}53$; $S_3 = 25{,}68$; $S_4 = 25{,}68$; $S_5 = 28{,}53$; $S_r = 155{,}97$ (3)

$I_{PG} = 1{,}52$ - Environment is submitted human activity within reasonable limits.

Vacuum system - $N_{b\ water} = 10$; $N_{b\ air} = 10$; $N_{bsol} = 10$; $N_{b\ a.u.} = 9$; $N_{b\ f.f} = 10$. Actual condition (S_r) is plotted in Fig. 7.

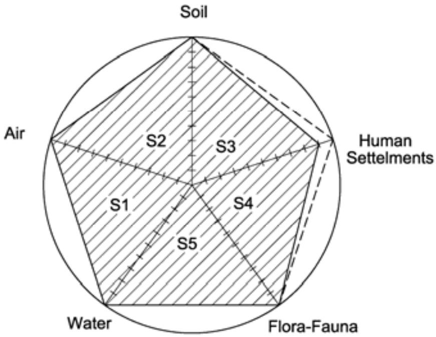

Fig. 7. Graphic presentation of impact assessment - vacuum system

$S_1 = 47{,}55$; $S_2 = 47{,}55$; $S_3 = 42{,}80$; $S_4 = 42{,}80$; $S_5 = 47{,}55$; $S_r = 209{,}23$ (3)

$I_{PG} = 1{,}14$ - The environment is not affected by human activity.

4. CONCLUSIONS

a) Impacts on ground and surface water

Implementation period - Groundwater is partially affected by the execution of the sewerage. Groundwater contamination may occur due to accidental leakage from cars and construction equipment, leakage can be avoided by using advanced machinery. During performance the groundwater pollution is limited.

Operation period - Proper functioning of household sewerage is affected by groundwater and rainfall that can infiltrate the sewage damaging the treatment processes. Exfiltration of wastewater can contribute to degradation of groundwater if these are used as a source of drinking water.

b) Impact on air

Execution period - To achieve the objective will perform work involving heavy vehicles, excavators, bulldozers, equipment exhaust emissions that contribute to air pollution in the activity areas. Impact on air quality is limited during the execution period for the sewage network.

Operation period - wastewater collection by gravity system allows volatilization of organic compounds from the wastewater in contact with atmospheric air. Odors due to presence of nitrogen compounds, sulfur and phosphorus in organic materials, which are biologically degraded by bacteria in aerobic or anaerobic conditions, leading to increasing smelling compounds levels. Impact of pollution sources in the area, and odors are local and have a major effect on air quality in the area.

d) Impact on terrestrial flora and fauna.

Execution period - During execution the landscape will be affected by the works of sewage achievement. They will recover after the works.

Operation period - During the operation period the terrestrial flora and fauna can be affected, because of leachate of sewer.

e) Impact on soil and underground

Execution period - Some land can be temporarily affected for laying sewer pipes. Land located on sewerage trenches will be brought to the initial condition. During execution time, there will not be used pollutant substances for soil, but there can be some low accidental leakage of fuel and oil from the used equipment; to prevent contamination of soil and underground, avoid direct placement of construction materials on the soil.

Operation period - During operating time soil and underground can be affected, because of the leachate of sewage system

f) Impact on human settlements

Execution period - During execution, because of equipment operation there can be recorded a moderate negative impact on the residential area but for a limited period of time.

Operation period - During operation, the dominant impact is positive by creating new jobs.

The impact study is the support for establishing the optimal solution of wastewater sewage in the population centers. This study is possible only if the feasibility study is prepared for at least two or three alternatives. For this case study, the vacuum collection system, proved the most advantageous terms for technical, economic and environmental protection requirements. The vacuum system is the one that ensures high reliability and reduced vulnerability.

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REFERENCES

[1] Rojanschi V.& Bran F.&Diaconu G. Protection and Environmental Engineering, Book/Economical Editura, Romania, vol. 1/issue 2, 2002.

[2] Mirel I&Florescu C&Staniloiu. Impact of the hydro work on the environment Conference - installation and construction for environmental comfort. Timisoara 18-19 april 2002. pp 565-569.

[3] Giurconiu M.&Mirel I.&Carabet A.&Chivereanu D.&Florescu. C.& Staniloiu C. Hydro construction and installations, Vest Publishing, Timisoara. 203-260, 2002

[4] Panfil C.&Mirel I.&Gîrbaciu A. Alternatives for collecting waste water from population centers located in low land areas" Scientific Bulletin of the Politehnica University of Timisoara, Transactions on Hydrotechnics, 56(70)2,2011.

[5] Mirel I.&Fabry A.&Peter A.&Carabeţ A.&Stăniloiu C.&Olaru I. Use of vacuum sewage collection and disposal of wastewater from rural communities. Rom Aqua year XVI, vol.70. 7-14, nr.4/2010.

[6] Mirel I.&Man T.E.&Fabry G.&Peter A. Use of vacuum gravitational alternative to wastewater sewerage from households located in the lowland communities. Scientific Bulletin of the Politehnica University of Timisoara, Transactions on Hydrotechnics, 53(9/10), 41-49 (2008a).

[7] Panfil C.&Mirel I.&Gîrbaciu A. Alternatives to wastewater sewarage system from residential areas located near populated centers. XXVI. microCAD International Scientific Conference University of Miskolc, 29-30 March 2012.

[8]*** HG 352/2005, Norms of discharge wastewater into the aquatic environment.

[9]*** HG 445/2009, for framework procedure for environmental impact assessment for specific public and private projects.

[10]*** NTPA 002/2005, the conditions of wastewater discharge of urban sewage networks and treatment plants direction.

THE IMPACT OF LEAD ACETATE ON THERMAL HOMEOSTASIS AND INTRAVITAL STAINING INTENSITY OF DIFFERENT ORGANS IN HYBRO CHICKENS

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ABSTRACT
The impact of acute onefold injection (45 minutes after) of Pb - acetate (100 mg/kg. i.m) in the speed of falling in shallow hypothermy (up to 35 ^{0}C) and spontaneous warm up until euthermy (41.5 – 42^0 C), was followed in Hybro brown chicken (N=16, six weeks old).
After eight individual measurements, it was observed that in comparison to control group, in chickens treated with Pb - acetate has shortened the period of falling in hypothermy for 1.14 min ($P<0.01$) and prolongs the time of spontaneous warm up of cold body until euthermy for 14 min ($P<0.01$).
The circadian rhythm (at 8 am and 7 pm) of intravital staining intensity in liver, kidney, heart and brain of chicken (N= 28), five days after injection of Pb - acetate (dose 100 mg/kg. i.m) was followed as well.
The findings show that in comparison to the control group of chickens the intensity of intravital staining in these organs was increased by this heavy metal, but not significantly ($P>0.05$). There was no circadian rhythm ($P>0.05$) regarding the intensity of intravital staining in these organs depending on the time of the day when this heavy metal was applied (N=28).

Keywords*:* lead acetate, hipothermy, euthermy, circadian rythm, intravital staining

INTRODUCTION

Organisms have a feature to perceive the time. This is a feature called "biological clock" that determines the circadian, seasonal and annual rhythm of the physiological processes. The phenomenon of biological rhythms manifests in all levels of life organization, such as unicellular, multicellular organisms, plants and animals, and even in cell organelles etc. (Pitendraj et al. 1964)[14]. Circadian rhythm enables organism its synchronization in harmony with the frequency of changes in the external environment

(Benjamin et al. 1979)[1]. The term chronotoxicology refers to the change of organism's sensitivity to toxicants in the time relation (Mohamed et al. 1995)[12].
The chronobiological, chronotoxicological and chronopharmacological data shown for the oscillations of different biochemical-physiological parameters in the same organism (glucose, body temperature, hormones, etc.) in the period of 24 hours (Delponte et al. 1978) [2]as well as the effects and different action intensity for several hormones, antigens, pharmacological products, pesticides, carcinogenic substances, X-rays, etc., depends on the time of the application, day or night (Hernandes, 1978)[10].
As for lead and chronotoxicology, respectively implications of lead in the thermal homeostasis and rate of hypofunction or necrosis of organs, depending on the time of application of this heavy metal (circadian rhythm), we did not find any research. But the literature on the toxic effects of heavy metals in general and in particular lead, it's abundant. It is about the lead as a multitarget toxicant that causes effects in the gastrointestinal tract, hematopoietic system, cardiovascular system, central and peripheral nervous system, immune system, deficiencies in cognitive and neurophysiologic processes (Ehle and McKee, 1990[3]; Stollery et al. 1991[18]).
Based on what we said above, we decided to follow the impact of lead acetate (doses 100 mg/kg i.m.) in the Hybro Brown chicken (age 6 weeks) to:

1. The speed of falling of chicken in shallow hypothermia (to 35^0C, 45 minutes after treatment with lead acetate) and spontaneous warming up of its body until euthermy (41.5-42^0C).
2. The intensity of intravital staining (in-vivo) of liver, kidney, heart and brain of Hybro chickens, five days after onefold acute injection of lead and depending on the time of its application (circadian rhythm).

MATERIAL AND METHODS

For the experiment were used the Hybro Brown chickens (N = 42 chickens) of the female sex, age 6 weeks and an average of body mass 420 gr. Before the experiment chickens were placed in vivarium for 7 days, in the Department of Biology, for acclimatization The vivarium conditions (temperature, light) have been adapted conform to external environmental conditions. Before and during the experiment chickens were fed with standard laboratory food *Ad-libitum*. For testing the effect of lead acetate (dose 100 mg/kg i.m) in thermal homeostasis, chickens were divided into two groups. The first experimental group (N = 7) was injected into the onefold dose of lead acetate (100 mg/kg i.m), while the second group, intact (N = 7), served as control. Chickens of this group instead of lead acetate were injected to the same volume of physiological solution for the birds. After 45 minutes from the moment of application of lead acetate, respectively physiological solution, cloacal temperature was measured in chickens. Then, to the both mentioned groups of chickens is provoked afrigore hypothermia. It was measured the time (in minutes) of falling in shallow hypothermia (35^0C) and time of reset of normal body temperature (euthermya).
For testing of the toxic effects of lead acetate depending on the time of injection (the marker circadian rhythm of intensity of intravital staining of several organs), 28 chickens were divided into 4 groups, each one had 7 chickens. The first and second group served as a control, while the third and fourth as test. The chickens of test group, at 8 ^{PM} and 7 ^{AM} were injected lead acetate (dose 100 mg/kg i.m) while to the control

groups at the same time were injected the same volume of physiological solution for birds.
Five days after the application of Pb - acetate, respectively physiological solution, the circadian rhythm of the intensity of intravital staining of liver, kidney, heart and brain, at 8 o'clock in the morning and 7 o'clock in the evening was followed.

METHODS

Hypothermy provocation

Certain depth of hypothermia can be caused artificially by cold or by using chemicals that blocks the thermoregulatory defense mechanisms. Shallow hypothermia is caused by plunging of chickens into a container with water-ice, at a temperature about 2^0C (hypothermia afrigore). With a chronometer was measured the time required for the decreasing of cloacal temperature of 41.5-42^0C, as normal body temperature is, up to 35^0C (shallow hypothermia). Then, chickens were removed from cold water, and were exposed to the thermostat temperature, until reaching the normal body temperature (41.5 -42^0C). The required time for spontaneous warming up of the cooled body to the level of normal body temperature is measured with chronometer, while cloacal temperature was measured with the animal mercury thermometer.

Intravital staining method

Aiming to prove the differences in degree of necrosis and hypofunction of various tissues and organs depending on the time of injection of lead acetate (in the morning at 8 o'clock and evening at 7 o'clock), in-vivo intravital staining was applied. Five days after the application of Pb - acetate, the chickens were injected by 1 ml 0.5% neutral red/50 g of body mass at 8 ^{AM} and 7 ^{PM} (depending on group). After 60 minutes from the time of application of neutral red, the chickens were sacrificed immediately and the extirpation of heart, liver, kidney and brain were done. Extirpated organs are rinsed in a physiological solution for birds and placed in special glasses (for neutral red extraction) filled with 20 ml of acid alcohol (99 ml of 70% ethyl alcohol + 1 ml of concentrated HCl). After 24 hours of staying in acid alcohol, was read the stain intensity of ethanol tissue extract in colorimeter. The dry mass of tissue was determined two hours after staying at laboratory thermostat, at the temperature 60^0C. The staining intensity of the ethanol tissue extract was expressed as optical density units per gram of tissue's dry weight (Romanov, 1960)[16].

RESULTS

Results of research dealing with the effect of lead acetate in thermal homeostasis of Hybro chicken are shown in Figures 1 and 2. The Fig. 1 show that this toxic heavy metal (45 minutes after application) decreased significantly the cloacal temperature of chickens ($P < 0.01$), compared with their initial cloacal temperature also to the cloacal temperature of the control group of chickens. Also, compared with control group, to the intoxication's chickens, 45 minutes after application of lead acetate, the time of falling in shallow hypothermia (35^0C) shortened (for 1.13 min) and the required time for spontaneous warming of their body to euthermy (41.5-42^0C) prolonged (for 14.2 min).

While in the control group of chickens, the depth hypothermia of 35^{0}C appears 4.3 min after their plunging in the water-ice, while for the chickens treated with lead, hypothermia with the same depth reached for a shorter time (3.2 min). This data represents an average of seven separate measurements, from the moment of exposure of the euthermic chickens in the ice-water mixture until the decrease of their body temperature at 35^{0}C. The results of this research shown that in the intoxicated chickens, the time of spontaneously body warming to euthermy prolonged, from 60 minutes (as is found in control group) to 74.2 minutes. These differences in time (after continual measurements of time and cloacal temperature) related to spontaneous warming of the chicken's body of test and control groups are statistically significant ($P < 0.05$).

Table 1. Circadian rhythm (at 8 ^{AM} and 7 ^{PM}) of the intravital staining intensity for various organs of Hybro chicken of the control group and test group, five days after intoxication with lead acetate (dose 100 mg/kg i.m.).

Chickens group	Liver		Kidney		Heart		Brain	
	Time of injection (hour) of n e u t r a l r e d dye							
	8 h	19 h	8 h	19 h	8 h	19 h	8 h	19 h
Control group	2.0+0.41 (7)	1.9+0.38 (7)	1.88+0.35 (7)	1.83+0.52 (7)	1.2+0,34 (7)	1.15+0.44 (7)	2.27+0.57 (7)	2.24+0.35 (7)
Pb-acetate	3.14+0.75	3.0+0.73	2.07+0.39	2.01+1.6	1.44+0.14	1.41+0.19	2.61+0.73	2.63+1.9
Significance P	<0.01	<0.01	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05
%	15.7	16.0	11.0	11.9	12.2	12.2	11.4	11.7

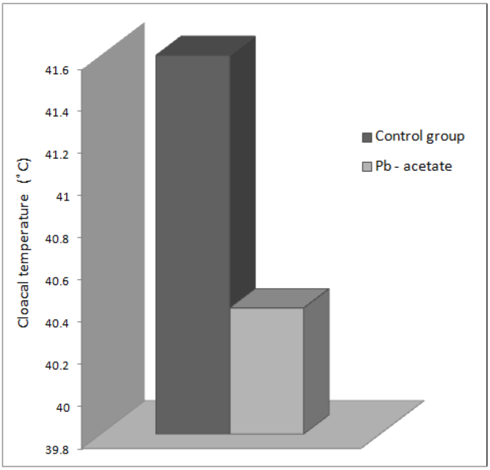

Fig. 1: The level of body (cloacal) temperature of the chickens, 45 minutes after application of physiological solution (control) respectively Pb-acetate (100 mg/kg. i.m.)

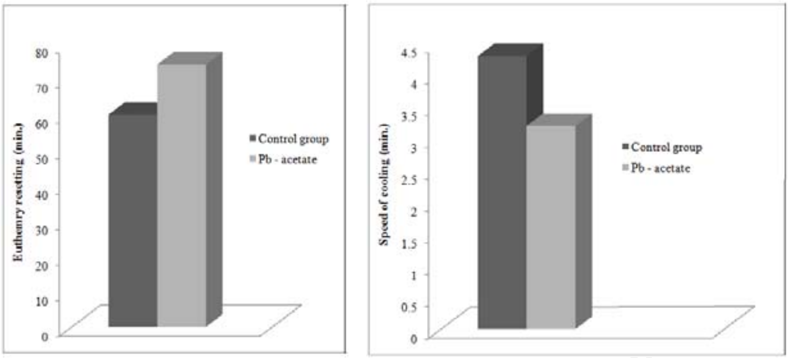

Fig. 2 Time required for falling in shallow hypothermia (35^0C) and euthermy resetting (41.5-42^0C) to the control group of chickens and chickens treated with Pb- acetate (dose 100 mg/kg i.m.), 45 min after intoxication

Table 1 show that compared with the control group, in the chickens treated with lead acetate, increased intensity of intravital staining of liver, kidney, heart and brain. This increase is significant (P <0.01) only in case of liver. Except the liver, the intensity of intravital staining of other researched organs of the intoxicated chickens does not depend on the time when the lead acetate was applied (morning at 8 and evening at 7). Also in the control group of chickens was not found circadian rhythm regarding the intensity of intravital staining of liver, kidney, heart and brain during the time when the research was done.

DISCUSSION

Chronotoxicological measurements of metabolism in the insect larvae show that insecticide disulfoton is associated with the maximum of presence of oxidative metabolites at 6 ^{AM} and 6 ^{PM}. Ros, finds that the circadian rhythm of diazepine toxic effect in white rats adapted to 12 hours - light and 12 hours - dark was more expressed after the cycle of light phase compared with the cycle of darkness phase. The same author previously found that cholinergic substances such as amphetamine, has a more toxic effect in rats if it is applied after the dark phase during day-dark cycle (FH Ros et al. 1980)[17]. According to literature the circadian toxic effect of picrotoxin, sodium phenobarbital, gamma aminobutyric acid (GABA) applied in exogenous way on mammals depends on the endogenous level of biogene amines in the brain. Thus, for example Shigehiro O., 2007[19], found that the toxic effect of drugs is associated with 24-hour rhythm of biochemical processes, physiological and behavioral characteristics that's controlled by biological circadian clock. Shingehiros researches lead to the findings that biological clock, or chronopharmacological phenomenon affects not only pharmacokinetic but also pharmacodynamic of drugs. According to him, identification of circadian rhythm of the drug action effect (chronopharmacology) may serve as a marker for selecting of the proper time for drugs application in order to increase their effect. Various toxic substances such as cyanides disrupt the circadian rhythms (Wan Soo Kim, 2008)[20]. The mentioned author by testing the toxic effects of sodium cyanate in the endogenous rhythm of oxygen consumption level in the fish *Sebastes* *schlegeli*, found that doses of 20 ppb of sodium cyanate causes physiological damages of the endogenous rhythm of these fishes. In the course of research for circadian rhythms are also interesting the data of Froy et al. 2009, who researched the biological clock of cytochrome P450, and conclude that the genes expression that regulate the molecular level of cytochrome P450 depends on the genes family, which's activity regulated by biological clocks. So, for example, according to him the hepatic P450 oxygenase metabolize the melatonin (epiphysis hormone), whose expression is controlled by the biological clock.

The biological clock also affects thermoregulation. Chronobiological researches shown about change in body temperature of different homoeotherm animals, as well the birds in 24-hour period (Moller and Bojsen, 1974)[13]. Based on our available literature, indicates that lead and thermoregulation chronotoxicology, respectively lead and hypothermia are not well researched. This is why the comment for the implication of lead in thermal homeostasis, we'll do on comparative basis. Thus, for example the literature data shown for the lead as a polytrop toxicant that attacks the normal function of tissue, organs and system bodies, such as CNS and PNS, synaptic transmission, cardiovascular system, endocrine system, mineral metabolism etc. (EPA, 1986 a,c[4],[5]; Ahlan and McKee, 1990).

Consequently, the literature data related to our research results shown that the injection of this toxic heavy metal in birds induce functional changes in the hypothalamic – hypophyseal - adrenal axis associated with endocrine disorders, neuroendocrine and neurocrine. These changes were reflected in thermal homeostasis, respectively thermogenesis and thermolysis mechanisms. In support of this assertion goes the fact that in the hypothalamus (as the center of thermoregulation) of people exposed to lead have been found high doses of lead (EPA, 1986, a,c[4], [5]) and functional disorders in the thyroid gland hormones which play important role in energy metabolism.

Therefore, the presence of the shallow hypothermia for a shorter time and the delay in the reset of the euthermy of intoxicated chickens with lead acetate compared with control group of chickens is a consequence of interference of this heavy metal with chemical mechanisms of thermoregulation, inhibition of these mechanisms respectively.

Regarding the our comment on the implication of circadian rhythms in toxic effects of various substances, we shall begin with the fact of differences in response, for example, rats, depending on the time of application of drugs, carcinogens etc. its mortality varies within 24 hours after application of the same dose of Phenobarbital (Mayersbach, HV, 1976[11]). This drug causes high rate of mortality if given early in the early morning (from eight experimental animals, five died), but when the same dose given in the late night, there is no negative effect.

There are many data on the impact of the biorhythm in carcinogenesis. Thus, for example, if the rats injected in the skin a single dose of benzopyrene on midnight and noonday associated with the lubrication of skin with Croton oil, its carcinogen effect on skin is higher for several time if it's given in the middlenight (in the skin appear more tumors) than when given at noonday. These examples show that there are differences in terms of intensity of drugs action in organs, depending not only on day period of application, but over 24 hours the detoxifications body's ability change (Frohberg, H., 1976[6]).

Therefore, when planning a toxicological and pharmacological research, in addition to other factors, such as specie, sex, age of experimental animals, the method of application of substance, the food and nutritional status, etc.., anyway should be taken into consideration also the time when substance, drug or toxin applied (chronotoxicology, chronopharmacology). Furthermore, there is evidence that the tissue or organ reaction in a pharmacological preparation depends on the time of its isolation from the body (Reinberg, A., 1974)[15].

Regarding the comment of the results related the effect of lead acetate in the intensity of intravital staining of liver, heart, kidney and chickens' brain, depending on the time of its application (circadian rhythm), emphasize the fact that we found only two researches (Gramenickij, 1958 [8]; Halili et. al., 1987[9]). Gramenickij, found an increase of affinity of various organs of frog for neutral red dye, after intoxication with lead of this amphibian's specie. Also, Halili et al. 1987, found an increasing in intensity of intravital staining of albumen gland in the natural populations of vineyard snail Helix pomatia, L., taken at the close surroundings of lead and zinc foundry "Trepça" in Zveçan, compared with intravital staining of these gland in control group.

CONCLUSIONS

Treatment of chickens with lead acetate (dose 100 mg/kg i.m. 45 minutes after treatment), has as a consequence:
A. Significant decrease of cloacal temperature compared with the start temperature (P <0.01)
2. Time acceleration (about 1.14 min) of chicken's falling in shallow hypothermia (35^0C) and prolongation of spontaneous warming time (about 14.2 min) of the cooled body until euthermy (41.5 - 42^0C) compared with control chickens.
3. Five days after onefold injection of the aforementioned dose of lead acetate, there is a significant increases in the intensity of intravital staining of liver (P <0.01)
4. For the applied dose of lead acetate and the time when researches were performed, there is not found circadian rhythm of action of this heavy metal in the intensity of intravital staining in the liver, kidney, heart and brain.

REFERENCES

[1] Benjamin R. & Irving Z. Neural regulation of circadian rhythms. Physiol. Rev., 1979; 59, pp 449-526.
[2] Del Ponte A., Capani F., Domani A., Sensi S. Diurnal variation of hypoglycemic action of insulin in diabetics: Preliminary results - In: Chronopharmacology. Proc. Satell. Symp. 7th Intern. Congr. Pharmacol; Oxford, pp 311-314, 1978.
[3] Ehle, A.L., Mc Kee, D.C. Neuropsychological effect of lead in occupationally exposed workers: a critical rewiev. Crit. Rev. Toxicol. 1990; 20, pp 237-255.
[4] Environmental Protection Agency (EPA) U.S.A. Air Quality Criteria for Lead. Vol. I of IV. Environmental Criteria and Assessment Office, research Triangle Park, NC. EPA-00/8-83/028a F. Aviable from NTIS, Sprigflied, VA; PB87-142378, 1986a.
[5] Environmental Protection Agency (EPA) U.S.A. Lead. Vol. I of IV. Environmental Criteria and Assesment Office, research Triangle Park, NC. EPA - 600/8 - 83/028 c F. Aviable from NTIS, Sprigflied, VA; PB87 – 142378,1986c.
[6] Frohberg, H. Uvod za simpozijum :Sta je znacaj hronobiologije u toksikologiji i faramakologiji. Arh. Toxicol, 36, ¾, 1976.

[7] Froy, Oren Cytochrome P450 and the Biological Clock in Mammals. Current Drug Metabolism, Volume 10, Number 2, pp 104-115 (12). Bentham Science Publishers, 2009.
[8] Gramenickij, E. M. Izmenjenie prizinjenoj okraski kletok holodokrovnih pod vlijaniem kis loga svinca. Bull. Exp. Biol. Med., 45, 96, 1958.
[9] Halili, F. Rozhaja, D.A .,V. Pantic and I. Elezaj Histopathological changes of albumen gland in snails (Helix pomatia, L.) kept in an environment polluted by lead metallurgy. Acta Veterinaria, 37:13, 1987.
[10] Hernandes R.E., Kuhl J.F.W., Halberg E. Circadian susceptibility rhythm of rat to alocsan ,Chronobiologia. Vol. 5, N 4, pp 369-378, 1978.
[11] Mayresbach, H.V. Time – A key in experimental and practical medicine. Arch. Toxicol. 36, 185-216, 1976.
[12] Mohammed N. Eesa. Pesticide chronotoxicity to insects and mites: an overview. Department of Entomology , Faculty of Science, Cairo University, Saudi Arabia and Department of Entomology , University of Minnesota, St. Paul Minnesota USA. Journal of Islamic Academy of Sciences 8:1, 21-28, 1995.
[13] Moller,U., and Bojsen, J. Circadian temperature rhythm in Syrian hamsters as a function of number of animals per cage. J. Interdiscipl. Cyle es., 61-69, 1974.
[14] Pittenbraj, K. Cirkadnie ritmi i cirkadnaja organizacija zivih sistem.- V kn. Biologiceskie casi. M. : Mir, s. 263-303, 1964.
[15] Reinberg, A. Ces ruthmes biologiques a la chrono-biologie, ed. Gauthier-Villars, 1974.
[16] Romanov, S. N. O primenjenii metoda priznjenava okrasivanija dlja izucenija tkanej v celom organizme. Zb. “Voprosi I citologii I obscej fiziologii”, red. Aleksandrov, V. J. i dr., ANUK SSSR, Moskva, 1960, 255, 1960.
[17] Ros F. H., Sermons, A. L., Owasoyo, J. O. and Walker, C. A. Circadian variation of diazepam acute toxicity in mice. School of Pharmacy, Florida A & M University (Florida 32307, USA), 1980.
[18] Stollery, B.T, Broadbent, D.E., Banks, H.A., Lee, W.R. Short – term prospective study of cognitive functioning in lead workers. Br. J. Ind. Med. 48:739-749, 1991.
[19] Shigehiro Ohdo. Chronopharmacology Focused on Biological Clock. Clinical Pharmacokinetics, Division of Clinical Pharmacy, Department of Medico - Pharmacoeutical Sciences, Faculty of Pharmaceutical Sciences, Kyushu University, 2007.
[20] Wan Soo Kim, Jong Wook Kim, Jae Hak Lee and Sung Hoe Huh Marine living research Department, KORDI, P. O. Box 29, 425-600 Ansan, Seoul, Korea, 2008.

THE IMPACT OF THE ENERGY COMPLEX "KOSOVO A" IN THE POLLUTION OF GROUNDWATER

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ABSTRACT

Activities within the energy sector of Kosovo undertaken for decades without any consideration of the environment have caused significant environmental damage in a wide area. A major concern for the environment and in particular for residents represents groundwater pollution. The sources with the highest pollution potential affecting groundwater in the area are the former Lignite Gasification Plant and the Thermal Power Plant (TPP) Kosovo A. To identify type and level of contamination hydro-geological and geochemical research have been undertaken.
The assumed industrial contamination mentioned above turned out to occur only locally, while physical-chemical features similar to the properties of the hazardous industrial substances appear in a wider area. There is evidence that the identified pollutants have also origin from natural background. Research shows that groundwater in a wide area from Fushe Kosova to Obiliq does not meet recognized standards for drinking water.

Keywords: Aquifer, energy, chemical waste, pollution, groundwater

INTRODUCTION

To improve environmental conditions within the energy sector, Kosovo, respectively Kosovo Energy Corporation has received donations from the World Bank and Dutch Government. The environmental research which is the subject of this paper has been undertaken in the course and in preparation of the environmental rehabilitation works. A major concern for the environment and surrounding residents in particular represents groundwater contamination. In the flood plain area of the Sitnica River groundwater is predominantly not usable for drinking. A large part of the groundwater is potentially under influence of the operations of Kosovo Energy Corporation related to lignite mining, lignite based power generation and lignite gasification. The purpose of this paper is the presentation of research and results conducted to determine the type and level of pollution of groundwater in the area of potential impact, respectively the area of the Kosovo A thermal power plant (TPP) complex as well as the area downstream of the industrial complex. To have a clearer picture and better understanding not only about the contamination of groundwater in, below and downstream of the impact zone, but also of potential pollutants and transport pathways, physical and geochemical analysis of soil and water are undertaken as well as geological surveys at the area of interest. Therefore some 25 geo-hydrological investigation drills have been drilled and used for physicochemical analysis of relevant groundwater parameters and hydro-geological determination of the affected strata. In addition, some 10 private wells as well as surface water have been included in the physicochemical investigation program. The results obtained from these surveys and investigations are analyzed according to internationally recognized standards. The interpretation of the results and conclusions about the extent of groundwater pollution follow international recognized standards, too.

Investigation area

The investigation perimeter is located about 4 km northwest of Pristina, in the eastern rim of the Sitnica River fluvial plain (Figure 1). In this area the "complex TPP Kosovo A" is situated. The Kosovo A complex consists inter alia of TPP Kosovo A, the area of the former gasification plant and separation plant and the coal drying Plant and the ash dump TPP Kosovo A. Of particular importance with regard to potential groundwater pollution caused by the former gasification plant are also underground mining galleries where in the past byproducts of the gasification process have been dumped as well as at the Kosovo A ash dump.

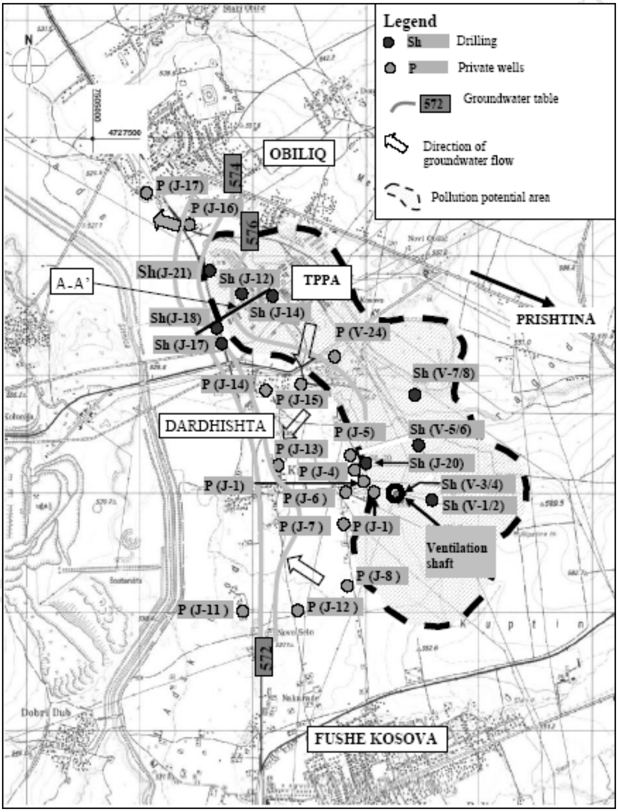

Fig. 1: The investigation area

Methodology

There is little detailed geological and hydro-geological data of this area available, therefore an extensive research program has been undertaken, including but not limited to:

- Core drilling and sampling (Fig. 1)
- Hydro-geological research based on existing materials and inventory of relevant wells and sampling (Fig. 1).
- Geochemical analysis (Table 1-4).

All drilling locations are selected based on available hydro-geological information and the current surface situation (the location of landfills, reservoirs, plants, etc.) to gain better knowledge about the contamination of soil, surface water and groundwater, and mobility of contaminants.

For environmental testing general geochemical parameters of the groundwater, such as major ions, heavy metals and typical by-products from the gasification process as possible contaminants have been explored.

Results and Discussions

Hydrogeological Characteristics

Area of the gasification plant

According to data conducted from drillings a shallow alluvial aquifer extends at the greater part of the gasification plant site. This aquifer is part of the small alluvial cones and channels extending to the Sitnica flood plain from the east and is embedded between less permeable soil and clay beds. The layers are encountered from the surface to 6 m b.s. with a thickness ranging from 0.1 to 2.3 m at an average of 0.6 m [2]. The sand and gravel layers can not be correlated to a homogenous and continuous stratum but must be seen as a widely interconnected system of channels once developed in an alluvial environment. The hydraulic conductivity ranges from 5×10^{-4} to 5×10^{-5} m/s. The depth of the water table ranges from 0 m to about 3 m b.s. and tends with a gradient of approximately 1.0% in direction southwest to northwest (fig. 1).

The fluvial aquifer of the Sitnica

Within the flood plain a more permeable area can be outlined, where the hydraulic conductivity exceeds 1×10^{-3} m/s. Former investigations [5] report layers of sand and gravel are building the main part of the fluviatil deposits.

Relation between shallow alluvial and fluvial aquifer

Derived from groundwater table measurements as well as from hydro-chemical characteristics there is evidence that the alluvial and fluvial aquifers are locally hardly connected. Such a location was found at sounding Sh (J-17) in the vicinity of the gasification plant site, where the groundwater table in the two aquifers differs for more than 3 m.

The relationship between fluvial and lignite aquifer at the gasification site

At this specific location, the fluvial aquifer consists of a moderate permeable sand and gravel layer which is in direct contact to the underlying lignite seam (Fig. 2).

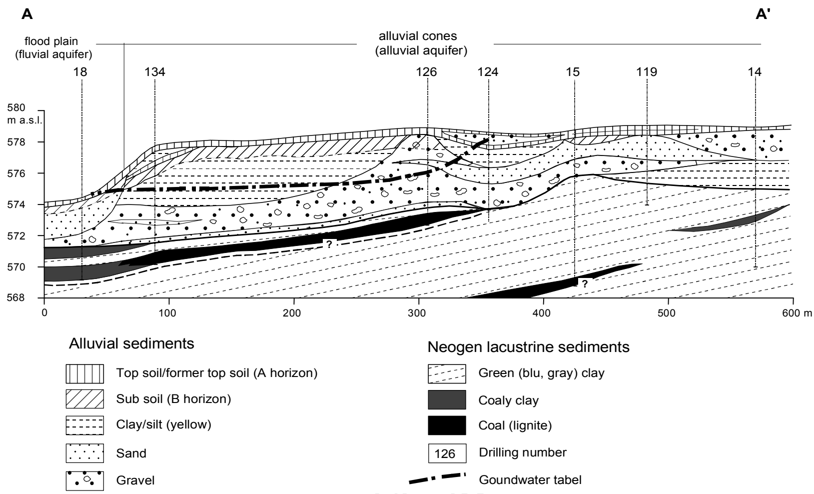

Fig. 2: Hydrogeological cross section in the gasification area (Fig. 1, AA ')

When in contact with the lignite, the hydro-chemical characteristic of the fluvial aquifer is influenced by water leaking from the coal seam. Noteworthy are the high electrical conductivity (2'380 µS/cm) caused by a high sulfate (990 mg/l) and hydro-carbonate (530 mg/l) concentration and the elevated DOC level found in the water analyzed from sounding Sh (J-17), (Table 1).

Alluvial aquifer at Dardhishte

In a drilling conducted in the northwestern part of Dardhishte, an alluvial aquifer of a thickness of 2 m only was encountered in a depth of 11 m under the clay layers. Layers of sand and gravel of the alluvial aquifer are explored in many wells in Dardhishte. Hydraulic characteristics of this aquifer are similar to those of alluvial aquifer at the gasification site.

Lignite aquifer at Dardhishte

Lignite is found at a depth of 20 m to 36 m below surface. During the drilling some cavities were encountered. These are probably remains of former underground mining. Following available mine documentations, the area is traversed by collapsed mining galleries and mine access roadways. The measured groundwater table is 1.7 m b.s only, revealing a subartesian groundwater table in the lignite aquifer. The piezometric level of this groundwater table shows that the water can permeate the alluvial sediment layers present in the area of Dardhishte. The hydraulic conductivity of the lignite aquifer in the sounding 08-20 is around to 7 x 10^{-5} m/s. Thus, it does not differ a lot from the hydraulic conductivity of the alluvial aquifer ranging from 1 to 5 x 10^{-4} m/s.

Tab. 1: General physicohemical parameters analyzed in groundwater (modified according to Jaeckli: 2009)

Sounding	Cond.	HCO3	Ca	K	Mg	Na	Cl	SO4	F	NO3	NO2	NH4	DOC
Sh(J-12)	863	440	99	<1	37	26	18	87	0.36	<1	<0.02	0.45	3.6
Sh(J-14)	1242	290	120	1	51	73	22	420	1.2	3	0.04	0.04	3.4
Sh(J-17)	2380	530	300	1	110	130	31	990	0.33	<1	<0.02	0.16	9.3
Sh(J-18)	725	430	92	17	18	21	12	27	0.47	<1	<0.02	1	7.1
Sh(J-20)	3660	1500	310	7	150	350	130	880	0.21	<1	<0.02	12	60
Sh(J-21)	501	310	71	1	24	24	15	58	0.55	15	0.12	3.9	1.7
P(J-1)	1888	480	89	2	79	170	290	160	1.6	<1	<0.02	0.03	5.8
P(J-3)	1684	270	94	3	64	160	150	420	0.91	35	0.05	<0.03	12
P(J-4)	2590	420	180	5	61	140	90	460	0.67	110	0.2	0.09	10
P(J-5)	1154	440	110	1	23	100	27	210	0.29	16	<0.02	<0.03	3.4
P(J-6)	931	320	74	4	36	68	34	190	0.57	7	0.02	<0.03	7.9
P(J-7)	2080	460	160	1	72	190	82	470	0.7	230	0.03	<0.03	2.9
P(J-8)	2550	380	280	2	73	180	120	480	0.33	530	0.08	0.16	3.3
P (11)	778	230	94	10	22	25	22	130	0.11	43	<0.02	0.04	2.1
P (12)	1194	370	110	1	46	54	28	200	0.7	44	<0.02	<0.03	3.8
P (13)	1300	420	170	3	33	58	47	290	0.3	10	<0.02	0.04	7.5
P (14)	1585	250	78	17	19	16	13	94	0.09	14	<0.02	0.03	4.3
P (15)	1107	370	160	12	27	30	22	260	0.38	7	0.07	0.05	2.9
P (16)	911	370	110	9	37	54	30	230	0.37	10	<0.02	0.03	11
P (17)	916	310	94	6	31	52	31	180	0.23	22	<0.02	0.03	3.7
DWD	**2500**					**200**	**250**	**250**	**1.5**	**50**	**0.5**	**0.5**	**2***

Conductivity in µS/cm, all other concentrations in mg/l
* limits accordings to Swiss nutrient regulation;

(light grey)	Elevated concentrations below DWD thresholds or elevated conc. not rate in the DWD
(medium grey)	Exeeds the chemical and indicative thresholds of the Drinking Water Directive (DWD)
(dark grey)	Strongly elevated values

Results of the groundwater investigation program

Samples taken from groundwater were analyzed with regard to general parameters, such as major ions, fluorides and DOC (Table 1) and relevant analysis of organic and inorganic ingredients, such as polycyclic aromatic hydrocarbons (PAH), phenols, BTEX (benzene, toluene, etilbenzen, xylen), and arsenic, boron, chromium and nickel (Table 2 & 3). Samples listed in Table 3 are analyzed for organic ingredients only. In some cases also cyanides were analyzed, but since they have not been identified, the results are not presented here.

Tab. 2: Organic and inorganic pollutants analyzed in groundwater samples (modified according to Jaeckli: 2009); All samples were analyzed as in Table 1, but here are presented samples with detected parameters only. Legend as in Tab. 1.

Mostrat	Phenol s.	PAH	As	B	CrVI	Ni
Sh(J-12)	<0.0001	0.00008	0.004	0.15	<0.005	0.008
Sh(J-14)	<0.0001	0.00002			0.006	
Sh(J-17)	<0.0001	0.00004	0.004	0.31	<0.005	0.014
Sh(J-18)	<0.0005	0.00002	<0.003	0.07	<0.005	<0.005
Sh(J-20)	<0.0001	0.0001	0.011	0.32	<0.005	0.022
Sh(J-21)	<0.0001	0.00004	<0.003	0.13	<0.005	0.006
P(J-1)	<0.0001	0.00005	0.003	0.12	<0.005	<0.005
P(J-3)	<0.0001	0.00002	<0.003	0.58	<0.005	0.007
P(J-4)	<0.0001	0.00002	<0.003	0.3	<0.005	0.018
DWD		**0.0001**	**0.01**	**1**	**0.05**	**0.02**

Tab. 3: Physico-chemical analysis of groundwater in the area of Dardhishte (Legend as in tab. 1)

Sounding	Cond. (µS/cm)	DOC (mg/l)	Phenol-Index (mg/l)	AOX (mg/l)	Hidroc. Index (mg/l)	BTEX total (µg/l)	PAH (µg/l)
Sh(V-1/2)	664	9,2	<0,04	<0,04	<0,1	3	-
	650	10	<0,04	<0,04	<0,1	2	-
Sh(V-3/4)	6880	13	<0,04	0,07	<0,1	-	1,79
	6560	15	<0,04	0,07	<0,1	7	3,77
Sh(V-5/6)	3560	22	<0,04	0,06	<0,1	-	-
	3420	27	<0,04	0,05	<0,1	-	-
Sh(V-7/8)	1160	11	<0,04	0,04	<0,1	-	-
	1150	9,4	<0,04	0,06	<0,1	-	-
Sh(V-9/10)	3300	15	<0,04	<0,05	<0,1	-	-
	3330	17	<0,04	0,08	<0,1	-	-
P(V-24)	1560	14	<0,04	0,04	<0,1	-	-
DWD	**2500**	**2***				**10****	**0.1**

The assessment of the concentrations is based on the values shown in annex 1 of the European Drinking Water Directive (DWD) [7], the Swiss regulation on soil nutrients and standards of the World Health Organization (WHO) for drinking water. Yellow colored values exceed the chemical and indicative thresholds of the DWD. Green colored values shows significantly elevated concentrations below these thresholds or elevated concentrations of compounds not rated in the regulations. The assessment of DOC is based on the Swiss nutrient regulation, which indicates a target value of 1 mg C/l and a limit value of 2 mg C/l for drinking water. Pink colored values shows strongly elevated concentrations.

Eye-catching is the difference of the water chemistry between the two adjacent sampling locations Sh (J-17) and Sh (J-18). The first one catches water from the fluvial aquifer, the second water from the alluvial aquifer. This proves the limited exchange that exists between these aquifers.

Phenols were analyzed as individual compounds with a detection limit of 0.0001 mg/l for each compound or as phenol index with a detection limit of 0.01 mg/l. In none of the drillings or private wells analyzed phenols were detectable, except for samples taken from a ventilation shaft connected to the former underground lignite mine (Fig. 1, Table 4). Below some of the high concentrations of phenol compounds, such as Chlorofenol, are presented [3]. The results support reports of former workers of the gasification plant confirming that the ventilation shaft has been used for the disposal of byproducts of the gasification process at the existing underground galleries in that area.

Tab. 4: The concentration of phenol in the water samples originating from the ventilation shaft (modified according toVattenfall-DMT: 2008).

Analizat nga pusi i ajrosjes			
Chloro-/Alkyl-Nitrophenols (ISO 8165-2), (µg/l)			
2,4-Dichlorophenol	36	2,3,5-Trimethylphenol	93
2,5-Dichlorophenol	10	2,4,6-Trimethylphenol	14
3,5 Dichlorophenol	19	3,4,5-Trimethylphenol	163
2-Methylphenol	5	Phenol	1
3-Methylphenol	1	2-Ethylphenol	107
4-Methylphenol	2	2-Naphtol	3
2,3-Dimethylphenol	195	2-Hydroxy-5-methylanisol	14
2,5-Dimethylphenol	45		
2,6-Dimethylphenol	237		

PAH do comply with the DWD drinking water standard hence when individual compounds are assessed, it turns out that any of the detected compounds does exceed the Dutch List target values. 60 to 100 % of the PAH contamination is caused by Naphthalene. Other encountered compounds are Fluoranthene, Phenatrene and Anthracene. Higher concentration of PAH were detected in groundwater Sh (V-3/4), taken from the well near to the ventilation shaft (Fig. 1, Tab. 3).
Although all samples (including those in Table 1) are analyzed for the content of BTEX, they appear slightly raised in drilling Sh (J-12) in the gasification site and in the ventilation shaft in Dardhishte only, being still under the limits for drinking water standards of the WHO.
As for the heavy metal concentration, a small increases observed only in the waters of the lignite aquifer by drilling Sh (J-20).
Of particular importance is that none of the analyzed samples did fully meet European standards for drinking water.

Conclusions

Contamination of groundwater in the area of the gasification plant

Under the greater part of the site a moderate permeable alluvial aquifer is existing. The aquifer is widely protected by overlying low permeable soils. Pollution migration through this aquifer is detected but so far is limited to minor extends only. In the shallow alluvial aquifer below the gasification site minor contamination of groundwater was found, mainly contaminated by PAH. PAH contamination is obviously originating from natural background, caused by the underlying lignite seam. Other specific contamination in groundwater has not been found, with the exception of Benzene and Xylene in drilling Sh (J-12), obviously originating from the gasification process. Groundwater below and downstream of the potential area of impact, namely the gasification site, presents similar physical-chemical characteristics compared the groundwater at the gasification site.

Contamination of groundwater in Dardhishte

In the alluvial aquifer at Dardhishte a presence of PAH in a very low level has been detected, not distinguishable from a possible contamination with natural background. Phenols were not detected. Organoleptic findings of water from private wells in Dardhishte suggest in many cases the presence of organic pollutants (hydrocarbons or phenols), but all samples were at or below the detection limits. These pollutants are more likely to be Chlorophenols, which are present in waters samples from the ventilation shaft, which may have penetrated even in neighboring aquifer through lignite aquifers or underground galleries. The wells with the strongest "chemical" smell of the water are very close to the mine galleries.

Overall quality of groundwater in the area between Fushe Kosova and Obiliq

The groundwater in the greater area between Fushe Kosovë and Obiliq does not comply with EU drinking water standards, most likely due to natural background concentrations deriving from the underlying lignite seam/aquifer and due to untreated domestic waste water. In the groundwater of this area no significant contamination originating from gasification process byproducts was encountered, but in all groundwater samples PAH were detected at a very low concentration level. PAH concentrations comply with EU drinking water standards.

Groundwater discharging from the lignite seam into overlaying aquifers does have an adverse effect on the groundwater percolating in these units. In Dardhishte such a discharge is very likely due to a significantly higher pressure potential in the lignite body compared to the alluvial aquifer. This local effect may be caused or reinforced by the former underground mining activities, resulting in reduced flow resistance in the lignite body, caused by still existing open underground galleries, and creation of "exchange windows" between the lignite body and the overlaying aquifer, caused by broken underground mine galleries.

REFERENCES:

[1] Circular on Target Values and Values for soil remediation intervention "Dutch List", Dutch Ministry of Housing, Spatial Planning and Environment, 2000.

[2] Consortium Chiresa / Dr. Heinrich Jäckli AG (2008): Clean Up of a Gasification Plant Site, Site Investigation, Feasibility Study, conceptual Design and Environmental Management Plan, Final Report, Part II: Hydrogeological Site Investigation.

[3] Consortium DMT / Vattenfall (2008): Site Investigation, Technical / Organizational Planning and Determination of Environmental Impact Assessment and Preparation of Environmental Management Plans: Final Report.

[4] Consortium DMT / Vattenfall (2007): Site Investigation Report

[5] EPA (1981): Environmental Assessment: Source Test and Evaluation Report - Lurgi (Kosovo) Medium-BTU Gasification, Final Report.

[6] Regulation concerning Protection and contaminated soil sites, Germany, 1999

[7] The Drinking Water Directive (DWD), Council Directive 98/83/EC, 1998.

THE IMPACT ON CULTURAL HERITAGE GENERATED BY WORKS OF IMPROVING THE NAVIGATION CONDITIONS IN THE COMMON ROMANIAN-BULGARIAN SECTOR OF THE DANUBE RIVER

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ABSTRACT

The Danube river in Romania and Bulgaria is an important section of the Pan-European Transport Corridor number VII. The common Bulgarian-Romanian sector of the Danube stretches from the mouth of the river Timok to the east periphery of Silistra. Critical points for the navigation sectors have been identified currently. Due to the nature of the project and its associated activities, a narrow area along the Danube riverside is analyzed. This area includes territories with very different characteristics. The study on the status of the cultural heritage sites on the right bank of the Danube river is based on information retrieved from the records of many specialised institutes and from specialized publications. Danube river, in its lower course, forms a crucial factor in all aspects of the human development from ancient times until present. As a result, traces from active human activities from the earliest prehistoric periods were recorded in close proximity to the river. There were analysed the curent situation of cultural and ethnical conditions, the cultural heritage both on the Romanian and Bulgarian banks of the Danube river and the potential impact generated by the activities for improvement of the navigation conditions. It is not forecasted that activities for improvement of the navigation conditions in the common Bulgarian-Romanian sector of the Danube river will cause any direct impact on the cultural monuments, located on banks of the Danube river. However during the excavation works and dredging, there is potential risk of damaging unidentified archeological monuments which are located in the Danube river, such as unknown bridge remains or ancient port facilities.

Key words: impact on cultural heritage, Romanian-Bulgarian common sector of the Danube river, improvement of navigation conditions

JEL Classification: R - Urban, Rural, and Regional Economics, R4 - Transportation Systems

INTRODUCTION

The Danube river in Romania and Bulgaria is an important section of the Pan-European Transport Corridor VII, a unimodal Corridor and a part of the TEN-T priority axis no. 18 – Rhine/Meuse-Main-Danube inland waterway [2]. The river connects the Black Sea with the hinterland from Romania and Bulgaria to Hungary, Austria, Germany.

The works proposed for improving the navigation conditions in the common Bulgarian-Romanian sector of the Danube river represent a part of the global Danube navigability project in order to improve the Pan-European Transport Corridor VII and to allow reliable and continuous international transport, by improving the navigability of the Danube river.

Danube river, in its lower course, forms a crucial factor in all aspects of the human development from ancient times until present. As a result, traces from active human activities from the earliest prehistoric periods were recorded in close proximity to the river. There were analysed the curent situation of cultural and ethnical conditions, the cultural heritage both on the Romanian and Bulgarian banks of the Danube river and the potential impact on them generated by the activities for improvement of the navigation conditions.

1. NECESSITY OF TAKING SOME MEASURES TO IMPROVE NAVIGATION CONDITIONS ON THE COMMON ROMANIAN-BULGARIAN SECTOR OF THE DANUBE

In the summer and autumn period of the year, water flow decreases in the main Danube branch, resulting in insufficient water depth and difficult navigation conditions at certain critical sections. Preparatory studies have been carried out, identifying the critical sections where minimal requirements for navigation as set out by the Danube Commission cannot be guaranteed throughout the year. The navigation problems relates mainly to:

- *Hydrologic peculiarities of the river*. The water discharge in the sector decreases significantly in summer and autumn. Because of that, the main branch of the river does not reach the criteria for minimum depth and the navigation conditions worsen;
- *The morphologic peculiarities of the river* - presence of single islands and groups of islands in the riverbed, which divide the river into different right and left branches/canals, and often cause shifting of the fairway to one or to the other branch;
- *Erosion of the Danube banks* - impedes the free traffic in the hampered areas.
- For the Danube River between Iron Gate II and Calarasi, the Danube Commission recommends a minimum channel depth of 2.5 m below the reference level ENR (Etiage Navigable et de Regularisation, or the level above which the flow is situated for 94 % of the time) to maintain continuous navigation. Upstream of the Iron Gates I and II, the recommended water depths are 35 dm below the minimum retention levels of the two dams.

For the Danube River between Iron Gate II and Calarasi however, bathymetric data show that the river depth at some locations in the fairway is less than the required minimum level. Causes are relocation of the original alignment of the navigation channel inside of the river banks or sedimentation. Areas where these minimum requirements are not met are considered *critical sectors*.

Thus, the recommended channel width is 180 m at ENR – 2.5 m and a channel width of 150 m can be considered for sections with sandbars. The channel radius of 1000 m has been recommended or 750 m, when unfavourable from a geomorphological point of view. An area where this is not accomplished is considered a *critical sector*. One critical sector may include one or several critical points.

Based on numerous discussions with local authorities and institutions responsible for the navigation on the Danube River and visits to the area, several locations with difficulties for navigation at present or with a history of bottlenecks for navigation in the last years were identified (figure 1).

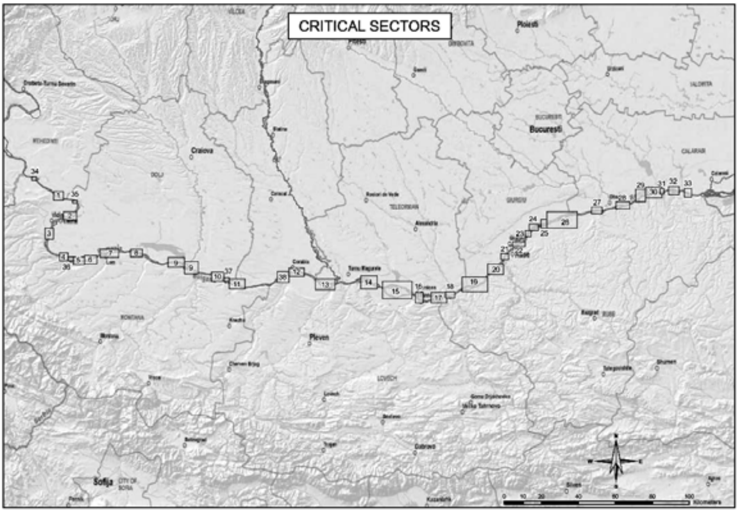

Figure 1. Critical Sectors for Navigation on the Danube between Iron Gate II and Calarasi/Silistra

Source: E.I.A., Technical assistance for the improvement of navigation conditions on the Romanian - Bulgarian common sector of the Danube and accompanying studies, Ministry of Transports of Romania, dec., 2009

2. GEOGRAPHICAL AND ADMINISTRATIVE LOCATION OF THE ANALYSED AREA

The common Bulgarian-Romanian sector of the Danube is situated in the south- western part of Romania and it stretches from the mouth of the river Timok to the east periphery of Silistra [1].

From administrative point of view the studied Danube sector is located both on the Romanian bank and the Bulgarian bank of the Danube, on the territory or on the borders of several counties. *On the Romanian bank of the Danube*, critical navigation sectors are located within the following counties: Mehedinti, Dolj, Olt, Teleorman, Giurgiu and Calarasi. *On the Bulgarian bank of the Danube*, critical navigation sectors are located within the following counties: Montana, Lovech and Ruse.

3. CULTURAL AND ETHNICAL CONDITIONS, CULTURAL HERITAGE

Due to the nature of the project and its associated activities, a narrow area along the Danube riverside should be analyzed. This area includes territories with very different characteristics.

The study on the status of the cultural heritage sites on both banks of the Danube river is based on information retrieved from the records of many specialised institutes from both countries, such as the Institute of Cultural Memory in Romania, or the National Institute for Monuments of Culture in Bulgaria. It is also based on information from specialized publications and field observations.

3.1. CURRENT SITUATION ON THE LEFT (ROMANIAN) BANK OF THE DANUBE

The Law 5/2000 regarding the approval of National Territory Planning identifies natural protected zones of national interest and values of national cultural patrimony, for which it is necessary to set up protection areas. Cultural patrimony values of national interest are historical monuments, architectural piles and architectural sites.

In certain zones along the Romanian-Bulgarian sector of the Danube some patrimony values mentioned in this law are present. The cultural patrimony of national interest (historical monuments of exceptional national value) present in the analysed area is listed in the following table.

Monuments and architectural piles	Old fortress	Giurgiu Fortress / *Giurgiu municipality*
		Turnu Fortress / *Turnu Magurele municipality*
Monuments and archaeological sites	Settlements and necropolis from Bronze Age	Settlement of Bronze culture Garla Mare (Middle Bronze) / *Garla Mare village*
		Necropolis Bronze Age, Settlement and Medieval necropolis (in point "Campul mortilor") / *Zimnicea town*
	Dacian fortifications	Getic-Dacian fortress / *Zimnicea town*
	Ancient cities	Ancient city Sucidava, on the place of Getic-Dacian settlement *Corabia town*

Table 1. Cultural patrimony of national interest
Source: The Institute of Cultural Memory, *National Archaeological Repertory*, Romania

Administrative local units with very high concentrations of patrimony with cultural value of national interest are the municipalities of Oltenita, Calafat, Giurgiu, Turnu Magurele, the towns of Corabia and Zimnicea and the villages Islaz and Salcia.

Most of the informations presented above regarding the cultural patrimony values and sites on the Romanian bank of the Danube, were processed data from the National Archaeological Repertory [7].

Mehedinti county - the sites along the Danube:

1. *Village Garla Mare* Settlement Pristol, Dunarea river bank, km 864, Neolitic, hallstatt, medieval age, sec. VII, a.C., century IX-XI

2. *Village Garla Mare* Villa rustica at - "km 840", settlement, villa rustica, Roman Age/Century II-III

3. *Village Garla Mare* Settlement from Bronze Age, at 200 m S of village, in water medow, civil settlement, Bronze Age/century I-III a.C.

4. *Village Salcia* Hallstatt settlement, civil settlement, Hallstatt Age

5. *Calafat town* Settlement, civil settlement, Neolitic, Medieval Age/century XV

6. *Calafat town* Getic-Dacian settlement, civil settlement, Post-Roman Age, century IV, I b.C, I a.C.

Dolj county - the sites along the Danube:

1. *Desa* Village Roman fortress, military settlement, Roman Age, Bronze Age Hallstatt, Centuries III, VIII

2. *Plosca* Village Roman camp, military settlement, Roman Age, Century III (at more than 5 km from the Danube)

Olt county - the sites along the Danube:

1. *Corabia town* Roman-Bizantin Fortress Sucidava, km. 634-635, South Caracal plane, archaeological site, Roman-Bizantin Age, Bronze Age, / Centuries IV b. Chr. – I a. Chr., III-VI, IV - III b. Chr., sec.XIV-XVI, sec. I b. Chr. - I a. Chr.

2. *Corabia town* Roman road, construction, Roman Age / centuries II - III

3. *Corabia town* Hallstattian settlement, civil settlement, Hallstatt

Teleorman county - the sites along the Danube:

1. *Islaz village* Roman camp - "Racovita, E of village, military settlement, Roman Age / century II – III

2. *Islaz village* Roman camp - "Vedea"S of village, beelow the Danube waters, Roman Age / Century II - III

3. *Zimnicea town* Necropolis Latene, E of town, necropolis discovery, Century IV b. Chr.

4. *Zimnicea town* archaeologic site - "Cetate" on the Dunube bank, V of town, Bronze Age, Hallstatt, Mediev Age / century IV - I b.Chr, IV-I b.Chr, XIV - XV

5. *Pietrosani village* Latene settlement "Reca Mare", at 1 km V of village, civil settlement, Latene Age

6. *Pietrosani village* settlement, "Locul popilor", left side of Vedea river, Roman Age, Hallstatt / Century II - III

Giurgiu county - the sites along the Danube:

1. *Giurgiu municipality* Pieces of the Turkish wall Tabia, fortress, Modern Age / Century XVIII

2. *Giurgiu municipality* Arhaeologic site - "Malu Rosu" at 1000 m N of customs Giurgiu, Bronze Age, Paleolitic, Hallstatt, Medieval Age

3. *Giurgiu municipality* Medieval fortress Giurgiu - "Island", fortress, at N of Cama, S of town, Medieval Age / Century XIV - XV

4. *Gostinu village* Archaeologic site - "Grindul Bunei", civil settlement, at V of village, placed in the flooded Danube plane, Hallstatt / Century III - II b. Chr.

Calarasi county - the sites along the Danube:

1. *Oltenita town* Settlement - "Gumelnita", at 3 km NE of town, civil settlement, neolitic, IV millenium b.Chr.

2. *Oltenita town* Latene settlement - "Valea Mare", civil settlement, neolitic/ IV b. Chr.millenium

3. *Oltenita town* Latene settlement - "Coada lupului" at 3 km from town, left side of the rail road, civil settlement, Latene.

4. *Oltenita town* Settlement Cernavoda I - "Renie", civil settlement, neolitic, Medieval Age, Century XVI-XVII.

3.2. CURRENT SITUATION ON THE RIGHT (BULGARIAN) BANK OF THE DANUBE

Cultural monuments. Settlements and necropolis representatives of the so-called "Encrusted *Pottery Culture*" are found on both banks of the river. During the first centuries of our era a fortification system was built along the so called Danube Limes - fortresses, castles and forts, connected with each other by a strategic road stretching on the right bank of the river.

Bridges were built at several points to facilitate the fast crossing of the river by the Roman troops. Later on, when the lands north of Danube became part of the empire, most of these military settlements have become prosperous cities with strong fortress walls and modern architecture - Bononiya, Ratsiariya, Auguste, Eskus, Asamus, Dimum, Nove, Durostorum.

The Danube riverside is also an important part of the First and Second Bulgarian Kingdoms. In the eventful Middle Ages, the fortresses Bdin (today's Vidin), Nikopol, Tutrakan, Drustar (today's Silistra) were the last bastions of defence against the Ottoman invasion on the Balkans.

During the Ottoman rule and especially during the Renaissance the towns along the Danube had advanced economic development thanks to trade exchange over the large European river. After the liberation, this trend grew and as a result of their economic prosperity, most of the towns on the Danube bank gained European appearance. This brief historical overview gives some ideas of the importance of the Danube riverside in the historical development of the Bulgarian lands from the ancient times until these days.

This region is distinguished by its rich culture-historical heritage and it has great importance. About 780 archaeological, architectural, historical and artistic monuments are registered.

Archaeological monuments of culture according to Regulation 5 of the Ministry of Culture (SG. 60/1998) are "material evidence of human existence and activities that are identified through archaeological studies and that are an integral part of the environment where they are created". According to the regulations for conducting archaeological field research in the Republic of Bulgaria (SG. 12/1997), the "archaeological sites are all movable and immovable material traces of human activity in past ages, located in the earth layers, on their surface, on the land and in water basins".

The diversity of human activities and the huge chronological period in which they existed, led to great diversity of such kind of objects. All archaeological sites included in the list of cultural monuments have the status of cultural monuments and museums according to the the Law for the monuments of culture (SG. 29/1969 amend. & last suppl. SG. 30/2006). In addition, all local and burial-mounds and medieval defense ramparts are designated as monuments of culture with national importance by an order of the Council of Ministers.

Three of the most important archaeological monuments have been designated as archaeological reserves. These are the *ancient and medieval town of Durostorum-Drustar* in Silistra, *the Roman and late Roman fortress near Augusta Harlets*, Vratsa district and *the antique city Ulpia Eskus* near Gigen, the district of Pleven. In the procedure for reserve designation are the antique and Late Antique town of Nove near Svishtov and the Antique and Late Antique town Ratsiariya near the village of Archar, Vidin district.

Monuments of architecture and construction are buildings with different function, built during the Renaissance and after the Liberation to the years ‘30 of the twentieth century. Some of them present preserved traditions in building, while others demonstrate the application of modern architectural decisions and styles for the time when they were built. There is a detached architectural reserve - “Ribarska mahala”, which includes 48 buildings - monuments of culture with national importance in the town of Tutrakan. It was a fishing village (unique one along the Danube), with authentic buildings, established in the Renaissance period.

Historical monuments have been designated as sites and buildings associated with important events or personalities from the Bulgarian history. Their protection aims to keep the memory of them and to memorize about their deeds. Historical site in the valley of the river Tekir dere, 4 km to the east of Svishtov was designated as a historical reserve (SG 24, 1969).

Monuments of Art are works of fine, monumental and applied arts as an integral part of the environment, where they were created. In several cases a monument combines two or more protective status - some churches and monasteries are both architectural and artistic monuments, wellpreserved archaeological sites have been designated as architectural monuments.

3.3. IMPACT ON CULTURAL HERITAGE

The envisaged works and activities are not proposed within locations of the above mentioned patrimony values. Since the distance between the Danube and the respective patrimony is large, the influence of the works is not felt at the locations of cultural value of national interest. However during the construction period there is potential risk of damaging the archaeological monuments which are located in the Danube river [5].

Only near critical sector Lakat/Paletz Island and the protected site of the fortress of Turnu Magurele can be found. Since the protected site is located upstream of the site, at a distance of 700 m from the Danube water, it is not expected that the works will have any impact.

Forecast made by experts show that at average values of the Danube flow, water level increased as a result of the proposed works has no impact on zones of cultural patrimony values, and the water level increase effect of the project at very high flows is too small to determine any impact.

CONCLUSIONS

It is not expected that the activities for improvement of the navigation conditions in the common Bulgarian-Romanian sector of the Danube River will cause any direct impact on the cultural monuments, located on banks of the Danube River. However during the excavation works and dredging, there is potential risk of damaging unidentified archeological monuments which are located in the Danube River, such as unknown bridge remains or ancient port facilities.

To prevent any damage to unidentified cultural patrimony, or cultural heritage sites which are covered with layers of soil, the following mitigation measures are proposed:

- Coordination of the works for improvement of the navigation conditions on the Danube in cooperation with the museums of the Danube towns;
- Prior to start of works, the river bottom should be studied in all locations for existing data of ancient bridges and ports, using side scan sonar and digital echo-sounder;
- Periodic observations by archaeologists during construction works involving the river bank or areas in its immediate vicinity;
- In case of discovering an unregistered archaeological item, to proceed in compliance with the requirements of the Romanian and Bulgarian Law.

The improvement of navigation conditions on the common Romanian-Bulgarian sector of the Danube tries to combine creating optimal conditions of navigation on the above mentionated sector of the Danube with the preservation of the natural state of river.

REFERENCES

[1] Ghinea D., *Geographic Enciclopedy of Romania*, Enciclopedic Publishing House, Bucharest, 2002

[2] Nedea Petronela-Sonia, *Traficul rutier transfrontalier in sud-vestul Romaniei - impact asupra mediului si a asezarilor*, Editura Universitara, Bucuresti, 2011

[3] Sobaru A. C.,Năstase G. I., Avădanei C., *Danube – Main – Rhin arterial shipping canal*, Economic Publishing House, Bucharest, 1998

[4] *** Trans-European transport network (TEN-T). Priority axes and projects. ec.europa.eu

[5] E.I.A., Technical assistance for the improvement of navigation conditions on the Romanian -Bulgarian common sector of the Danube and accompanying studies, Ministry of Transports of Romania, dec., 2009

[6] *** *Geographic Enciclopedy of Romania*, Scientific and Enciclopedic Publishing House, Bucharest, 1982

[7] *** The Institute of Cultural Memory, *National Archaeological Repertory*, Bucharst, Romania

[8] *** National Institute for Monuments of Culture, Bulgaria

THE IMPACT ON ENVIRONMENT GENERATED BY URBANIZATION

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ABSTRACT

The urbanism is facing increasingly more global issues regarding the systematization problems of urban planning with a special complexity that comes to define the geographical expansion of settlements under the circumstances of a more limited natural ecosystem. The environmental damage is caused by the existence of large urban agglomerations whose main problems refere to the fact that these urbanised areas represents the space where progressive forces of civilisation and social development converge.

Key words: urban development, urban pollution, environment, overbuilding

JEL Classification: Q, I, M

INTRODUCTION

In a broad sense (lato senso), urbanism represents the art of building people's lives in a harmonious and rational manner, in a determined geographical area. Urbanism, perceived as a synthesis discipline or science which includes contributions from various domains (architecture, economy, geography, sociology, law, psychology etc.), wants to ordinate the available geographical space according to the necessities of that specific area and to human community's development. It was born as a result of the Industrial Revolution's great impact and as a consequence of the urbanization process' acceleration.

After the Second World War, we faced the development of big cities and the evolution towards new urban forms (areas, regions, metropolitan areas, satellite-cities etc.) as a result of population's growth and technological progresses.

Under these circumstances, the main preoccupations of current urbanism are the following:

- ✓ The proportion between built areas and unbuilt areas (the index of constant areas);
- ✓ The balance between civil buildings and trade buildings; the balance between green areas and built areas;

- ✓ Harmonizing the pedestrian's necessities with the exigencies of cars' circulation or those of increasing the density etc.

1. URBANISM AND ENVIRONMENT

Urbanism faces more and more the growing world problems of cities' structuring, problems which have a high degree of complexity when it comes to defining the locality's extension geographical areas, to reshape or underline the extra-necessary urban centre in each case, to renovate antique rooms, to make the necessary decongestion processes which must be done in order for the big cities to fulfill their functions etc.

The urbanism concept refers to: **natural environment, the territory's economical functions, population, the general localities network and the technical equipment of the territory**.

The elements and characteristic features of **the natural environment** refer to: relief, resources, geotechnical conditions, seismicity, hydrographical and hydrological network, courses, discharge, potable water resources, industrial water resources, polluted waters, climate, thermal condition, precipitation, wind condition, specific degradation phenomena and conditions, floods, humidity excess, erosion, landslide etc.

The final purpose of the natural environment's analysis is to determine the way in which it influences the development and organization of localities networks.

Nowadays, it is becoming more and more difficult to establish a strict delimitation between the natural and the artificial environment if we take into account that by means of their organic symbiosis it has appeared a qualitatively new phenomenon, called "human environment" [2].

The contemporary society is the cause of an extremely dangerous phenomenon, that of transforming human environment in an anti-human environment, because of people's inability of understanding the phenomenon in its complexity. Among the causes of this process we mention:

- ✓ Aggressive agriculture;
- ✓ Industrial activity;
- ✓ Human settlements, especially cities.
- ✓ An excessive agglomeration of industries which perturb the environment, a high concentration of the number of inhabitants and a high urban density, the chaotic development of communication and transportation networks which use huge areas, the destruction of fertile lands, deforestation, water pollution, atmospheric pollution etc.

Undoubtedly, cities development leads to negative environmental consequences and it also has negative effects over the quality of life. In this sense, we can mention the following elements [2]:

- ✓ Space consume with an important impact on the ecosystem because of deforestations, erosions, modifications of the proportion between population and habitat;

- ✓ Exploitation (without restrictions) of natural resources, especially nonrenewable ones, of raw materials, water, wood;
- ✓ Pollutant effects of the big cities which bring in discussion the issue of urban waste, pollution and the disappearance of green spaces, climacteric changes, influences on the fauna etc.
- ✓ Effects over the population's health because of the increasing number of mental illnesses, cardiovascular diseases etc.

The continuous explosion of the urban phenomenon has led to an increase of the prices in the case of equipments for buildings, circulation, health, education, free time spending etc. in parallel with the development of the tendencies which regard cosmopolitism and segregation, unemployment rate, poverty and social insecurity, financial insecurity and real estate speculation, contributing to a degradation of life and environment.

The main issue of a big metropolis is represented by the fact that it can be perceived as a space which gathers progressive forces that assure the evolution of society, on the one hand and phenomena which accentuate the degradation of both human civilization and the environment. The result is the cities' hypertrophy and its symptoms are listed below [1]:

- ✓ Deformation of residential and industrial areas by means of concentrating bank activities, assurance and real estate firms, the entire tertiary sector in big metropolises, and this leads to huge regional disproportions. The tertiary agglomeration in big metropolises is a characteristic of developed countries and the metropolises in undeveloped countries are characterized by an industrial activity agglomeration. In what regards residential areas, which are insufficient most of the time, they extend beyond the minimum comfort line, at the level of many cities' periphery. They also extend inside the city by means of insalubrious buildings which shelter a large number of inhabitants.
- ✓ The degradation of the environment is a result of both overpopulation and economical activities which determine ecological disequilibrium inside and outside metropolises. High quantities of water, air and soil pollutants determine a high degree of morbidity among inhabitants. In this case, the legislative measures cannot stop the process. Sometimes, they determine an increase of pollution sources (creating waste deposits at the periphery of the city).
- ✓ A continuous overpopulation of cities due to demographical increase and the pressure which is applied to soil use. It is estimated that a third of non-developed countries' population lives at the periphery in insalubrious buildings, under the minimum comfort limit.
- ✓ Spatial expansion is determined by an increase of metropolises' population and their movement towards the periphery. Therefore, it is noticed a density decrease which, paradoxically, determines a series of problems in what regards managing the interurban traffic, providing buildings to inhabit, waste management, pollution sources increase etc.

Taking into account the direction of cities' development, their role in economic development, the diversification of functions and of functional areas, the environmental impact, their development needs to be strictly controlled.

Moreover, when perceived in relationship to their touristic valorization, cities can be looked at as products. Therefore, they are to be approached from a marketing perspective. This imposes a scientific management of their dynamics and the use of marketing tools and techniques in the process of strategic planning.

Nowadays, there can be established a direct relationship between the scientifically-technical progress and the concept of urbanism: progress has determined cities development and an intensification of the economical and social activity.

Urbanism is a general interest and continuous activity which is being developed all over the national territory and it is based on the sustainable growth principle. This means that the decisions made by the current generation must assure the development of society without compromising the next generations' right to existence and development [1].

The urbanism activity wants to accomplish the following **main objectives**:

- ✓ Determining the locality's functional structure;
- ✓ A rational and balanced use of those terrains which are considered to be necessary for the locality's urbanism functions;
- ✓ Providing a proper habitation according to population's needs; providing a decent life;
- ✓ Providing specific conditions in order to satisfy children's special needs; setting up proper environmental conditions;
- ✓ Protecting the population and the environment from pollution and predictable natural and technological risks;
- ✓ Protecting, conserving, valorizing and revitalizing historical monuments and the natural patrimony.

2. THE ENVIRONMENTAL IMPACT OF URBANISM

The main factor of cities' pollution is industry; this is also a factor that determines urban development. Urbanism and industry are interrelated, the industry being a sine qua non factor of urbanization. Therefore, where there is industry there is pollution. Perceived as economical activity, industry releases into atmosphere chemical substances, particles and gases (carbon dioxide CO_2, carbon monoxide CO, unburnt hydrocarbons, ammonia NH_3, industrial dust), it discharges industrial waste that affects flora and fauna etc. Until recently, the energy used in industry had been provided by coal charring, wood and petroliferous products which highly pollute the cities. Over-industrialization characterized the last few decades and it represented the main cause of the carbon dioxide CO_2 increase in atmosphere; at the beginning of the industrial revolution - with the energetic base focused on petrol and coal – the carbon dioxide atmospheric percentage was 0.030; nowadays, it has reached the value of 0.033 and in 2050 it would reach the value 0.060. Another representative industrial pollution example is Freon (a chemical compound used in cosmetics industry and for refrigerators) which, once reaching the superior layers of atmosphere, under the influence of high intensity UV rays, decompose and eliminate chlorine, fluorine etc. which attack the ozone in the atmosphere [2].

Industry (with all its components: energy industry, ferrous industry, chemical industry – chlorosodics, sulfuric acid H_2SO_4, chemical fertilizers, petrochemical products – construction industry – cement, paint, bricks etc) plays a double part in polluting the biosphere [2]:

- ✓ The nowadays technical man consumes a much higher oxygen quantity in order to provide burnings in factories or other technological processes; industry consumes natural resources (petrol, gases, coal, wood, iron etc.);
- ✓ At the same time, industry releases dangerous products (polyethylene, glass, rubber, radioactive waste, slowly biodegradable materials) which cannot be part of the natural renewal circuits.

Another factor which contributes to **environmental degradation** inside and outside the city is **agriculture.**

This statement is supported by the following arguments: an improper use of irrigations, which can bring ground water to the surface, producing sloughing; using chemical fertilizers, pesticides (for example, the spreading of DDT, detected even in Antarctica penguin's eggs, has led to the conclusion that it might be structured in the human alimentary chain, accumulating until reaching a highly dangerous level) [3].

Moreover, agriculture can affect the quality of the environment through animal husbandry, which is necessary for satisfying urban population's food necessities; therefore, this branch of agriculture produces big amounts of waste and used waters.

Animal husbandry also represents a source of pollution because of the high amount of anhydrous sodium carbonate and detergents used in sanitation activities.

Moreover, agriculture can also become the victim of urban activity because of cities development, by means of constructing industrial buildings, roads etc. over the last few years, it has been noticed an aggressive territorial expansion of cities, and this phenomenon affects the areas near these cities; this way, a continuous flux of arable land is being realized and this circuit of destruction would include forests (because of deforestations made in order to expand agricultural crops).

Therefore, in most cases, bringing arable areas into agricultural circuit is done by means of deforestations, and this way forests disappear from large areas.

If the actual deforestation process continues (2 hectares/minute), it is said that forests will completely disappear in the next 80-85 years.

When deforestations are made in order to obtain more arable lands and when an intensive agriculture is being practiced, the result is not a positive one: ground water is affected and it appears a widely spread ecological disequilibrium. Under the effect of demographical growth and rural exodus, human settlements, especially cities, are gradually becoming a threat for the environment.

The land surfaces eliminated from the agricultural circuit because of urbanization and industrialization, as compared to those which still remained in the circuit, represent important lots in developed countries: 28.0% in Belgium, 12.0% in Great Britain, 9.2% in Netherlands. In Romania also the proportions of this phenomenon are quite alarming; for example, in the capital Bucharest there is less population than in Paris, France, but it occupies a bigger surface than in the case of the French capital [2].

There were many cases in which industrial platforms were set up without taking into account the limited number of arable lands. Consequently, the main production factor in agriculture – the soil – becomes the victim of urbanization. This is due to two phenomena: because of a highly mechanized and chemical activity which forces the soil to produce more than it is capable of, in order to provide aliments for a growing urban population, on the one hand and because of introducing in its composition harmful substances such as: chemical fertilizers, industrial waste discharged in rivers, water rain which gathers dangerous substances (mineral oils, detergents) from the cities, domestic waste etc., on the other hand.

Another domain which has a negative impact on the environment, being perceived as a functional component of the city, is the transportation field. Besides soil, water and air pollution, this domain represents a stress factor in the case of urban population because of the high number of cars, phonic pollution and changes of urban landscapes etc. therefore, road traffic is the main source of carbon oxides emissions (approximately 90%) and nitric oxides (approximately 59%). In what regards carbon dioxide emissions, it occupies a less important place, and it has a reduced influence on sulfur dioxide (SO_2) (approximately 4%) [3].

Road traffic is the main source of volatile hydrocarbons emissions (approximately 45%), of plumb emissions, being three times bigger than those generated by industrial fields.

3. THE CONTRIBUTION TO THE POLLUTING EFFECT OF ENGINES USED IN URBAN TRANSPORTATION

Transports are a highly pollutant domain as they have a negative impact by means of the toxic substances they use, easily detectable atmospheric pollutants (by means of smoke, smell), long term effect gases (carbon dioxide). Transports affect the environment in an aggressive manner, as a consequence of the last 40 years' economic development which led to a continuous increase of public transportation (the number of passengers per km is 2.20 times bigger) and merchandise transportation (1.75t/km) [3].

Such traffic levels generate stress elements which become harder to accept by the population. Taking into account the complexity of transportations problem (road traffic security, its influence on the environment), the main conclusion is that the speed should be reduced (under 30km/h) in urban areas. The same thing should be done with traffic intensity (for example, the centre of Goteborg doesn't allow car traffic) [2].

Transports negatively affect the urban perimeter because of the development of infrastructure and road/railway networks; for example, the space lost because of highways is important: a six lane highway affects approximately 8 hectares of land/km.

Another polluting source which derives from urban activities and negatively influences nature is represented by domestic and industrial waste. Currently, the amount of this kind of waste reached its highest level due to population growth, economic agents, urban activities development and diversification.

The main issue in the case of waste is the manner in which they are managed (generated, incinerated, recycled and reused). Moreover, there are elements which prove the fact that this issue has been thought of: less waste is being produced; at the same time, more waste is being recycled, incinerated or reused.

Industrialization and economic growth led to an increase of waste quantities and to a change in its structure. While paper and cardboard is the main domestic waste in developed countries (approximately 15-40% of their total mass), there are noticed other waste categories, such as aluminum, plastic, glass, steel, synthetic fibers [4].

The last couple of decades allowed almost all developed countries to reach the conclusion that the huge amount of waste is improperly deposited on barren areas. The characteristics of these terrains allow toxic substances to reach the ground waters.

Waste incineration is not a clean process. The result is represented by tones of toxic ash which pollute the atmosphere. Combustion at high temperatures breaks the chemical chains which consequently pollute the air because of toxic emissions.

These can pollute the atmosphere or they can be taken by rain water and transported underground, towards ground waters. Incineration installations release nitric and sulfuric oxides, dioxins and furans (extremely toxic substances which produce cancer and genetic defects), heavy metals (plumb, cadmium, mercury).

Another pollution source is the water used to cool hot ash: the water becomes contaminated with acid substances and it raises serious problems when it comes to its storage, in the case in which it cannot be reused. Although there are many energy installations, the quantity of energy produced is much smaller than the necessary one.

For example, by means of paper recycling we can spare five times the amount of energy used for its incineration; in the case of polyethylene recycling, we spare two times the amount of energy which would be used for its incineration. Therefore, domestic and industrial waste management is based on alternatives such as: reducing waste sources (avoiding those processes which produce waste), a direct reusing of waste products, waste recycling or incineration in order to regain the used energy and, as a final solution, waste deposits [4].

Although governments allocate programs and budgets for domestic and industrial waste recycling, a recent study made in the USA (in 18 states from the north-west and Middle West of the USA), shows that they would spend 8 to 10 times more money on waste incineration than waste recycling over the next five years. We must not forget the activities in the tourism field which also destroy the environment to a lesser extent than industrial activities. Unfortunately, tourism has led to the destruction of some cities because of the high number of tourist, the development of access ways or by changing the city's profile from a touristic one into an industrial one. These phenomena had a huge impact on the environment.

CONCLUSIONS

As a conclusion, the anarchical development of cities which does not take into account the human being's necessities can eventually lead to humanity's destruction. It depends on the human being and its will to prevent this phenomenon. One should change one's mentality regarding the society in which one lives.

The World Bank's prognosis regarding urban development [2]:

✓ In 2050, the population would reach 10 billion inhabitants under the circumstances in which 240 human beings are born every minute in third world countries, while in Europe and in developed countries the number of newborns is approximately 26. If this direction keeps its current path, over the next few decades it's possible that the population in Asia would reach 5.8-6 billion people, that of Africa – 2 billion, Latin America – 810 million, Australia and Oceania – 46 million, Europe – 720 million.

✓ The number of urban population would grow from 1.5 billion to 3.5 billion and 2 out of 3 city inhabitants would be third world inhabitants.

The dimension of this phenomenon can be acknowledged only if we realize that in order to host an extra number of inhabitants - 1.7 billion – specialist estimate that a city for 200 thousands should be built every day.

REFERENCES

[1] Florina Bran, *Ecological Issues and Economic Risks*, the ASE Publishing House, Bucharest, 2007

[2] Lester Brown, *Humanity's Global Issues*, the Technical Publishing House, Bucharest, 1997

[3] *** Economy, nr. 1-2/1997

[4] *** Economy and Local Administration, nr. 1/1998

THE INFLUENCE OF CHEMICAL COMPOSITION OF MIXTURE ON THE MECHANICAL PROPERTIES OF FLY ASH CONCRETE

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ABSTRACT

The main challenge of the 21st century is oriented on the increasing effectiveness of the materials processing and significantly reduced energy usage. Because concrete is the most used building material in the world, the new approach consists in change in the design of concrete structures and in developing and implementing new concrete processing technologies based on cement reduction demand. Although new technologies are being developed to solve these problems, there is a viable solution for the present time utilization of alternative raw materials. Each year, industries produce over half a billion tons of potentially usable materials such as coal combustion products. Therefore the paper is discussing the chemical, mechanical properties of hardened concrete composites with various content of energetically waste (fly ash). Results of strength tests of composites showed significantly differences in overall value. As consequence of this state, the study of chemical composition of composites has been started. Chemical testing was made by using X-ray fluorescence method (XRF) and thermal analysis.

Keywords: environment, wastes, fly ash, concrete, chemical properties

INTRODUCTION

Building industry as one of the largest producers of pollutants should use the environmental suitable technologies as well as the utilization of green materials or of materials with long life cycle.

Concrete is the preferred construction material for a wide range of buildings, bridges and civil engineering structures [1]. It is made by mixing small pieces of natural stone (called aggregate) together with a mortar of sand, water, Portland cement and possibly other cementations materials. One of the advantages of concrete is that it is readily moulded into virtually any required shape. Because concrete is the most used building material in the world, the new approach consists in change in the design of concrete structures and in developing and implementing new concrete processing technologies based on cement reduction demand is necessary, i.e a viable solution is for the present time utilization of alternative raw materials (properly designed and constructed, concrete structures compare favorably with regard to economy, durability and functionality with structures made from other structural materials, such as steel and timber). During the last few years, some cement companies have started using fly ash as cement replacement or in manufacturing cement, known as ‘pozzolana Portland cement’. Fly ash closely resembles volcanic ashes used in production of the earliest known hydraulic cements about 2,300 years ago. Those cements were made near the

small Italian town of Pozzuoli - which later gave its name to the term "pozzolan." A pozzolan is a siliceous or siliceous / aluminous material that, when mixed with lime and water, forms a cementitious compound [2]. Fly ash is the best known, and one of the most commonly used, pozzolans in the world. Instead of volcanoes, today's fly ash comes primarily from coal-fired electricity generating power plants. These power plants grind coal to powder fineness before it is burned. Fly ash - the mineral residue produced by burning coal - is captured from the power plant's exhaust gases and collected for use. Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity. These micron-sized earth elements consist primarily of silica, alumina and iron. The difference between fly ash and Portland cement becomes apparent under a microscope. Fly ash particles are almost totally spherical in shape, allowing them to flow and blend freely in mixtures. The capability is one of the properties making fly ash a desirable admixture for concrete [3 - 5]. The current annual worldwide production of by-products is estimated about 700 million tons of which 70 % is fly ash at least. Large quantities of fly ash are available at low costs around the world and the use of fly ash concrete seems to offer the best solution to reducing consumption of cement, but the overall percentage utilization remains very low, and most of the fly ash is dumped at landfills. Due to reduce environmental concerns and disposal difficulties, the utilization of fly ash has become of great importance [6].
Our previous research was oriented on utilization of mechanically and chemically modified fly ash as an active addition in cement and concrete [7, 8] as well as the investigations of biocorrosion [9, 10] of concrete samples based on a partial cement replacement by fly ash exposed under the model conditions. The paper is aimed to research of use of amount untreated fly ash as cement replacement in concrete.

MATERIAL AND METHODS

An experimental investigation was carried out to evaluate the compressive and flexural strength as well as freezing and thawing coefficient of concrete cured at normal curing condition. Results of selected tests constitute a significant factor for assessing the availability of prepared concrete. Our research was provided in cooperation with Slovak building company. In accordance to the proposed prescription, the C 25/30 grade concrete made with 0 - 15% fly ash (class C - properties of fly ash are presented in Table 1) replacement of special kind of Portland cement CEM I 42,5 N. Water cementations material ratio was 0.36, natural gravel aggregate from stone – pit Soporna and Hanisberk in specific ratio of the fine to coarse aggregate 40 (0/4): 10 (4/8): 50 (8/16, 16/32) and three different types of chemical admixtures from Slovak producers were used in mixture. The mixtures were prepared in the labor mixer type ZZ 150 SH with horizontal rotary drum with capacity 150 l. Four based properties of fresh concrete: consistence assessment (slump test), air-volume compressive method), volume weight (relative compaction - STN EN 12350 - 6:2001) and temperature assessment (STN EN 206-1: 2002) before the forms filing were tested according to STN EN 12350 (parts 3 and 7). The forms filling were performed in two layers. Each layer was rammed on the vibration plate VSB 40 for 8 seconds. Total time of the concretion was 16 seconds. Next day the composites were taken out of the forms and saved in the water bath. The testing composite were prepared at temperature 20 ± 2 °C. According to Slovak Technical standard the composites were taken out of the water bath and tested for the required properties resulting from the special purpose their use for class of concrete C 25/30 after

28 days of hardening (chemical: water activity, de-freezing substance resistance of concrete surface, freezing, and thawing and mechanical properties: tensile flexural and compressive strengths of hardened concrete based on fly ash was studied).

X-ray fluorescence method (XRF) was used for the chemical compositions investigation of both concrete samples and admixtures used. The samples of concrete were pulverized by using planetary ball miller SFM (MTI corp., USA) and prepared as tablets of diameter 32 mm by mixing of 5 g of concrete powder and 1 g of dilution material (M-HWC) and pressing at pressure of 0.1 MPa/m2. The chemical composition was determined by using SPECTRO iQ II (Ametek, Germany) with SDD silicon drift detector with resolution of 145 eV at 10 000 pulses. The primary beam was polarized by Bragg crystal and Highly Ordered Pyrolytic Graphite - HOPG target. The prepared samples were measured during 300 s at voltage 25 and 50 kV, at current of 0.5 and 1.0 mA, respectively. The standardised cement method of fundamental parameters was used for the measurements. The admixtures were measured during 180 s the same way by using the method of fundamental parameters for liquid samples. Thermal properties of prepared concrete composite were studied by using STA 449F3 (Netzsch, Germany) in the temperature range from 25 to 1000 °C with the heating rate of 10 K/min under nitrogen atmosphere using DSC/TG mode.

RESULTS AND DISCUSSION

The assessment of measured values of fresh concrete mixture properties: consistence, air content, concrete temperature and density (volume weight) in comparison with the specific requirements of standard as well as with reference composite (density) are presented in Table 1. As shown, the results of tests proved that prepared fresh mixture of concrete of strength class C 25/30 met the requirements of technical standards.

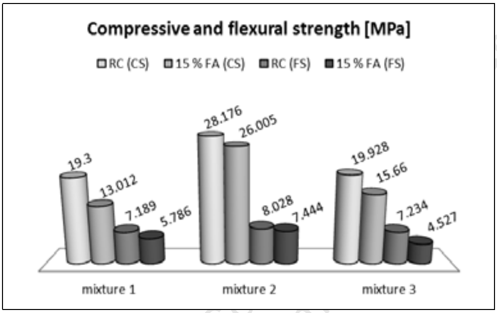
Table 1: The requirements of Slovak Technical standard and results of fresh concrete mixture test

Measured value	Type of test			
	Consistence [mm]	Air content [%]	Concrete temperature [^{o}C]	Density [kg. m^{-3}]
	*S1 (10 – 40 mm)	*maximal 7 – 8 %	*+5 °C to +25 °C	*Reference composite
0%	30	6	23.5	2330
5%	30	6	22.5	2330
10%	40	6.4	19.5	2310
15%	40	6.5	19.5	2280

Water activity results with respect to all replacement (5 – 15 wt. % fly ashes) and de-freezing substance resistance of concrete surface based on certificate interpretation of the test performance showed that the composites met the requirements of Technical standard in both cases with result: slightly disturbed. The obtained frost resistance coefficient showed that the requirements of Technical standard after 300 cycles were fulfilled and composites prepared on the base of 15% CEM 42.5 N replacement by FA are suitable (frost resistance coefficient of 0.85) for the using in the area of Civil Engineering.

Developing of strength characteristics (compressive strength and tensile flexural strength) of composites based on selected 15% fly ash portions after 28 days (average values of strength [N.mm^{-2}]) is shown in Figure 1. Both strength characteristics of experimental composites are compared with values of reference composites and Technical standard requirements (compressive strength – 25.0 MPa / 28 days; tensile flexural strength – 4.2 MPa / 28 days). Based on these results it can be stated that the utilization of fly ash with 15 wt. % of cement replacement (mixture 2) met the standard requirements. Conversely, samples prepared with additives of mixture 1 and mixture 3 did not meet the required strength parameters. As it is seen from Figure 1, the results showed significant differences in the measured values of the strength properties.

Figure 1: Results of strength characteristics of fly ash after 28 days



* FA – fly ash; RC – reference composites; CS – compressive strength; FS – flexural strength

Chemical composition of admixtures and concrete composites

The differences in strength values probably consisted in chemical constitution of composites prepared based on various Slovak admixtures. Subsequently it has been started research oriented to composition of fly ash concrete composites. The results of XRF element chemical analysis of mixtures used in tested concrete samples are summarized in Table 2 and the overall oxide concentrations of tested composites are shown in Table 3.

Table 2: Comparison of the chemical analysis of mixtures

Chemical composition	Mixture 1 [mg/kg]	Mixture 2 [mg/kg]	Mixture 3 [mg/kg]
Mg	< 101	2140	< 101
Si	< 8.3	113	< 5.1
P	< 3.0	473.4	< 3.0
S	93 160	47 280	99 680
Cl	188.9	294.4	195
K	222	324.2	224
Ca	5 799	2 476	5 130
Mn	< 5.1	184.1	39.7
Fe	30.4	129.3	57.4
Co	15.5	8.1	14.7

Obviously, the chemical composition of mixtures 1 and 3 was very similar. The concentrations of elements measured in mixture 2 were quite different. Silicon, phosphorous, manganese and iron contents were measured to be much higher in mixture 2. On the contrary, the calcium and sulphur concentrations reached lower values when comparing to the mixtures 1 and 3. The high sulphur content in mixtures 1 and 3 detected can negative influence the surface of particles as well as hydration reactions. Along with the Si content seems to be crucial in terms of the strength parameters evaluation.

Table 3: Amount of some oxide concentrations of tested composites

Symbol	Element	Mixture 1 [concentration %]		Mixture 2 [concentration %]		Mixture 3 [concentration %]	
		*RC 1	15 % FA	*RC 2	15 % FA	*RC 3	15 % FA
MgO	Magnesium	2.051	2.101	1.880	2.084	1.731	1.762
SiO_2	Silicon	40.11	40.40	32.08	34.49	25.99	32.67
P_2O_5	Phosphorus	0.0869	0.0984	0.0835	0.0899	0.0795	0.0782
SO_3	Sulfur	2.782	2.792	2.865	2.853	2.952	2.897
K_2O	Potassium	0.7949	0.9262	0.7603	0.8642	0.6426	0.8624
CaO	Calcium	19.86	17.49	20.46	19.07	20.70	15.20
MnO	Manganese	0.3643	0.3618	0.3630	0.3640	0.3679	0.3613
Fe_2O_3	Iron	3.444	4.068	3.501	3.997	3.230	4.083

*RC 1, 2, 3 – reference composite (0% fly ash replacement)

Considering the importance of calcium and silicon in the concrete composite in terms of its strength parameters, the concentrations of calcium and silicon oxides are discussed. As it is seen from Table 3, the fly ash mixtures represented the lower content of calcium oxide comparing to the reference sample without fly ash. This likely result in the decrease of the strength characteristics for ash samples (Figure 1). On the contrary, the silicon concentrations seem to be similar for the tested composites. The chromium as one of environmental parameter was also monitored. Its content in the concrete samples was chosen for the environmental assessment of the health safety. The total chromium concentrations in tested samples were measured in the range 158.4 to 232.6 ppm [mg/kg] (Table 4).

Table 4: Environmental assessment FA-concrete composites based on chromium

Symbol	Element	Mixture 1 [concentration ppm]		Mixture 2 [concentration ppm]		Mixture 3 [concentration ppm]	
		*0% FA	15 % FA	*0% FA	15 % FA	*0% FA	15 % FA
Cr_2O_3	chromium	232.6	187.9	225.5	202.1	173.4	158.4

Chromium is an indelible non-volatile trace element of raw materials (clay, limestone and iron additives in particular) used in cement clinker production in the form of chromium (III). Naturally occurring chromium (III) is not initially harmful, since it is chemically stable. Only at high temperatures found in cement rotary kilns, inert trivalent chromium oxidizes to form reactive hexavalent chromium. The measured concentration is suggested to be the hexavalent water-soluble chromium which is harmful and allergenic. Therefore its impact to health as well as the thermal properties of concrete composites to obtained new results will be next aim of our further study.

CONCLUSION

The cement production has the largest impact of the production of the raw materials, and the comparison of the results of Life Cycle Analysis studies indicates that the environmental impact of the cement production has decreased between 60-80 % over the past ten years. The reasons for this may be the development of better cleaning steps in the production and more effective incineration, together with increased use of renewable fuels. One of the most common and most effective options is to replace a portion of the Portland cement with fly ash (commonly between 25-50 % by mass of cement), a by-product of the coal-burning power industry. However, the future of fly ash availability is in comprehensive assessment of the strengths and durability of concrete with fly ash share, the environmental impact of its use on human health as well as a number of economic factors in terms of construction companies.

REFERENCES

[1] Khalid. Ali. & M. Gelim: Mechanical and physical properties of fly ash foamed concrete, Faculty of Civil and Environmental Engineering, University Tun Hussein Onn Malaysia, 2011.

[2] Sinsiri, T., Chindaprasirt, P. Jaturapitakkul, Ch., Influence of fly ash fineness and shape on the porosity and permeability of blended cement pastes, International Journal of Minerals, Metallurgy, and Materials, 2010, vol. 17/issue 6, p 683, 2010.

[3] http://www.iflyash.com/whatisflyash.htm, accessed on April 13, 2012.

[4] Siddique R. Effect of fine aggregate replacement with Class F fly ash on the mechanical properties of concrete, Cement and Concrete Research, India, vol. 33, pp 539–547, 2003.

[5] Pattanaik Ch. S. & Sabat K. A. A study of Nalco fly ash on compressive strength for effective use in high volume mass concrete for a sustainable development, International Conference on Sustainable Technologies for Concrete Constructions, India, 2010.

[6] Ahmad I. & Mahanwar P. A. Mechanical Properties of Fly Ash Filled High Density Polyethylene, Journal of Minerals & Materials Characterization & Engineering, USA, vol. 9/ issue 3, pp.183-198, 2010.

[7] Stevulova N. & Filkova I. Coal fly ash as a raw material for low-energy belite cement preparing, CEST 2009, Greece, 2009, pp 88- 95.

[8] Junak J. & Stevulova N. New direction for waste utilization in civil engineering production, Czasopismo Techniczne, vol. 108/issue 8, pp 79-87, 2011.

[9] Ondrejka H. V. Biocorrosion of concrete sewer pipes, In: JUNIORSTAV 2008. – Brno, VUT, Czech Republic, 2008.

[10] Ondrejka H., V., Estokova, A., Stevulova N. The investigation of concrete' biodeterioration in sewer pipes, Pollack Periodica, vol. 5/issue 1, pp. 87-95, 2010.

THE INFLUENCE OF THE TAILING DUMP AND FLOTATION HYDRO-TAILINING OVER THE ENVIRONMENT IN THE DOMESTIC COOPER MINE

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ABSTRACT

The presentation of the influence that the tailing dump or waste as well as the flotation hydro-tailing dump over the environment around the region of copper mine Bucim, surrounding rivers, places, villages and mine lake. Generally speaking, the monitoring will be done for two periods. The first analysis relating to the period from the year 2005, and the second analysis relating to the period from the year 2010. The monitoring with samples of waters, soil, sediments and ambient air as well as the monitoring with samples of the dust will be done.

Keywords: tailing, pollution, soil, hydro-tailing

INTRODUCTION

The flotation concentration of mineral raw materials produces large quantities of tailings with significant volumes of water that should be disposed of in appropriate place. The right discharge means better protection of the environment, prevents settling of underflow. It provides certain volumes of water for use in the technological process. The tailing dam that consists of sand dam, settling lake, drainage system and equipment for evacuation of decanted water is an important part of the mine. It must meet the requirements as follows:

- to provide good safety and stability to the dam,
- to have permanent hydraulic input of tailing,
- permanent work of hydro cyclones during separation of sand and overflow,
- to have operational drainage system at any time,
- to provide sufficient time for the physic-chemical processes, or settling of coarse fraction and dissolving of other flotation reagents in order to obtain clear and purified water to be used in the plant or flow into the water courses without contaminating the environment,
- to possess built in collectors to receive and evacuate clear water,
- to have a sand dam with appropriate thickness and porosity to receive and evacuate the clear water,
- to possess sand dam of appropriate thickness and porosity to receive and evacuate clear and percolating water,
- to be economically justifiable in the concentration process.

Hydro tailing dams and tailing dump in copper mine

Over the past years much higher dams (reaching up to 100 meters in height) were constructed. Their economy is seen in the continuation of the lifetime of the drainage system, the collector, the flotation pulp station and the water system between the flotation plant and the tailing pond which are the major costs in construction and maintenance of the tailings dam. Larger dams make possible the housing of flotation waste, to reduce, at the same time; the costs per ton processed ore.

The terrain chosen for the construction of the tailings pond and dam must be examined in order to determine its geological characteristics and rock mechanics.

The construction should be as inexpensive as possible. This requirement leads to the application of the so-called upstream method, since the centreline of the dam extends upstream or downstream. In the application of this method the small starter dam is located at the end of the favourable downstream point, whereas the dam goes upstream. Two major methods are used in dam construction – hydro cycling and spigot.

The advantages of the upstream method are its low cost and the time period necessary for the construction during each successive dyke increment.

The disadvantage is that the dam is constructed on earlier deposited unconsolidated slime. The limiting height during the construction of this type of dam (before a failure occurs) led to the less common construction of this type.

The second, so-called downstream method is fairly new system. It has evolved due to the efforts to construct larger and safer tailings dams. Unlike the upstream method, here the centreline increases downstream and the dam is founded on coarse tailings. Most procedures use cycling or produce sand for the dam construction. The method makes possible the design and construction of the tailings dam with acceptable standards. All tailing dams in seismic areas or almost all-major tailings dams were constructed using the downstream method.[1]

The main disadvantage of the method is the large amount of sand necessary for the construction of the dam. There is also a third method the so-called centre-line method - used in the construction of downstream dams, and the crest remains horizontal as the dam wall is built. The advantages are that it requires smaller volumes of sand-fill for the crest at any given height.

Sand dams differ from dyke dams since they are permanently built during the use of tailings pond by depositing new layers of hydro cyclone sand of lower compactness. The sand comes from the flotation pulp and contains 60 to 75 per cent coarse fractions. The concentration of sulphide minerals in the hydro cyclone sand is higher than in the flotation tailing, particularly higher in the hydro cyclone overflow. With the time, oxidation of sulphide minerals occurs. This changes the permeability of the sand dams and the angle of internal friction among sand grains, which is also important for the static stability of the dam.

The water from the accumulation area penetrates sand dams causing physical, chemical, hydrogeological and consolidation processes to take place during and after the construction of the dam.

Oxidation of sulphide minerals in tailings depends on the time necessary for the reaction of their surfaces with the oxygen in the air. The speed of the oxidation process is related to the quantity of air, temperature, the degree of moisture and the specific surface of oxidising minerals. Of all sulphide minerals - pyrite, which is most common in flotation tailings, is most prone to fast oxidation in a sand dam due to its crystal-chemical properties and easy commination. Products of pyrite oxidation are: Ferro hydroxide - Fe $(OH)_2$, Ferry hydroxide $(Fe(OH)_3$, Ferro sulphate $FeSO_4$ and sulphur hydrogen H_2S.

Seeping waters in the tailings pond often contain heavy metals such as iron, zinc, copper, nickel, and manganese. Lead is known to be of limited solubility. Larger presence of individual elements is harmful for the environment. In that regard we must prevent outflow of water with heavy metals in order to keep water safe. Understanding the chemical reactions that take place in the flotation tailings helps to prevent the aggressive action of water of concrete reservoirs whose disasters may cause undesired consequences.[2]

The most serious issue regarding the protection of the environment related to the disposal of flotation tailings in the ponds is the discharge of contaminated waters in surface and underground courses. It must be said that it is more complex in surface courses.

Remediation of the pond envisages new and more efficient methods. The land used to be a good valley, but today it is a plane area of greyish colour and a pond with no animal or plant life. Changes of the relief result in changes of the climate that have an enormous impact on the biota.

The high concentrations of heavy metals in the soil have an impact on its quality and prevent the formation of humus material. They break the bonds between the humus material and the mineral part of the soil that leads to the destruction of the soil and loss of humus and reducing the anti-erosive capacity. Heavy metals enter the plants and crops causing a number of biological distortions. Many plants are resistant to saturation of heavy metals and survive. However, saturation of heavy metals in vegetables that are consumed by humans may result in serious health problems. Possible disaster of the dam would result in serious disturbance of the environment and casualties, including great material damage. The issue should be given greater attention.

Experience has shown that disasters are caused due to various factors such as instability of slopes, earthquakes, floods, large quantities of drainage waters, poorly constructed foundations, erosion etc. In dam construction it is of importance to use all project parameters. Exceeding the dam means disposal of new layers of waste so that the body of the dam increases and the fine particles in the substrate make the large mass unstable.

The environment is a complex system consisting of mutually connected factors. The changes in one factor may cause changes in the other. So, the issue of the protection of the environment from contamination can be solved through integrated and systematic approach. Any partial solutions are not permanent solutions and mean improvisation that take us away from the real solution of the problems. The measures to be taken in protection call for good understanding of the negative effects in mining operation and their elimination. The measures include protection of waters, air, and soil. In environment protection it is important to pay attention to the reduction of pollution of water courses in which waste waters from the tailings pond are discharged. Today, large volumes of contaminated water are recycled and fresh water input does not exceed 5%. As mines use their own wells for the supply of fresh water, the use of the water from the tailings pond would be no economical.

Water and soil from tailings in copper mine

Water protection includes certain measures. The most common are those that in the flotation process the toxic reagents are replaced by non - toxic or less toxic, settling of water in the pond in order to assist decomposition of residual flotation reagents, clogging of overflow collector when the water is not sufficiently clean, temporal extension of overflow collector and drainage pipe etc. Extension of overflow collector calls for urgent measures since during the dam construction, the flotation waste has not passed the part where the overflow collector ends. The drainage system is functioning well as seen from the measurements carried out by piezometers. However, for better monitoring of filtration and rising waters it is necessary to clean the broken piezometers or replace them with new ones. The impact on ground waters is small. Each raises of the dam results in overflow and run off part of the water into the ground. The problem could be solved through controlled hydro isolation. Contamination of earlier tailings ponds has been reduced to a minimum. They have also been cultivated and do not pose any danger to the air. [3]

For the crest and the slopes several solution are possible one being water spraying with nozzles under high and low pressure. The low-pressure nozzles work under pressure of 4 bars and have a small range amounting from 15 to 30 meters and economical use of water. This does not require installation of expensive high-pressure pumps. One of the advantages also is that the low pressure of the jet does not damage the dam. Their disadvantage is that a number of pipes have to be fixed and requires higher investment. Low-pressure nozzles are most common in dam spraying. Combined spraying is when one part (the crest) is sprayed with low-pressure nozzles, whereas the downstream slope is sprayed with high-pressure nozzles - water guns.[4]

Possible solution is spraying with certain suppressants that form crusts husks that connect fine fractions and prevent the formation of large volumes of dust.

Lands formed from discharged flotation waste are called float salts. Because of the harmful component parts and the manner of discharge they pose multiple dangers to the environment. They have no biological importance and the chances for their revitalisation are very slim.[5]

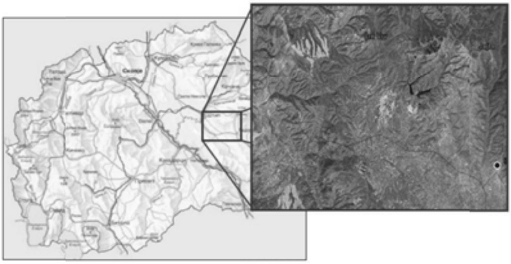

Figure 1. The view and location of hydro tailing in copper mine

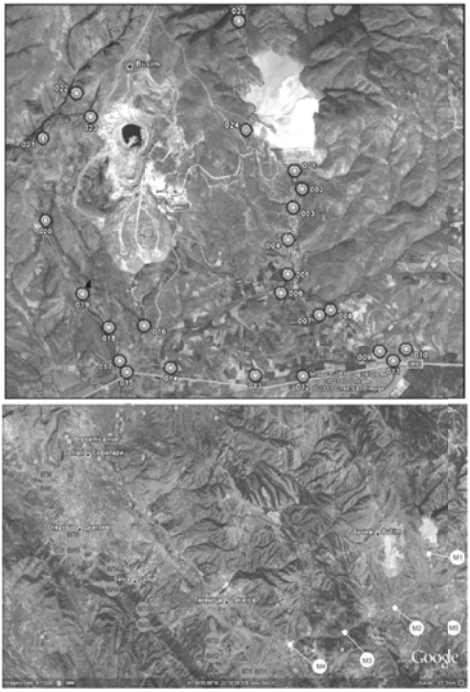

Figure 2. The measurement points in the copper mine region

Figure 3. The differences between river water from tailing dump in copper mine

CONCLUSION

The possible disaster of the dam may cause great material and ecological damages or losses in human lives. The issue should be paid great attention. Statistics says that collapse of dams occur due to several factors (according to data from USCOLD 1994, US Conference of Large Dams). The most common causes are unsuitability of slopes (amounting to 22%), earthquakes (17%), floods (16%), poorly constructed fundaments, excessive quantities of drainage waters (9%), erosion etc. Three dam disasters have taken place in the Republic of Macedonia over the past years. They all caused significant damages to the waters, air, and land in particular. Such were the disasters in Zletovo lead and zinc mine in Probiship, the Buchim copper mine and the latest in the Sasa lead and zinc Mine (the last one in September 2003). The collapse in the Sasa flotation dam formed a crater of 120 - 160 m at a depth of 30 to 40 m. After the disaster over 1.000.000 tons of waste with heavy metals entered the River Kamenicka, further on Lake Kalimanci, the River Bragalnica and the surrounding land.

REFERENCES

[1]. Wills, B.A. (1989). Mineral Processing Technology, Pergamon Press. pp 686-698;

[2]. Klohn, E.J. (1981). Current Tailings dam design and construction methods Min Eng. 33, pp 798

[3]. Krstev B. (2000). Using Administrative Controls to Reduce Tailing Dams Risk on the Active Tailing Dams in Macedonia; /International Conference "NEW TRENDS IN MINERAL PROCESSING IV" Ostrava, Czech Republic, 26-28.6.2000/

[4]. Krstev B. (2001). Tailings Dams in the Republic of Macedonia; /International Conference "NEW TRENDS IN MINERAL PROCESSING V" Ostrava, Czech Republic, 28-30.6.2001/

[5]. Krstev B. (2001). Dust Control Technologies for Mineral Processing Plants; /IX Balkan Mineral Processing Congress, Istanbul, TURKEY 11 - 13.09.2001/

THE POLLUTION STUDY WITH ALDEHYDES OF WATER COURSES

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ABSTRACT

Pollution with aldehydes of water courses is less and inconclusive studied today. However, current researches don't establish limits of some quality parameters that can be admitted into surface water by point of view of these contamination resources. Having this objective is given possibilities to emphasis the emission of aldehydes in the environment

Accordingly to an experimental program for its identification and assessment, present the effective techniques of sampling and analysis. Chemical Plant, the biggest chemical complex in Romania operates a prominent Oxo-Alcohol production in Chemical Plant and causes significant emissions of aldehydes and the relevant imissions into the river Olt. It has been used a new diffusion gadget as against the process based on the adsorption principle in the liquid, used so far, but which is rather complicated and extremely sensitive to other substances.

So far there are no directives to regulate air pollution or surface water of aldehydes. There are parameters according to which the aldehydes are a potential risk on health, which has imposed by this study, group of substances analysis, knowing that by production of Oxo – Alcohol is formed a considerable amount of aldehydes.

The detection limit for the aldehydes has been located around the value of 40 mg / l. Measurements have been effectuated both in braking off and working period of the Oxo - Alcohol outfit from Chemical Plant, by comparing the results of the new sampling system with diffusion separator built and with existing measurement process.

Experimental research results are evaluated and established the solutions from the reduction of the pollution.

Keywords: aldehydes, imissions, environment, pollution

1. INTRODUCTION

There has been little and so far inconclusive research on watercourses pollution caused by VOC emissions (Volatile Organic Compounds). The existent body of knowledge does not determine the limits for quality parameters to be applied to surface waters in relation to these pollutant substances.

The present paper aims to study and indicate the ways in which aldehyde emissions can be identified and analyzed, especially in what regards watercourses, through the design and implementation of a sampling device.

An experimental program has been carried out in order to identify and evaluate these substances with the result of presenting efficient techniques for sampling and analysis.

Research has been conducted in a Chemical Plant where significant quantities of aldehyde substances have been discharged in the river Olt and in the atmosphere.

There are indications that aldehydes represent a potential health risk. So far, there have been no directives to regulate aldehydes pollution of surface watercourses.

A new diffusion device has been employed as an alternative to the method based on the adsorption principle, a device that has been used up to the present but which is rather complicated and extremely sensitive to other substances.

Aldehyde detection limits ranged at around 40 mg/l. Measurements were made within and outside the functioning period of the oxo-alcohol installation at the Chemical Plant, comparing the results of the new sampling device against the existent one.

Experimental research results are evaluated and solutions to reduce pollution are established.

The main objective of the research was the identification and evaluation of such emissions in an area (soil, water) with the view to establishing modern original solutions for reducing the pollution of the environment.

Research objectives:

- identification and study of monitoring area for the soil/water environment and of emission source
- establishing the sampling points and indicators in the environment and in the river Olt
- outlining the general framework of integrated monitoring program
- drawing the theoretical framework and measurement program through various measurement procedures
- evaluation of measurements, model implementation and evaluation of results
- providing solutions to reduce environmental pollution

2. METHODS EMPLOYED IN THE THEORY AND PRACTICE OF ALDEHYDES MEASURING

An appropriate emission sampling device has been designed in order to demonstrate the relation between the emissions of volatile organic compounds, represented by aldehydes, and the infiltration in the river Olt.

A sampling system based on the principle of denudation was initially built, a system that can be used at temperatures between 5 and 130 degrees Celsius. Thus, all the advantages that this procedure offers, such as selective separation, an analysis that is easy to conduct, limit values that are easy to detect, have now become applicable also for measuring emissions. The sampling system may be used in corrosive environments, too, and the detection of aldehydes can be separately performed for particles and gaseous state emissions. By comparison with the existing sampling systems, a significant improvement in aldehydes enrichment has been obtained, this causing a considerable decrease in the limit value they can be detected.

This paper includes an analysis of the presence and origin of aldehydes as well as aldehydes characteristics that are to be found in various environments like water, air and soil. A number of toxic characteristics of aliphatic aldehydes are being highlighted:

respiratory system attacks, even in the case of low concentrations, pungent odor and, because of solubility in water, they may also attack the eyes.[6]

The sampling system components are divided in two boxes, according to their function (fig.1). The first box contains all the components (probe, cyclone and dryer) up to analyze evacuation, while the second box contains all the controllers (heat, gas and level).

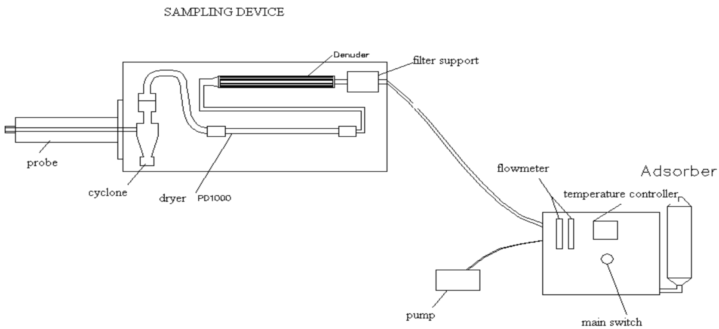

Figure 1 – Sampling device scheme [7]

The sampling system sized for a flow rate of 10 l/min was found to be suitable for the annular denuder (diffusion device). The sampling time is of approximately 30 minutes for this flow volume.

The paper indicates the details corresponding to each component (sampling probe, cyclone and permeability dryer). The volume rate of the measured gas is monitored in the control unit (controller) by a flow meter. It is conveyed by a gas meter to the membrane pump.

The sampling probe consists of a steel pipe on the outside, which protects the heating hose responsible for maintaining, in the steel pipe, the same temperature of the evacuated gas.

The cyclone represents a diffusion system used to separate both liquid and solid particles.

The separation occurs when the particle trajectory is deviated from the gas flow by centrifugal force and the particles reach the limit of gas flow.

The cyclone bend is attached to the gas dryer. Laboratory tests (fig.2) have shown that aldehydes separation, as they are found in the evacuated gas, significantly decreases in case of high humidity in the denuder. This is why the evacuated gas must be dried first.

The controller unit contains all the components used for influencing the processes and sampling part (the heat regulator, the pressure regulator and the flow meters).

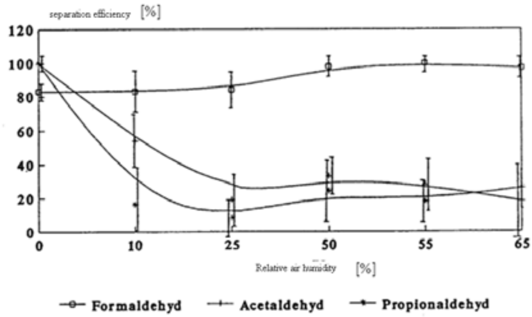

Figure 2 - Accumulation of aldehydes in simple denuder [G. Kallinger, 1994].

The diffusion device (the denuder) indicates a new sampling system, which uses for the first time a denuder as the nucleus of a device for measuring emissions. The results show that this system is superior to other sampling methods.

3. EXPERIMENTAL PROGRAM. CASE STUDY

The Chemical Plant along with the Olt River is an ideal object of study, as it is the largest issuer of aldehydes (Fig. 3). Due to long periods of downtime because of the economic crisis, all amounts of aldehydes from the past were completely decomposed. After restarting the installation it could prove a direct link between emissions and existing pollution from the surrounding surface waters. Due to the proximity from R. city it is imperiously necessary to monitor the pollutants that are health risks. In addition, currently there are numerous studies in Chemical Plant, including measurements of aldehydes.

Thus it was possible to compare and evaluate the effectiveness and usefulness in detecting new sampling system with the existing methods.

The concentrations of aldehydes from Olt, respectively from the discharge canal of Chemical Plant (Fig. 4) were measured in parallel with the recommissioning of the factory facilities. To link the values measured in water and the emissions from the production of oxo-alcohol, aldehyde emissions were captured using the new sampling system.
In parallel with each measurement, meteorological data, such as air temperature and wind speed were also recorded.

Water samples were collected from four selected locations on the river Olt. For sample A and B were taken 20 ml from 4 sections of the river, at a distance of approx. 5 km from each other.

Two of the locations from which the samples were taken are upstream, compared with the factory location, another location is right at the spout Chemical Plant wastewater, and the last location is downstream. The aim was to select a sample of water in the section farthest upstream as possible, without any influence from the chemical plant or from the city on top of it. [8] A second sample was collected just where the river goes outside the city, in order to analyze the influence of combustion processes resulted from traffic within the city, and that of home heat

Figure 3 – River Olt

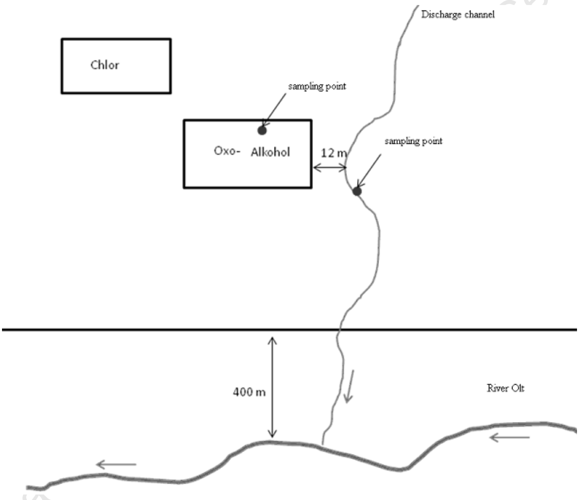

Figure 4 - Discharge channel scheme

The samples were searched for the following substances: formaldehyde, acetaldehyde, propionaldehyde, butyraldehyde, valeraldehyde, hexane and acrolein. With this analysis all the main groups are covered, particularly aldehydes, which are supposed to be harmful to health, for example the formaldehyde. The detection limit of all aldehydes in this procedure lies around 40 mg/l. In order to measure aldehydes, the Chemical Plant uses the measurement in wet chemical environment.

In order to have a further comparison of the results from new sampling system constructed and the existing measurement process, a location where also the Chemical Plant has already made measurements was selected.

4. DISCUSSION. CONCLUSIONS

Different sampling procedures led to similar results (Fig. 5). By the new developed sampling system almost all measured values obtained were higher than values obtained by existing processes.

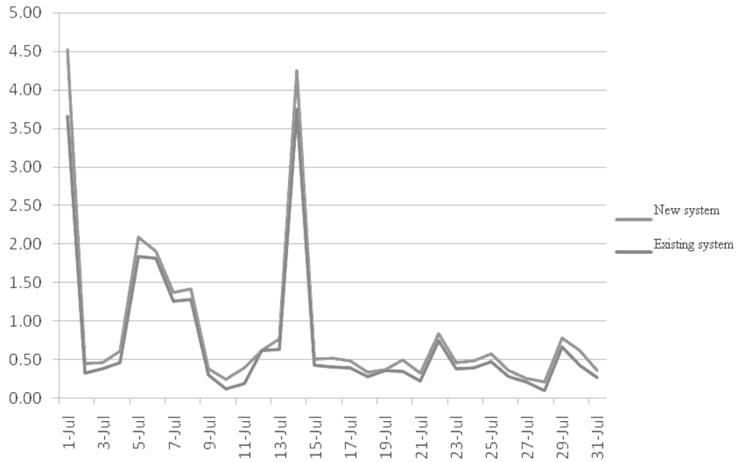

Figure 5 - Comparison results of aldehydes measurements in July [mg/m3]

Compared with the method practiced by the Chemically Plant, with the new sampling method for aldehydes the results increased from 18% to 30%. This demonstrated that the accumulation of aldehydes records much better values if measurements are made with the new sampling system than the old one used. 30% increase from the first use leaves space for assumption, even more improvement can be reached if sampling is optimized and especially the analysis from the denuder. In addition, costs are considerably lower for the new system, because all components can be reused and so, costs result only for the analysis itself when it operates. While the initial costs of sampling device and a sufficient number of diffusion separation devices are higher.

To make an evaluation of the aldehydes emissions, a material balance can be made by comparing the raw materials used, plant level potential efficiency and actual production of oxo-alcohol. The resulted value is about 15.2%. Taking into account an annual output of 52,000 tons, the amount of emissions will result 780-1040 tons/year. This explains why the concentration of aldehydes in the river does not exceed the detection limit of 40 µg/ l. However 1,000 tons/year is a considerable amount, whose repercussions on health, surface and environment must be investigated further.

In the Olt River aldehydes could not be detected neither before, nor even after the commissioning of production facilities. Detection limit for aldehydes is in the range of 40 µg/l. The average flow of the river Olt is about 1,300 m3/s. If we assume that aldehydes are distributed optimally in the river, we can calculate the amount of aldehydes required to cross the detection limit of the river:

Pollution / 1300 m3/s = 40 µg/l

Pollution = 40 µg/ l x 1300 m3/s = 52 g/s

The value of 52 g/s from Olt could be registered only if in the river reaches 3% of total production of aldehydes from Chemical Plant. The existing installations take into consideration a product loss of 1-2%, as emissions. Only part of this value reaches the river. As long as there are no measurement methods with much lower detection limit, aldehydes, their repercussions on surface water cannot be detected directly in the river. The method to obtain the actual detection value of 40 µg/l is already a highly sensitive technique compared to the other methods of measurement. At the moment a considerable improvement in analytical methods is not reachable.[8]

The probability to detect aldehydes in waste water channel (Fig. 7) was much higher than to detect them in the river Olt. The discharge channel is much closer to the emission source, it comprises a much smaller quantity of water at a rate of about 1 m3/s and thus there is not the same dilution that takes place in the river Olt. However, only in certain days a contamination with aldehydes could have been recorded. Important factors in this respect were the meteorological influences (Fig. 6).

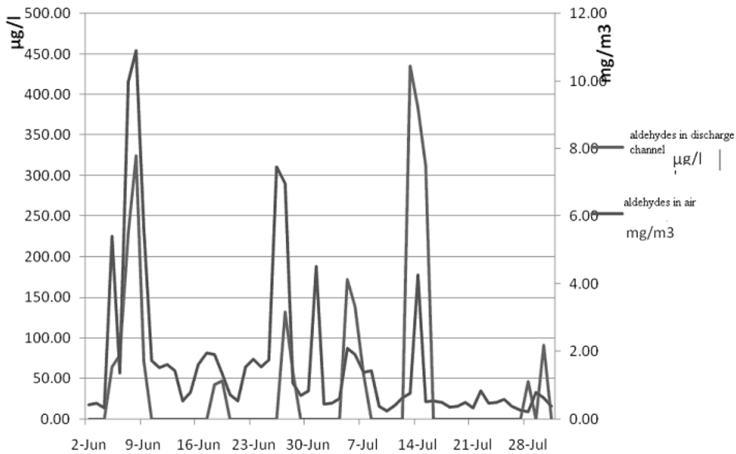

Figure 6 - Concentration of aldehydes in waste water discharge canal

In Figure 7 is shown the connection between aldehydes concentrations measured and wind speed, and aldehyde contamination from the discharge channel resulted. In this way it is observed that only in case of calm and, therefore, after the air enrichment with aldehydes, a concentration of aldehydes can be measured in the discharge channel, which is above the detection limit of 40 µg/l.

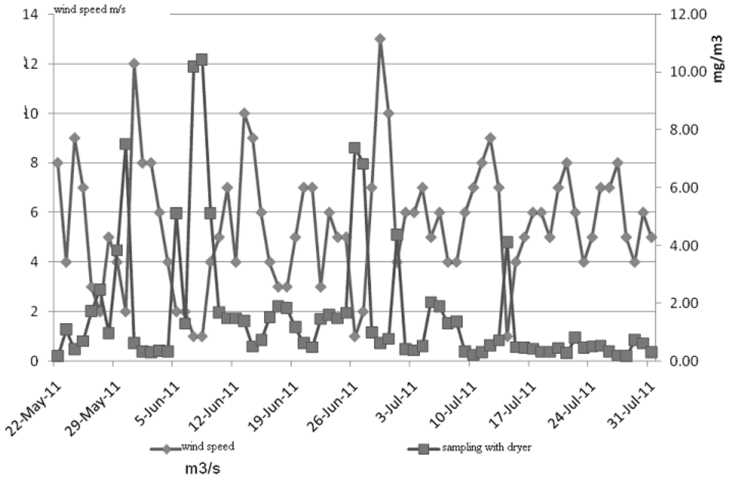

Figure 7 - Comparison between wind speed and aldehydes concentrations measured

REFERENCES

[1] Badaluţa-Minda C., Creţu Gh., 2010, Bazele gospodaririi apelor, Orizonture Universitare, 2010, Timisoara

[2] Brown V. M., Crump D. R., Gavin M. A., Gardiner D., Aldehydes in the Non-Industrial Indoor Environment, Royal Society of Chemistry, Spec. Publ. 108, 1994, pp 357-365

[3] Garcia J. P., Beyne-Masclet S., Mouvier G., Masclet P., Emissions of Volatile Organic Compounds by Coal-Fired Power Stations, Atmos. Environ. 26 A, 1992, pp 1589-1597

[4] Götze H.-J., Harke S., Determination of Aldehydes and Ketones in Natural Gas Combustion in the ppb-Range by High Performance Liquid Chromatography, Fres. J. Anal. Chem. 335, 1989, pp 286-288

[5] Maunz M., Büttner H., Particle Collection by Small Cyclones as Function of Flow Rate, Geometric Dimensions and Particle Size, J. Aerosol Sci. 25, 1994, pp. 457-458

[6] Pfann O, Cretu Gh., Economic crisis of Romania, new chance to relate pollution of surface water to contaminator, Buletinul Sciintific, 2010, Romania

[7] Pfann O, Badaluta Minda C., Cretu Gh., A new environmental sampling instrument for volatile organic compounds, Journal of Environmental protection and Ecology, vol.13. no.4, 2012

[8] Pfann O., Denuders as a sampling tool for Volatile Organic Compounds, SGEM, International Multidisciplinary Scientific Geoconference, 2011, pp 1193-1199

THE PROBLEMS OF ESTIMATION AND PRESERVATION OF NATURAL LANDSCAPES IN THE RUSSIAN FEDERATION

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ABSTRACT

In the progressive accumulation of environmental issues the preservation of the unique natural landscape reflecting and supporting the richness and diversity of life on the planet is becoming especially important. The landscapes of Russia on the most part of its territory have lost their natural harmony and beauty as a result of human activity. The natural landscapes of Russia must be considered as overall natural and cultural heritage of the country, as national capital, supposed to be an object of special state policy and public attention and support based on the strict scientific foundation. For effective management of landscapes condition some tasks in economic, management, law and scientific fields are proposed to solve.

Keywords: landscape valuation, landscape protection, nature reserve, biodiversity

INTRODUCTION

The landscapes of Russia on the most part of its territory have lost their natural harmony and beauty as a result of human activity. Meanwhile harmonic landscape and beautiful scenery have a positive emotional, psychological and biochemical impact on the human whereas destroyed and deformed landscape oppress and depress human causing the feeling of unbalance and vexation.

Irrational and overly intensive exploitation of natural ecosystems and bioresources during the industrial and agricultural activities result in their depletion and destruction, that attach not only scientific but also social and economic significance to the ecological balance preservation. The conception of environmentally sustainable economic development is based on the principle of ecological balance that means the use of the components of biodiversity in the way and at the rate that do not lead to its depletion in the longer term; the necessity of the implementation of scientifically grounded technologies of restoration of ecosystems, destroyed due to human activity.

The publication of the first Red Book of International Union for the Protection of Nature in 1963 was a reaction of scientists and the public to the accelerating loss of particular species and whole biological systems. After this publication state regulatory enactments related to threatened species conservation were prepared in many countries. For example, The Endangered Species Act of 1973 in the USA, The Wildlife and Countryside Act of 1981 in Great Britain, The Threatened Species Conservation Act of 1995 in Australia. These documents describe the mechanisms of conservation and restoration of endangered species, communities and landscapes in detail. The interests of landholders are taken into account, when it is possible.

Although in the Russian Federation regulatory enactments on biodiversity conservation and the Red Book of the Russian Federation were passed it seems that conservation of endangered species biodiversity is not related to significant goals of the state. It does not correspond to the world practice where state plays the leading part in the organisation of such activity [4].

PROBLEMS OF LANDSCAPES PRESERVATION

In the progressive accumulation of environmental issues the preservation of the unique natural landscape reflecting and supporting the richness and diversity of life on the planet is becoming especially important. The solution to this problem is possible based on knowledge of the fundamental laws of the genesis and evolution of landscapes, as well as their roles and functions in the modern development of the Earth.

Regional Red Books do not so much solve the global problem of biodiversity, as the task of maintaining the diversity of local natural systems, so the Red Books often contain species widely distributed outside the region. Species with different categories of rarity are equally protected in the regions. There are no special preferences for species with higher status or species from the Red Book of the Russian Federation, there are no special measures for their protection. Under conditions of shortage of population dynamics data the status of rarity in the regions are set entirely subjective. They rarely reflect the real level of threat to the species and do not contribute to the development of priority measures to conserve the species.

Threatened species serve as good markers of valuable habitats, communities and landscapes. The Red Books, solving particular problems for the conservation of particular species, provide an implementation of complex of environmental problems of a single territory as a whole. However, it requires cooperation of many departments, the implementation of multi-stage procedures and finance.

For a scientific forecast of environmental changes in the future, assessing the impact of various forms of human activities on natural systems and methods for finding the most rational use of natural resources the reserves acquire exceptional significance. As models of natural ecosystems, they require a comprehensive study. There is an obvious necessity to have standards of all major ecosystems, improve and expand the network of reserved areas.

In the list of World Heritage of Russia there are over 500 objects today. At the I International Conference on "Natural Heritage of Russia: the study, monitoring and protection" it was recognized that many of Russia's natural attractions of world and national values are at various stages of degradation and even under the threat of extinction. This situation is explained by the fact that, firstly, Russia lacks its own category of the natural heritage, as there is no the status of "national natural heritage" itself, and secondly, Russia has still not adopted the Law on the national landscape, thirdly, Russia does not have a specialized state-legal, scientific, public organisation responsible for the development of the network of national and world natural heritage objects [2].

Tishkov, A. [6] believes that the restoration of black soil in establishing the benign use of agro-landscape mode is an effective means of stabilizing global carbon balance and, consequently, climate.

PROBLEMS OF ASSESSMENT OF LANDSCAPE COMPONENTS

Natural landscapes of Russia must be considered as overall natural and cultural heritage of the country, as national capital supposed to be an object of certain public policy, as well as public attention and support, based on rigorous scientific foundations.

The main economic challenge for biodiversity conservation in global understanding is a justification for the costs that society must carry out without hope to obtain economic returns in the foreseeable period, i.e. costs to prevent loss of biodiversity. At the same time in the economic literature attention is being increasingly focused on another issue - economic evaluation of biodiversity and biological resources. The study of methods of such assessment developed by various authors leads to the conclusion that these methods are more suitable for evaluation of biological resources rather than biodiversity, as in most cases they have no accounting of system effect, derived from the existence of entire ecosystems [5].

Individual components of natural landscapes can be assessed on the basis of existing approaches to determining the economic value of natural resources and facilities that provide a specific estimate, based on: the total economic value, cost, rent, point scoring, regulations, market assessments, indirect assessments, alternative value.

Table 1: Natural features and services included in the total economic value [1]

Categories:	The cost of the direct use		The cost of indirect use	The cost of the delayed alternative (potential value)	The cost of non-use (existence value)
	Recoverable kinds of use	Unrecoverable kinds of use			
General	Means of subsistence, commercial use, medication, recreation, habitat	Recreation, education, research, transport	Material cycles, climate regulation, watershed protection, sanitary function	Potential direct and indirect types of use in the future	Ethical, cultural, inheritance, heritage
Ecosystems (e.g. wetlands)	Fuel, water biological resources, agro-ecosystems	Birdwatching, water sports, amateur fishing	Flood control, coastal protection, the protection of winter quarters of birds, etc.	Opportunity to obtain goods and services in the future	Monitoring of migratory species, protection by restricting access for outsiders
Species (e.g. tree species)	Wood, fuel, fruit, fodder, medicines, building materials,	Selection work, pharmaceutical, chemical and biochemical	Accumulation of carbon, nitrogen fixation, protection	Renewable forest resources and services in the	Protection of forests as places of rest, for ritual

	industrial raw materials	research	against erosion, habitat for animals	future	purposes, etc.
Genetic diversity (e.g., cultivars species)	Food	Plant breeding	Evolutionary value	Prospects of varietal improvement	Protection of the gene pool

From the perspective of a complexity of an approach to the nature estimation and try to take into account not only its direct resource function, but also the assimilation functions, natural services, the most promising is the concept of total economic value.

Klinkova G. [4] offered to account 10 indicators divided into 3 blocks for determining the calculated conservation status. "A" Block of indicators allows evaluating the level of threats to gene pool species that depends on the size of the range, type of activity in its different parts, loads associated with the use, as reflected in the conservation status of species throughout its range.

"B" Block of indicators describes the likelihood of a loss of regional populations, taking into account the number of known populations of species in the region, the proportion of populations that are preserved in protected areas of the region, and the prevalence of specific habitats, set according to the trends of numerosity change.

"C" Block of indicators defines the possibility of maintaining and restoring damaged populations, describing the methods of reproduction and duration of the regenerative period.

Providing services on visiting the unique and beautiful landscapes is a significant portion of the income of travel companies. Taking into account these revenues it is also possible to calculate the economic value of landscapes. The development of ecological and landscape tourism has a positive effect on economic development of regions in which natural objects are recognized as global or national heritage.

RECOMMENDATIONS FOR THE MANAGEMENT OF LANDSCAPES

The management of landscapes means a system of measures aimed at safeguarding the quality of the landscape, the restoration of its qualities and development. A system of such measures includes:

• research into the components of the landscape, their inventory and monitoring;

• regulation and control of various actors that have an impact on the landscape, including legal support and organization of the protection;

• verbal and graphic simulation of the initial and the desired state of landscapes, the calculation of anthropogenic stress;

• action planning to maintain or change the qualitative parameters of landscapes;

• developing concepts, strategies, projects, programs, plans, schemes, including their logistical, financial and staffing support;

• implementation of initiatives put forward by management and the achievement of goals.

For the effective management of the landscape it is necessary to solve several problems in the economic, managerial, legal and scientific spheres.

Economic problems are connected with the inclusion of landscape diversity in the country's macroeconomic indicators, calculation of the potential economic gains from biodiversity, including direct (medicine, raw materials for breeding and pharmaceutics, etc.) and indirect (ecological tourism), as well as it is necessary to consider the costs of reinstatement of destroyed biodiversity.

Management objectives are to develop cooperation by engaging in joint activities of government and commercial agencies, local communities and public organizations in order to preserve the natural landscapes.

Legal problems are related to the inclusion of definitions and concepts affecting the conservation of landscapes and biodiversity into all appropriate legislative rules, the establishment of legal support for biodiversity conservation.

Research tasks include formalizing procedures for decision-making regarding the conservation of landscapes, the search for indicators of biodiversity, determining the degree of degradation of landscapes, inventorying of biodiversity, monitoring.

The problem of applying spatial data in Volgograd region remains unsettled meriting better attention to ensure creation and development of regional GIS of landscape-ecological and social-economical content. The goals to be realized are: establishing in GIS bases of spatial landscape-ecological and social-economical data; composing new thematic electronic maps; forming a system of integrated indices of social-economical development with landscape-ecological peculiarities taken into consideration. In order to do this, one faces the need to first create a model structured base of spatial data which might help reflect natural-resource and social-economical potential of the territory in thematic electronic maps and attributive GIS tables [3].

It is necessary to use a Land and Resource Management Plan (LRMP), which represents a strategic multi-disciplinary, integrating resource plan, based on the principle of publicity, accounting of value of all resources, compliance the taken decisions with sustainable development.

It is proposed to establish a Commission to develop and implement a new strategy for the conservation of the natural heritage. As the main directions of the strategy the following ones can be offered: modernization of the territorial organization of the network of nature reserves, optimization of the regimes of the use of natural resources and protected land development of the natural heritage, improving and expanding the functional challenges faced by protected areas, introduction of new forms of protected reserves, ecological restoration of standards of zonal landscapes, the integration of natural heritage in the socio-economic development of regions, using the experience and traditions of the local population and taking into account their interests [2].

CONCLUSION

It is necessary to create mechanisms that provide access to the received information for most of the general public and all interested persons, agencies, organizations, management structures, including the using of modern geoinformation technology. It is necessary to make environmental education a part of education programs, as well as to increase the level of environmental education for graduates from all educational institutions by establishing appropriate divisions, departments and training centers.

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REFERENCES

[1] Bobylev S.N., Medvedeva O.E., Sidorenko V.N., Solovyeva S.V., Stotsenko A.V., Zhushev A.V. Economic Assessment of Biodiversity, Moscow, 1999.

[2] Chibilev A.A. The Beautiful is Useful, or Why to Preserve Natural Heritage, Science of Ural, Russia, 2005, N 26-27.

[3] Kirillov S., Plyakin A., Kanischev S., Kholodenko A., Ryabinina N. Integration of landscape-ecological and geoinformational approaches to administration of specially protected natural territories, Bulgaria, SGEM 2011, vol. 2.

[4] Klinkova G.Yu. The Red Book of Plants: How to Provide Effective Preservation of Threatened Species and Communities, Specially Protected Natural Areas of the Lower Volga as the Most Important Mechanism of Biodiversity Preservation: Results, Problems and Prospects, Volgograd, 2010.

[5] Ryumina Ye.V., Karachevtsev I.L. Specificity of Biodiversity Conservation Problems at Territorial and Temporal Aspects, Environmental Economics, Russia, 2005, N 1.

[6] Tishkov A.A. Ten Priorities of the Russian Steppes Biodiversity Conservation, Steppe Bulletin, Russia, 2003, N 14.

THE RECENT TRENDS AND PERSPECTIVES FOR FINAL REFUSING OF THE HAZARDOUS WASTE IN THE REPUBLIC OF MACEDONIA

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ABSTRACT

As a result of the developments of industrial production and increased consumption with produced hazardous waste, although in the last two to three decades technological processes has been reported, the amounts of hazardous waste has been significantly increased, which is a worrying problem for today's civilization. The current state of treatment of waste can qualify as irregular and chaotic. This unfavorable situation is result to lack of a system for integrated management of the waste in the municipalities.

Key words: industry, modern approach, reduction, recycling of waste.

INTRODUCTION

Major problems and constraints in the field of waste management in Macedonia are present in almost all areas of the existing system of waste management, as in all relationships in society concerning waste management, legal framework, organization of institutions and human resources, coverage of costs and financing of services and investment, awareness of stakeholders and informing them of all phases of technical management from collection to disposal of waste, the existence of environmental burdens, the impacts on human health and the environment environment with potential impact on the Macedonian economy.

Hazardous waste generated by the Macedonian mining and manufacturing industries encountered serious problems: odlagalishtata waste from certain processes are abandoned, there is little or no information about the history of odlagalishtata waste and environmental consequences, the legal legacy in terms the same is unclear.

Development of the Republic of Macedonia towards sustainable waste management will require further harmonization of domestic legislation with the EU, institutional changes and large changes in the general practice of waste management. Successful changes in waste management can initiate government by setting specific strategic goals and practice of modern waste management, taking into account existing damage to the environment and the use of its legislative and regulatory power, but ultimate success in practice can be achieved only if all representatives of society understand the relationship between improper waste management and negative effects on the environment and human health, if you become aware of their responsibilities, duties and tasks in the field of waste management if they are motivated organizational and even more with economic measures.

Waste definition and classification-genesis of solid waste associated with the earliest period of human activities. Solid waste is a direct product of human existence, whether he lives alone or in community (rural or urban). The process of urbanization and industrialization affect the rising problem of collection and disposal of solid waste. Therefore this problem is an important and complex tasks within the communal activities.

The adequate solution of this task depends on human health and environmental protection. Population growth, urbanization and industrialization lead to an increase in the amount of waste. Besides the quantitative change, comes to the qualitative change of solid waste. All this gives rise to the surface that are disposed waste. The increase of solid waste represents one of the important issues of our time and from environmental, sanitary and epidemiological, technological, urban, hydrological, construction, energy and others. Under the solid waste means waste generated as a result of everyday human life and work, and waste generated on open surfaces. Solid waste represents a complex heterogeneous material, which under normal conditions is hard. It may be of natural origin such as leaves, snow, fallen branches etc.. [1], [2]

The basic composition of solid waste can be: organic, with rapid period of decay (food, animals, waste vegetable oil); waste (organic or inorganic, which have a long period of delay). Depending on the place of creation and the properties of the waste, the waste can be classified into the following categories: Municipal solid waste is waste generated in daily life ie housing, dvornite, business premises and land (waste from households, waste food, vegetable, fruit and other crops, paper towels, scrap wood, plastic, rubber, metal and other waste).

This waste can be further classified in several ways. The usual classification is in the following categories: Food waste, paper, glass and ceramics, metals, plastics, rubber and leather, textiles, stones and ashes, garden waste technological (industrial) waste is waste that results from production processes in industry and in institutions, and its abundance of composition and properties differ from municipal wastes. There is little similarity in the type of waste is thrown out of different industries. Forecasting the quantity of industrial waste is harder to predict than municipal wastes. Mining waste which is produced by extractive operations, ie operations that are involved in the processing of mineral raw materials are one of the largest generators of hazardous waste. Improper disposal of mining waste pose a major threat to the environment and man.

Hazardous waste is waste containing substances that have one of these properties: explosiveness, reactivity, flammability, irritability, toxicity, infectivity, carcinogenicity, mutagenicity, teratogenicity, Ecotoxicity and the properties of discharges of toxic gases through a chemical reaction or biological decomposition.

It is important to emphasize that hazardous waste in agriculture and livestock is present and has a negative impact on the environment. Hazardous waste is the use of online resources for plant protection products for protection of livestock, as well as infectious hazardous waste through the dead and infected animals. In current practice (especially in our country) often waste deposited in landfills that do not meet standards for a landfill. Given these reasons are more tries before depositing waste should be: Preventers i.e. reduction / minimization of waste; Reuse, recycling / composting; Utilization of energy contained in waste by combustion; Disposal. The purpose of this procedure is to eliminate and neutralize the amount of waste that will be deposited and will be able to separate hazardous waste from utilities.

Summary and evaluation of the current state of waste management in Macedonia

The current state of waste management in Macedonia can be characterized as substandard in terms of the financial and human resources, and insufficient and ineffective in terms of monitoring and enforcement of regulations prescribed, resulting in a variety of dysfunctional systems in society and many related adverse effects on the environment and human health. That level of environmental awareness and waste problem in Macedonia is low, in fact people are not aware of the problems resulting from improper management of waste and the negative effects on their health and the environment and nature. People have no awareness of their own responsibility and role as generators of waste. On the other hand, public attitudes may be manifested in strong opposition to any permanent changes in the practice of waste management, such views are relying on management and real concerns, as well as insufficient information and lack of practice for public access information about the importance of properly treating the waste.

The current legislation regarding waste based on the concept of hierarchy in waste management. This means ideally waste should be prevented, while that which can not be prevented should be re-used, recovered or recycled as little as possible because it is the worst option for the environmental implication of loss of resources. Hierarchy of waste management should be viewed as hard and quickly accessible accessible goal, especially when having in mind that there are different methods of waste treatment that have different impacts on the environment of waste treatment and different impacts on the environment. However the goal of moving towards recycling and recovery of waste represents a move towards hirarhijata in waste management and reduced use of landfills.

Prevention of waste generation should take place initially, because reducing waste means reducing the need for its collection and treatment which is correlated with cost and environmental impact. Prevention of waste in terms of use of tangible goods, services in such a way that their production, use, reuse, recycling will result in the least possible waste production. Prevention of excessive waste production is just one part of the concept of cleaner production, which is promoted by the United Nations Environment Programme.

Most of the municipal solid waste and other collected waste is deposited without pretreatment of municipal landfills such as old tires, car batteries, oil-based automotive components and other wastes. Landfills are working without work permits, without any techniques that apply to landfills and no regular monitoring in terms of environmental impact. There is no record of delivered waste, not carried out any visual inspection of the characteristics of waste to be deposited. Deposition of mixed hazardous and hazardous waste and incineration of municipal waste, waste plastics plant tissues and the open space, represent the most serious risks and consequences for the environment. One third of the existing 51 landfills are classified in the class with the highest risk assessment of their risk in terms of environment and their closure or remediation is a priority. [7], [8], [9]

Hazardous waste generated by the Macedonian mining and manufacturing industries encountered serious problems, odlagalishtata waste from certain processes are abandoned, there is little or no information about the history of odlagalishtata waste and environmental consequences, the legal legacy in terms the same is unclear. Sixteen major industrial areas and dump the waste is identified as "hot spots" based on the identified environmental impacts and the high potential of danger. In both situations, this is done with little or no involvement and supervision by authorized veterinarians, mainly in an uncontrolled way and far from the required sanitary standards. Packaging contaminated with pesticides and other agrochemical waste characteristic are disposed together with municipal waste and open burning, where the remains of pesticide solutions usually discharged into the aquatic environment. Development towards sustainable waste management will require further harmonization of domestic legislation with EU policies [5], [6], changes in institutional organization and major changes in the general practice management. Successful changes in waste management can initiate government by setting specific strategic goals and practice of modern waste management [10], [11], taking into account existing damage to the environment and the use of its legislative and regulatory power, but ultimate success in practice can be achieved only if all representatives of society understand the relationship between improper waste management and negative effects on the environment and human health, if you become aware of their responsibilities, duties and tasks in the field of waste management if they are motivated organizational and even more with economic measures. [3], [4]

Incineration of waste with energy recovery is another option for avoiding landfills. [12], [13] Deposition of waste in landfills is the lowest possible option in waste management, but still the most dominant method used here. Landfills in our country often improperly managed and do not meet minimum standards. A challenge is to reach certain standards in building the landfill be closed and inadequately managed and maintained sites. Accurate and timely data on waste is one of the key elements for long-term prevention of illegal places of disposal of waste. Inadequate information can lead to inappropriate decisions regarding the legislation on waste and the establishment of an inadequate infrastructure for waste management. Municipalities are generally responsible for organizing sisitem effective management of solid waste on their territories, except for hazardous waste, which under legislation is the responsibility of the state. Public enterprises providing utilities (mainly in urban areas), which consist of solid waste, or collect, transport and disposal at the expense of municipalities. The system of waste management must introduce landfills for hazardous and non-hazardous waste and other facilities for waste removal, fully harmonized with European standards. Data on the quantity produced Hazardous Waste in Macedonia Quantities of waste generated are estimated based on data from the State Statistical Office in 2004 and the analysis within the study of waste management in southwestern Macedonia made in the same period. Although this study presents indicators for the creation of waste solely in the southwestern region of Macedonia, according to the analysis made in the quantities of MEPP waste generated in other parts of the country, they are compatible with the results of the study, and fully applicable to the entire territory. Based on these results, defined is equal to the production of municipal waste per capita in the Republic of Macedonia, which is: 0.7 kg / day for urban areas (which comprises 60% of the total population);0.5 kg / day for rural areas (where live 40% of the total population).

Figure 1. Municipal landfills in the Republic of Macedonia
Picture first Municipal landfill

In other words, the annual production of municipal waste in Macedonia izneuva 470.00 tons, 322.00 tons of which are disposed in municipal landfills, and 148.00 tons in rural areas near the settlements. Figure 1 is marked municipal landfills. Data on hazardous waste does not exist except for medical waste, while the generation of waste oils is estimated at 3859 tons per year, and will create conditions for treating the same in Macedonia. It has 101 more health institutions, mainly hospitals and specialized health institutions of secondary and tertiary health care centers and primary health care. The total number of hospital beds at tertiary and secondary level, including private hospitals is around 10 000. In addition there are private and 745 dental clinics and 117 veterinary clinics and veterinary stations. The number of pharmacies is 498 and has 54 laboratories. Medical waste is produced in the Republic of Macedonia has no organizational system for the management and collection, with the exception of the capital Skopje, where there is no organized system of collection, transportation and incineration of medical waste.Inceleratorot the landfill is located Drisla. For the purposes of medical institutions in the City of Skopje, in accordance with decision of the Ministry of Health of Drisla performs collection and disposal of medical waste, or its processing. Ministry of Health prepared a plan for treatment of medical waste in two stages, namely the City of Skopje and other cities.For now only be collected from Skopje. In the treatment of this type include selection as is done in health care organizations, picking and transport to landfill and incineration furnace. According to the landfill monitor work, medical waste combustion for the period 2000-2006 period is presented in table 1.

Table 1. Incinirated Medical waste for 2000-2006 year

Incinerated medical waste (kg)	2000	2001	2002	2003	2004	2005	2006
	114.90	231.900	248.600	255.060	322.670	375.648	327.006

The amount of solid medical waste is produced annually in hospitals and other medical institutions in Macedonia are estimated at 1625 tonnes, of which about 380 tons per year represents a solid medical waste, which Skopje is only about 114 tons. Estimates for the total medical waste (solid and liquid) from zdrastvenite institutions in the Republic of Macedonia amounted to 2178 is 2004.

Figure 2. Incinerator-Drisla

Table 2. Evaluation on quantities create medical waste in Republic Macedonia

Assessment of quantities produced medical waste in Republic of Macedonia for 2004 year							
Infective		Potentiality toxic		Toxic		Corrosive	
Solid/kg	Liquid /l	Solid/kg	Liquid/l	Solid/kg	Liquid /l	Solid/kg	Liquid /l
Skopje							
114.000	45.000	387.000	66.870		38.890		635
Macedonia total							
380.000	150.000	1.290.000	222.900		129.630		2.120
Drugs -solid phase (tablets, capsules, etc.).(kg)				Drugs liquid phase (infusions, solutions, tc.).(kg)			
2500				2000			

Table 3. Collected and burned quantities of solid medical wastes in the interval 2000-2003

Collected and burned quantities of solid medical wastes in the interval 2000-2003 year				
Year	2000	2001	2002	2003
Quantity kg	114.900	231.190	248.600	255.000

Table 4. Data on hazardous waste generated in the Republic of Macedonia in 2005 year

Type of waste	Total waste/year	Hazardous waste (tons/year)	Hazardous Waste (tons / year)	(%)
Waste from mining	17.246.000	12.700.00	4.546.000	26
Waste from thermal processes	2.090.726	2.015.379	75.347	3.6
Waste from other processing indu stries	108.877	106.830	2.047	1.9
Total	19.446.603	14.822.209	4.623.394	24

CONCLUSION

Development of the Republic of Macedonia towards sustainable waste management will require further harmonization of domestic legislation with the EU, institutional changes and large changes in the general practice of waste management. Successful changes in waste management can initiate government by setting specific strategic goals and practice of modern waste management, taking into account existing damage to the environment and the use of its legislative and regulatory power, but ultimate success in practice can be achieved only if all representatives of society understand the relationship between improper waste management and negative effects on the environment and human health, if you become aware of their responsibilities, duties and tasks in the field of waste management.[8], [13]

REFERENCES

[1] Alan E. Kehju: Geology for Engineers and environmental experts.
[2] Bernd G. Lotermozer: mine-waste characteristics, treatment, and ecological consequences.
[3] Annual amount of waste generated by industry in 2008 in Macedonia.
[4] Annual report of the processed data on environmental quality in 2007.
[5] EUROSTAT:
http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=ten00109
[6] EEA-European Environment Agency:
www.eea.europa.eu/soer/countries/it/soertopic_view?topic=waste
[7] European commission environmental:
http://ec.europa.eu/environment/index_en.htm
[8] European commission environmental-Directorate-General Environment: Costs for Municipal waste management in the EU.
[9] European commission environmental: Hazardous waste generation in EEA member countries.
[10] European commission-Directorate-General Environment: Thematic Strategy on the prevention and recycling of waste, 2005th
[11] EU focuses of waste management.
[12] The incineration of waste in Europe: issues and perspectives.
[13] European-waste-management-waste-policy-and-legislation.

THE TOURISM AS RISK IN THE LARGE LANDSCAPE PROTECTED AREAS AND OPPORTUNITY AS ACTIVE OF CONSERVATION AND SUSTAINABLE REGIONAL DEVELOPMENT

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ABSTRACT

The list of risk, which stems from uncoordinated travel and tourism in the territory of large protected areas are very extensive. On the other hand, the public accepts the fact relatively few well-informed citizens and visitors and those who provide services in tourism, and their ability to contribute to the active nature conservation. By extension, and above all, directly and indirectly to sustainable development of protected areas. This paper provides a case study of the issue in the context of its solutions in the Czech Republic.

Keywords: tourism, sustaineble development, nature conservation, Czech Republic

INTRODUCTION

The list of potential risks that may be related to mass, no matter how rough or environmental tourism and tourism in the territory of large protected areas, is what the hypothetical list of very rich and varied.

On the other hand, in the end of that list of negative effects - if they were actually and demonstrably it is always only a very brief list of negative impacts. For example, reduction in size, as well as the number of individuals protected by this or that kind of introduction or invasion of alien species, the accumulation of contaminants, especially in terms of visitor's rubbish, etc.. [1] [8]

Not always, however, they can all be major consequences above the main "negative" changes only be attributed to the presence of larger or smaller number of visitors. For along with their possible and demonstrably provable negative influences acting on the nature of the area are many other factors that you can not put the blame alone visitors. It is not only gradual climate change, but also our efforts to fully independent and locally instable migration trends of individual species. At the same time it would be disingenuous not to allow false and that its share of responsibility for the many side effects and trends against the subject or completely wrong and the actual management activities absentujícím conservation. The results of nearly twenty years as a systematic collection of both of these and related findings can be more than amply documented everything. And not only that. Simultaneously with this also think about what to do, therefore, that the relations between professional conservationists and local residents were better than those for the last two decades in the Giant Mountains National Park was developed.

KRNAP – KPN these are the official abbreviations of both national parks that together cover an area of about 425 km^2 (KRNAP 370 and KPN 55). In 1986 the buffer zone of an additional 184 km^2 of area around the Park of the Krkonoše Mts. was declared. The Administrations of both national parks with their seats in Vrchlabí and Jelenia Góra-Sobieszów were authorized to take over the responsibility for the fate of the wildlife and landscape in the Krkonoše Mts.

Unfortunately, even the strictest and highest statute of landscape conservation - the national park - has not preserved the Krkonoše Mts. from adverse civilization pressure during the last 30 years and more. Their oustanding natural attractiveness, easy accessibility and good facilities for tourism and recreation have been reflected in a great number of visitors coming to this small range of mountains. Annually over 10 million people pass through the combined Czech and Polish sides of the Krkonoše Mts. Thus they belong to group a of the most visited national parks in the world (to their relatively small area). For this they unfortunately pay a cruel tax. The high number of their visitors and the unmastered conception of tourism have left their fatal trails on the sensitive ecosystems; - trampled paths and earth erosion, damaged flora, tons of collecting waste products of all kinds, noise and emissions of transport means, excess of buildings and building sites and the damage of the traditional local color of the mountain landscape.

Tourism, together with the whole European problem of the last few decades - industrial emissions (the consequence of which the whole areas of the Krkonoše forests have been wasting and dying since the end of the 1970s) are two limiting factors for the survival of the Krkonoše Mts. in the future. Due to the extremely big danger to the natural substance of the mountains themselves the Krkonoše Mts. were registered in the list of the most endangered national parks of the world.

Despite the present quite unpleasing condition of the Krkonoše Mts. and of the serious socioeconomical problems of this mountain region, or even possibly therefore, they seem to be extraordinary suitable to become an example of how to solve the problem of conservation in a national park which has found itself at the breaking point of an ecologic disaster. The Krkonoše Mts. have a very good international reputation. Their recent classification in the world network of about 300 UNESCO Biosphere Reserves (1992), and the big interest of some international institutions in helping to preserve the Krkonoše Mts. (e.g. the project of the Netherland foundation FACE for the preservation and restoration of the Krkonoše forests, the World Bank project for the preservation of the biodiversity of the Krkonoše Mts. and others) are clear evidence of this reputation.

In spite of the existing problems with excesses of visitors in the Krkonoše Mts. it is evident that tourism is the only one potential source of prosperity for the local inhabitants who have been permanently living in the area of the national park or in its closest neighborhood. Well planned tourism can become the source of possible jobs for the local residents, can stimulate the local economy, foreign exchange, the improvement of the recreation facilities, and it can give life to regional cultural traditions. Thus the conditions for stimulating the interest of local people, autonomies and authorities to join the conservation of the wildlife and landscape of the national park are ripe for exploitation because only a preserved nature is a guarantee of prosperity for this region. The existence of the national park should become an advantage in economic development for local inhabitants rather than an obstacle. A lot of foreign national parks, for example Bavarian Forest NP, are evidence of the fact that such relations can be developed and that they work.The national park is then a real source for lasting useful development across an even broader region. Of course, this hinges upon the condition that we would solve the essential problem of where the limit is between a sustainable or a destructive development. Furthermore, we need to assess the carrying capacity of this very sensitive mountain area and work out a realistic management plan of permanently sustainable tourism. The Administrations of both national parks have been co-working intensively on this problem for the existence of the Krkonoše Mts.

Care of the Krkonoše National Park Administration is responsible for the Giant Mountains National Park in Vrchlabí. During his nearly 50 years of history has undergone numerous changes in the concept of work and organizational structure.

Since 1991, the state managed by the Ministry of Environment. The protection of nature are interconnected by four unions present organizational structure KRNAP. All professional and managementové activities that care for the Giant Mountains National Park requires competence in direct care of the Department of National Park.

His staff including:

• provide any scientific basis for territorial and species protection of all components of nature and landscape Giant

• carry out or mediate practical care for non-forest ecosystems and forest Giant

• organize or participate directly in research and monitoring of all components of the natural environment Giant and publish findings in professional and scientific press,

• provide the necessary information and support of other unions KRNAP,

• participate in any activities that result from national and international obligations ME (international conventions, Natura 2000, EUROPARC Federation, IUCN and others). [9]

Just from this description it is clear that in addition to the state administration, which focused on all building and planning activities in the national park and its buffer zone, the competence of the National Park Mountains, as well as other administrations of national parks in the Czech Republic significantly larger than other administrations of national parks in the European Union. This is confirmed by other powers of the National Park Mountains, such as: evaluation of all activities under § 45i of Act No. 114/1992 Coll. On nature and landscape protection as amended, in connection with the terms of the protection of important bird areas habitats and Natura the 2000th In addition, the state administration regarding felling and care for trees growing outside the forest, except for species protection under § 56, which concerns the assessment of exemptions from the prohibitions of protected trees and protected species, particularly plants, animals and minerals. She also giving consent to the entrance to the national park, organizing public events, scientific and research activities, protection of protected trees, waste management, including the protection of forest and agricultural land.

It is therefore not work as well as activities in the national park and its buffer zone to the staff of the National Park had not commented to him, or in its entirely and often internal or personal opinions, interpretations and ideas beyond the generally accepted standards but nevyhodnocovali laws. These and other similar approaches, or from the administration of the national park generates about in many cases the authorities, as well as representatives of local authorities who are responsible for the operation and life of local people in very difficult situations. Because, unlike local authorities here in the national park, as well as higher regional administrative bodies in charge at the cities and municipalities that have environmentally friendly development directly in terms of their activities, management of national parks do not have this responsibility. Therefore, to find consensus on the solution of many problems in the individual and historically built by man or otherwise of the territory is very demanding and time-consuming problem in particular. Despite the last few years, access to top management of national parks in these issues to a positive change, because everything is not as it might be. Missing especially helpful by nature protection of individual workers, or even their whole and hardly defined teams, who are active supporters of particular "orthodox" and now entirely unreasonable approach to nature conservation and landscape, which survives from the period before 1989, when protection nature and the landscape was perceived more as a "partisan or other illegal" activity, and when any step obstacle, challenge and rightfully criticized against investment plans have been welcomed as an appropriate defense. Today is the legal status of nature and landscape protection, as well as environmental protection in the Czech Republic not one of societal priorities, including the foremost concern of the vast majority of civil society yet, as if in the way of thinking for many employees of the state of nature and landscape has not changed. Beyond here and there - the case of a case are purposefully formulate arguments why this or that can, without accepting themselves not only earlier published results of scientific research activities that their fears or doubts, including practical experience, refute, or deliberately not accept a very specific and for this to formulate legal provisions.

Another local residents and often criticized approach is to conceal the purpose of historical experience, building works or other similar evidence of life and land use in this area. An even bigger embarrassment and misunderstanding fully justified in such a small territory, which Giant Mountains National Park is an occasional act different approach to similar intentions of individual investors. As if the great and powerful capital investors should be more demanding with their investment objectives considerate approach to the protection of nature and landscape for investors and their intentions smaller. In same cases arouse embarrassment and lack of post-project analysis, which could legitimately forced by large investors in the national park to comply with all conditions set out previously mentioned in connection with the issuance of building permits.

Fig. 1 – *Nardus stricta L.*

CONCLUSIONS

Not only among experts causes considerable embarrassment to scrupulous protection of solid mat-grass *(Nardus stricta L.* – see Fig. 1), which is typical and dominant, as well as a very strong kind of competitive mountain grasslands and shallow soils indicates poor. [7] In terms of the Giant Mountains National Park is found on more than 35 to 45% of the total area of mountain meadows and pastures without current conditions in the not so passive - extensive management of these lands, which were originally for its diversity of one of the main incentives for the protection of the publication Giant Mountains National Park and unlike the ever-expanding areas of forest and meadow vegetation at the expense of enclaves, was actually an endangered species. At the same time with regard to its "protected status" fundamentally in this case again are purposefully limits the development potential of the protection zone of the Giant Mountains National Park, including urban areas by municipalities. For example, the zoning plan of Pec pod Sněžkou and many other cities and municipalities in the National Park. Words, workers territorially relevant building authorities: "There's a new Conservation Zone I in the protected zone of the national park." [4]

Experienced by professional representatives of municipalities, which are its administrative territory, or part thereof included in the Giant Mountains National Park and also on the recommendation of the National Park administration is associated to the union of municipalities and rural micro-regions individually or through the land into a large towns Volume Mountains and villages, is regularly heard criticism that, for the National Park is through their efforts and many years based on current scientific knowledge and research developed concept (development) tourism.[1][2][3] This should not only analyze objectively - update previously collected data, but also objectively determine realistic and environmentally friendly development potential in the national park. Reluctance to take this step by the administration of the national park is quite evident. Just as well as sounded by the administration of the National Park protests at the incorporation of results from previous tasks of science and research in strategic development programs for individual cities and towns, as well as their ties to the national park. Specifically, reducing the negative impact of large point sources of emissions during the years 1986 to 1998 the National Park, or reducing air pollution loads along the main road routes through the demonstrable increase in traffic intensity[2][3]. Which was very specific consequence of the overall modernization of the fleet. Not otherwise it was the publication of such research results in relation to the development of methodologies for determining the ecological carrying capacity, stability and vulnerability of forest biome in relation to different types of activities on the forest biome Giant Mountains National Park, including forestry, traffic loads, hiking up to the downhill skiing and many other findings, such as starting materials for the determination of objective and environmentally sound development potential of the area.[5] [6]

If they could soon eliminate these problems would certainly be the essence of protection by the Giant Mountains National Park has suffered. Conversely, administration of the national park would not only gained more respect, but also significantly greater understanding in defining its terms of individual development plans in order to protect nature and landscape. At present, however, not surprising 'jealous' views and attitudes over the conditions of nature and landscape protection in Germany, Austria and other EU states, which also have very different competencies defined administrations of national parks.

Fig. 2 - The average annual concentration of SO_2 in the Eastern Giant

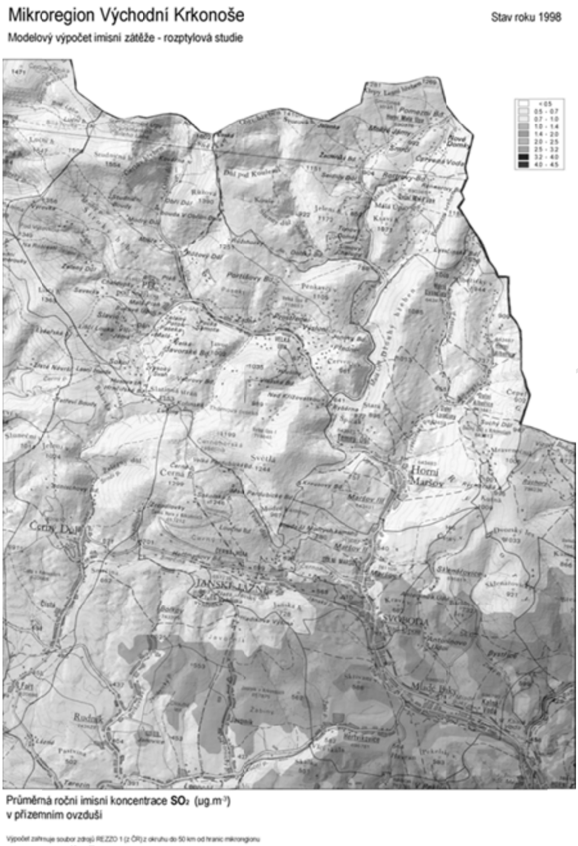

Fig. 3 - Set of forest types of Eastern Giant

Fig. 4 - The minimum short-term NO_2 concentrations in the main section of the Eastern Transport Giant

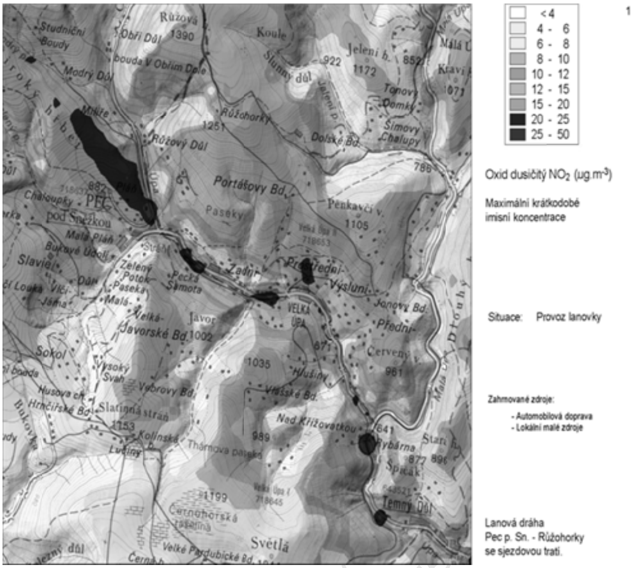

Fig. 5 - The vulnerability of forest ecosystems

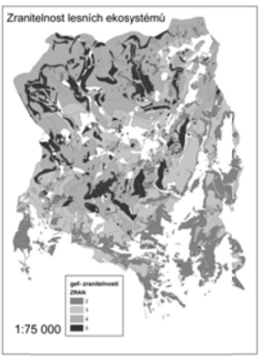

Fig. 6 - Resistance of forest biome for downhill skiing

Fig. 7 - Resistance of forest biome for forest management

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REFERENCES

[1] Houdek K. el al. VaV-SM/2/62/04 - "Proposal for management of environmentally sound tourism Biosphere reservation Giant CR", CZE, 2004-2006.
[2] Houdek K. el al. Strategic Programme for the Development of rural micro - volume of towns and villages Eastern Mountains - K. Houdek et al. (2001/2004)
[3] Houdek K. el al. Strategic development programs of cities and municipalities of Pec pod Sněžkou (1998) Mala Upa (2004); Svoboda nad Upou – CZE, 2005.
[4] Houdek K. el al. SEA - evaluation of the proposed amendment to land use plans of cities and towns over Upou Freedom (2010) and Zacler, CZE, 2011.
[5] Houdek K. el al. EIA - notification / documentation of construction of the cableway to Snezka, including slopes Růžohorky - Pec pod Sněžkou – CZE, 2001/2003.
[6] Houdek K. el al. EIA - Draft notification-technical snow slopes tailings - Velka Upa – CZE, 2011.
[7] Houdek K. el al. The results of sociological surveysincluding the systematic collection of data from available data servers, Bachelor's and Master's theses available only from the database KRNAP, but also awarded in the Faculty of Environment of the Czech Agricultural University Prague, CZE,1998 – 2010.
[8] Institute of Applied Ecology CULS Prague Program - GRF Project - Protection of biodiversity Biosphere reservation Giant, CZE,1994-1997.
[9] www.krnap.cz

THE TREATMENT OF MEDICAL WASTE – TECHNOLOGIES, LOCATION AND ORIGIN

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ABSTRACT

The medical waste categorization belongs to the group of hazardous waste. The management and the treatment in most cases are invalid. The resolving of these wastes should be effectively and economically and requires special functional systems or scenario. It's a challenge for the countries in the development, similar to our country. The establishment of the system like the integrated management of medical wastes has occurred and looked for clear information and education for people. Also, there is the demand for proper treatment and handling, together with necessary to strengthen the local legislation in terms of its complete implementation.

Keywords: medical waste, incineration, autoclave

INTRODUCTION

Medical waste may be generated in: hospitals, clinics, surgical, dental hospitals, veterinary centers, larger farms, factories with dangerous machinery and processes, sporting clubs, barracks, police stations, universities, research centers that work with animals or pharmaceutical means and factories that produce medical materials. In R. Macedonia there is no special way of collection and disposal of medical waste. Currently, the exploitation are only two furnaces for the incineration of medical waste in: Military Hospital in Skopje Municipality Karpos with a capacity of 140 tons / year in Drisla with a capacity of 1400 tons / year. The remaining medical waste in Macedonia are delayed along with other waste.

Types of Medical Waste

There are few types of medical waste as following: Human blood and bloods products; Cultures and stocks of infectious agents; Pathological waste; Sharps; Glassware; Contaminated equipment etc. Human bloods and blood products are classified and managed as medical waste because of the possible presence of infectious agents that cause blood-borne disease. Wasters of this category include bulk blood and blood products as well as smaller quantities of blood samples drawn for testing or research.[1],[2] Cultures and stocks of human infectious agents, regardless of storage method, must be managed as medical waste. Animal pathological wastes are the medical wastes if the animal has been intentionally exposed to a human infections agent it is capable of transmitting the disease back to a human. All types of hypodermic needles and syringes, intervenous needles and tubing, scalpel blades, lances and other such devices are regulated as medical waste. All sharps must be placed in an approved sharps container. Glassware includes pipettes, capillary tubes, test tubes, stir rods, and other laboratory equipment. Broken glassware should be placed into a container designed for such materials and either recycled or disposed. Contaminated equipment includes any equipment not mentioned above which may come into contact with human infectious agents.[3]

The sharps container must be red in color and display the International Biohazard Symbol or one of the following phrases: Medical waste; Infectious: Infectious waste or Biohazardous. Since sharps must be rendered non-recognizable prior to disposal all sharps are shipped off-site to an approved medical waste treatment facility on a weekly basis.

Medical waste incineration or Autoclave waste treatment

The reality is that incinerators don't eliminate toxic substances, they concentrate them, saying for this one toxics in/toxics out. The heavy metals, mercury, lead and cadmium, don't just disappear, they are basic elements not destroyed by burning and are still present after incineration, only concentrated in the ash and released to the air from the stack. Of all the trash that enters the incinerator, 30% remains as ash at the end of the process. Here, there is a great deal of toxic ash which is easy to see. Another primary hazard with incineration is the toxic chemicals in the emissions leaving the stack. According to the EPA, medical waste is the third leading source of dioxin and forth leading source of mercury emissions in USA.

Autoclaves used for the treatment of medical waste must be operated in accordance with medical waste regulations. Steam sterilizers have to be equipped to continuously monitor and record temperature and pressure during the entire length of each cycle. These ones not so equipped shall have affixed a temperature sensitive tape to each bag or container of medical waste. Each one shall be exposed to a minimum temperature of 250 degrees Fahrenheit and at least 15 pounds of pressure for 30 minutes. Each sterilizer shall be evaluated for effectiveness under full loading by an approved method at least once for each 40 hours of combined operation. A written log or other means of documentation shall be maintained for each steam sterilization unit and shall contain the following: The date, time, and operator for each cycle; Approximate weight or volume of medical waste treated during each cycle; The temperature and pressure maintained during each cycle; Method utilized for confirmation of temperature and pressure, and Dates and results of calibration and maintenance. Sterilizers utilized for waste treatment shall not be utilized for sterilization of equipment, food or other related items.[4]

Most regulated medical waste can be treated effectively with an autoclave. But questions are they harmfull? Every medical waste treatment system releases pollutants to the environment and autoclaves are no exception. Autoclaves differ from most other medical waste treatment systems for two reasons: ***New pollutants are not formed in the process*** *(due to lower operating temperatures),* ***No toxic or reactive chemicals are used in the treatment process.***

That means that ***pollutants released from autoclaving are the same ones that enter the autoclave in the medical waste.*** This is the fundamental reason why proper waste segregation – particularly to avoid placing hazardous or radioactive materials in red bags is essential to safe autoclave operation.[5]

Domestic scenarios for medical waste treatment

The analysis made in lot of investigations for the medical waste in our country will show three possible scenarios for autoclave waste treatment, but scenario 3 (decentralized system with autoclaves) generally is most acceptable decision for establishing of new management system for medical waste by the national level. Shortly, the analysis results have showed following points:

- The management system of the medical waste will functioned with establishing of three autoclaves; one of them in Skopje (larger one) will cover the Skopje area, north-western and north-eastern part of the country located in the Clinical centre, one of them in Bitola (smaller one) in the General Hospital which will cover the south and south-western part of the country, and finally the one of them in Stip (smaller one) which will cover central, south-eastern and south part of Macedonia.
- Installed capacity of the proposed system is 1200 tons/year which is bigger for 30% than medical waste quantity in the moment. This margin or limit will ensure system functionality in the future, specially in the cases of the increased quantity of the medical waste.
- Projected/proposed system is financial sustainable and the level of the taxis will not be significantly higher. The maintenance of the collection will be on the high level (100%).

The users satisfaction is a key element for the system success and professionally and system efficiency will ensure benefit and confidence from the system. The finance of the system model has to be carefully choose, contemporary seeing the possibility of the grants or self-financing mixtures. The aim of the economic analysis is to identify the project on the macroeconomic level impact. These projects from the field of the Environment and Hazardous Waste Management, the socio-economic analysis have to view the questions for the type of:

- The decreased costs of health services;
- The decreased route of illness and death resulting to the increased hygiene and sanitation conditions;
- The acquisitions of the decreased pollution/damage of the soil, underground water and land.

The new investments of the objects for medical waste treatment in the Republic of Macedonia will lead to positive aspects which will improve the environment quality and the people health. The modernization will contribute for the better life with suspension of the health risks according to the potential infectious waste. The proposed system of the medical waste management will have local economic acquisitions. Generally, the projects from this sector promote local development ensuring direct services for the operation activities and their aim is to satisfy more spread needs of the local inhabitants. On the other hand, improvement of the environmental standards will ensure systematical and final decision for medical waste treatment. The disposed treated waste on the disposal (nonhazardous medical waste after autoclave treatment) at the usual disposal for the municipality waste will not be future danger for the environment. The general improvement of the health and sanitation conditions with the new medical waste management will decrease the risk of spreading infections.

Figure 1. The view of possible production of medical waste

Figure 2. Scenario 1 & 2 for medical waste treatment

Figure 3. Scenario 3 for medical waste treatment

CONCLUSION

The analysis made in lot of investigations for the medical waste in our country will show three possible scenarios for autoclave waste treatment, but scenario 3 (decentralized system with autoclaves) generally is most acceptable decision for establishing of new management system for medical waste by the national level. The new investments of the objects for medical waste treatment in the Republic of Macedonia will lead to positive aspects which will improve the environment quality and the people health. The modernization will contribute for the better life with suspension of the health risks according to the potential infectious waste. The proposed system of the medical waste management will have local economic acquisitions.

REFERENCES

[1] Public Health Report (1996), Hospitals and Plastics: Dioxin Prevention and Medical Waste Incinerators, Vol. 3, July/August, 1996

[2] Elliot P. et all. (1996), Cancer incidence near municipal solid waste incinerators in Great Britain, British Journal of Cancer, 73(5): 702-10

[3] Stewart-Pinkham SM., (1998), The effect of ambient cadmium air pollution on the hair mineral content of children, The Science of the TE, 78:289-96

[4] Takata T. (2003), Survey on the health effects of chronic exposure to dioxins and its accumulation on workers of a municipal solid waste incinerators, IH, 41(3):189-96

[5] EPA – <u>http://www.epa.gov/glnpo/</u>...........

UTILIZATION OF THE CHAUVENET STATISTICAL TEST IN ENVIRONMENTAL RESEARCHES RESPECTIVELY BIOGEOCHEMICAL PROSPECTION FOR ESTABLISHMENT OF FUND VALUE, THRESHOLD VALUE AND ANOMALOUS VALUES

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ABSTRACT

In Romania, one of the most frequent methods used to determine the biogeochemical fund and threshold, without using complicated equations, is the method proposed by Buracu and by Hawkes. One of the problems that occur when using this method is that, due to the high variability of a population, in the case of an environment research and of prospecting works, respectively, induced, in our case, by the variation of the physical-chemical parameters of the soils and parental rocks, the standard discrepancy of the statistic population increases very much, and the abnormal statistics remain below the threshold values [3] [4].

Keywords: naturally contaminated areas, anomalous values, biogeochemical fund, biogeochemical threshold, Chauvenet test, corelation coefficients, intensity of the halos, intensity contrast.

INTRODUCTION

The aim of the present thesis is to study new methods in order to establish the fund values respectively pedogeochemical and biogeochemical threshold and the starting-point is offered by Buracu and Hawkes method, thus we did not use more modern methods which are difficult to manage. In this matter we used a less known statistical test the „Chauvenet test", which we tried to adapt into the pedogeochemical respectively biogeochemical research. Thus we made a pedogeochemical and biogeochemical test in the metaliferous district of Bălan (Eastern Carpathians).

The biogeochemical research was done on *Vaccinium myrtillus*. We have to mention that the test was undertaken in the known mineralized areas (naturally contaminated), where we had precise information about the position and dept of mineral lens.

It was interesting the fact that even the individual analyses of the tests showed high values of heavy metals, using the above mentioned methods we did not observe anomalous values despite of the fact that the physiological changes as nechroses and chloroses suggested the existence of considerable quantity of heavy metals in the absorbtion area especially in case of the juvenile plants. In this condition through the utilisation and adaption of the statistical criterion Chauvenet for this type of research the results were more than satisfying, meaning that anomalous values are following mineralized areas and are perfectly corelated with the physiological changes respectively with the nechroses which appear on the leafs.

Material and Methods

As we mentioned before, for starting-point to determine fund values respectively threshold values, we used two simple, frequently utilised methods, which can be easily applyed without complicated calculations.

Thus for the fund value we used the value of the grouped data of the aritmetical value of population, while the biogeochemical threshold was determined according the following formula:

$$Pr1 = Fb1 + 3s$$

where: Pr1 – represents the threshold value

Fb1 – fund value

3s – estimator for standard deviation of population.

Through the establishment of the fund and threshold values we can also establish other parameters which refer to the pedogeochemical respectively biogeochemical halos; such an indicator is the intensity of the halos utilised especially to appreciate the importance of mineralisation which is reflected [5]. This indicator is shown by the anomalous values situated between the pedogeochemical threshold and maximal concentration; namely the aritmetic average of the values which characterise each halo individually [5]. In case of an acidic environment the halos are of low intensity duet o the relatively homogenous values on the whole ore-reserve, while in slight dispersion conditions their intensity increases [5].

An other parameter is the contrast – esentially for the conturation of the secondary dispersion halos, this represents the relation between the halos intensity and fund concentration [2] or biogeochemical threshold [1], being a value indicator which size is proportional with the halos intensity.

The secondary dispersion halos can be analysed through the quality differencial distribution of the chemical elements, in realtion with their mobility in the geochemical conditions of the studied area and with results which appear by approaching the mineralising sources of the soil. The zonality represents one of the most important parameters of the secondary dispersion halos with direct implications in their interpretation and utilisation in order to identify the mineralisation sources [6]. The secondary dispersion halos can present three zonality types: axial, transversal and longitudinal [1]. The axial zonality appears in the direction of mineralised solutions and coincides with the vertical direction of the ores with significant inclination or horizontal for the ores with low inclination. The transversal zonality is reflected by the distribution of the elements from the halos perpendicular on the mineralisation sources. Having in view that the determination of the biogeochemical fund and threshold through the Buracu method did not evidence anomalous values due to the intense dispersion of the values which determined a high standard deviation, we decided to introduced the Chauvenet test – in case of this the minimal and maximal value of the biogeochemical samples presents an anomalous value in the following condition:

$$|X_i - X_m| > Z * \sigma \text{ [8]}$$

where, X_m – represents the aritmetic average of the data population,

σ – standard deviation of the experimental values,

Z – is a tabeled value,

For ex. for n = 16, Z = 2.14. The value Z can be determined also by calculations, using the following ecuation [8]:

$$Z = \frac{0.435 - 0.862 * a}{1 - 3.604 * a + 3.213 * a^2}$$

$$a = \frac{2 * n - 1}{4 * n}$$

The excesive values in this case are not eliminated from the population data, on the contrary they represent the anomalous values utilised for the establishment of pedogeochemical respectively biogeochemical halos; these are practically those values for which is not verified the above presented condition.

The value is registered as anomalous value and for the rest of the data is recalculated the standard deviation and the average. For the remaining values is verified again the condition until this is no more verified (the tested values are ranged in increasing order and the testing is started at the higest value*)*; the first tested normal value in decreasing order represents the biogeochemical threshold. All the samples which register bigger values represent anomalous values. The fund value through Chauvenet method is represented by the average of the samples situated under the Chauvenet threshold value.

We present below the chemical analyses on *Vaccinium myrtillus* collected in the metaliferous district of Bălan *(tab. 1*).

Table 1 Content of the heavy metals in the plants existing in metaliferous district of Bălan (ppm) [7]

No crit.	Plant	Cu	Mn	Ni	Pb	Zn
1	myrtillus	109	200	5	4	95
2		225	160	7	32	110
3		330	178	12	45	73
4		96	355	4	3	63
5		96	240	9	10	90
6		21	98	4	8	65
7		21	105	2	6	74
8		240	200	4	29	75
9		24	90	10	15	54
10		15	345	5	3	65
11		6	220	9	5	98
12		335	340	13	38	90
13		102	400	8	26	68
14		9	130	6	2	55
15		8	280	10	8	60
16		2	318	14	12	75

Establishing the biogeochemical threshold and fund values in case of the analysed elements we can observe the decreasing of the fund and threshold values *(tab. 2) (fig. 1)* through the utilisation of Chauvenet method, which evidenced anomalous values for all analysed elements except Mn and Zn.

Table 2 Recorrected fund and threshold values for the analysed plants (ppm)

element/parameter	Zn	Mn	Ni	Pb	Cu
Element fund	77,187	241,125	8,250	17,125	111,375
Biogeochemical threshold	211,428	684,546	69,844	57,413	390,880
Chauvenet biogeochemical threshold	75.000	400	14	8	109
Chauvenet biogeochemical fund	69,769	241,125	8,250	4,875	42.417

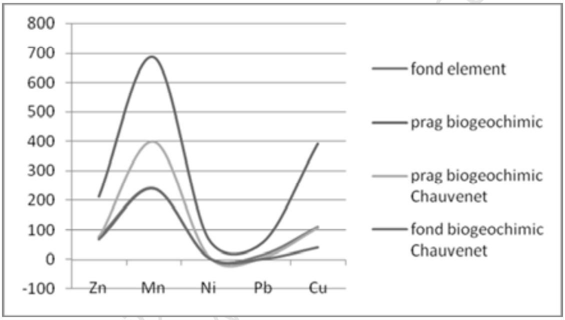

Figure 1 Variation of the biogeochemical threshold value of the analysed elements in the plants existing in metaliferous district of Bălan, of thenormal threshold and fund values through the Chauvenet method

Watching the map of the mineralised areas respectively the biogeochemical halos of the anomalous samples we can observe their coexistence in the mineralised areas (fig. 2).

From the analysed elements we choose as example the Zn, which in Bãlan ore-reserve is associated with Cu, forming a galenic chalcopyrite paragenesis, but the sizes are much smaller comparatively with the chalcopyrite; in this way the Pb and Zn content represents an indirect indicator of CU mineralisation.

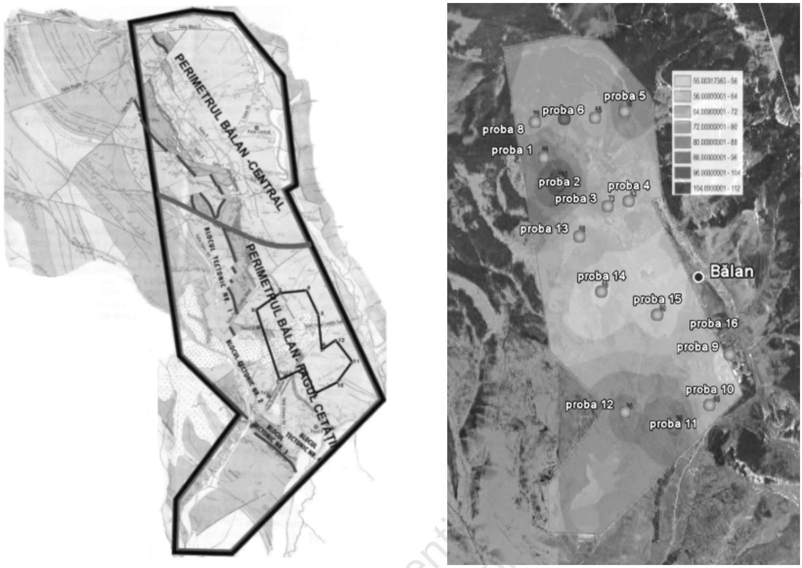

Figure 2 thematic map regarding Zn distribution in plants in metaliferous district of Bălan and in mineralised areas

Conclusions

The Chauvenet method utilised on plants existing in the mineralised areas of metaliferous district of Bălan (Eastern Carpathians), Romania evidenced anomalous values in case of all elements (Cu, Pb, Zn) through direct and indirect indicators of copper mineralisation.

The biogeochemical halos of the anomalous samples follow the ore-lens in the studie darea, fact which certifies the viability of the purposed method.

The determined anomalous samples are coexisting in the areas where can be observed physiologic changes or necrosis of the plants due to the heavy metals concentration in the soil.

Through this method we succeed to reduce the values of the biogeochemical fund and threshold comparatively with the classic methods, without utilising the values of the standard deviations in case of the analysed elements population. Though the reducement of these values the intensity and the intensity contrast of the halos reflect more precisely the characteristic and importance of a mineralised or contaminated area respectively of a polluted area.

REFERENCES

[1]. Buracu, O. (1978) – Prospecţiunea geochimică a zăcămintelor de minereuri. Ed. Tehnică.

[2]. Hawkes E Herbert and Webb, J. S. Geochemistry in mineral exploration: New York, Harper and Row 1962.

[3]. Szép, R,. – Aspecte biogeochimice în zona fagul Oltului (extinderea nordică a zăcământului Bălan) – primul simpozion al studenților geologi - București – 2000

[4]. Szép, R,. - Aspecte biogeochimice asupra mineralizției din extinderea nordică a perimetrului minier Bălan. Lucrare de Licentă – 2001

[5]. Szép, R, Crăciun G,. Considerații biogeochimice în zona Bălan Central (Carpații Orientali) - al II-lea simpozion al studenților geologi - Cluj Napoca; secțiunea Petrologie, Mineralogie, Geologie ambientală – 2001

[6]. Szép, R – Biogeochimia zonei Bălan – Simpozionul Mircea Savul Al. I. Cuza Iași – 2003

[7]. Szép, R**.** Arad, V. Arad, S. Borboly, Cs. **–** Determination of the fond values and of the biochemical threshold determined on spontaneous flora from Bălan metteliferous district. 15th Conference on Environment and Mineral Processing - Part II - 8.-10.6.2011 VSB-TU OSTRAVA Czech Republic, Page 272-282, ISBN 978-80-248-2388-1 – 2011.

[8]. ***http://www.labsmn.pub.ro/academic/undergraduate/MS/Lab/1%20Statistica/Exemplu%20Chauvenet.htm

THE YIELD OF BIOGAS AND METHANE FROM ANAEROBIC DIGESTION OF MIXED WASTE OF FRUIT AND VEGETABLES FOR DISTRIBUTION TO SUPERMARKETS

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ABSTRACT

The article presents the results of laboratory test anaerobic digestion of biological waste generated from the distribution of fruit and vegetables to supermarkets. Biological waste with an average dry matter content of 9.1% wt., loss on ignition of 91.9% wt. and value pH of 3.8 was supplied by Hortim International, Ltd. Co. Test measurement of biogas production and methane was carried out in constantly stirred tank reactor with a capacity of 0.06 m^3 for 70 days at an average load of 0.865 $kg_{VS}.m^{-3}.d^{-1}$ and hydraulic retention time of 100 days. Measured specific biogas production was 0.083 $m_N^3.kg^{-1}$ and specific methane production 0.537 $m_N^3.kg_{VS}^{-1}$ (expressed due to the weight unit of dry matter loss on ignition at 550°C). The average methane content in biogas was 53% vol. Biological wastes from fruit and vegetables are very valuable substrate for suspension anaerobic digestion. The test result was used in the design of new mobile technology of high-solid anaerobic fermentation in silage bag.

Keywords: anaerobic digestion, methane, biogas, biowaste, fruit, vegetables

1. INTRODUCTION

Anaerobic digestion is one of the best methods for processing biological waste mainly from agriculture and food industries. In practice, it proved to dozens of different technologies for wet anaerobic digestion and the last time a variety of technology of high-solids digestion. Most of these technologies are designed for biogas on a large scale.

For those interested in production of biogas on a smaller scale isn´t yet on the market many technologies. For this reason, VSB-TU Ostrava in cooperation with Cernin Ltd. Co. [1] develops the technology of mobile potentially low-cost biogas plant suitable for low- and high-solid digestion. The core of technology is developed fermenter consisting mainly of silage bags.

A lot of tests were performed on specific production of biogas and methane of various potentially treatable substrates with solids above and below 10%. This paper presents the results of laboratory test of biological waste from sorting of fruits and vegetables before the distribution to retail networks.

In the literature it is possible to trace a series of works dealing with mesophilic single-stage anaerobic digestion of different mixtures of fruit and vegetable waste or biological waste generated during their processing. For example Bouallagui, H. et al. [2] in the review indicate that wastes of this type have solids content usually 8 to 18%, while loss on ignition of solids are commonly 86 to 92%$_{TS}$. They point out that the main problem of single-stage digestion is too fast acidification or noticeable accumulation of lower fatty acids. Garcia-Peña, E.I. et al. [3] measured the production of biogas averaged 0.420 $m_N^3.kg_{VS}^{-1}$ in single-stage batch digestion. In contrast, Lin, J. et al. [4] measured the production of methane 0.420 $m_N^3.kg_{VS}^{-1}$ in a single-stage constantly stirred fermenter at 35 ° C and relatively high load 3.0 $kg_{VS}.m^{-3}.d^{-1}$. It is obvious that the production of biogas can vary greatly depending on the specific composition of the biowaste. Callaghan, F.J. et al. [5] at co-fermentation of fruits and vegetables with beef manure (and poultry manure) achieved the production of methane to 0.450 $m_N^3.kg_{VS}^{-1}$ by load digester 3.2 $kg_{VS}.m^{-3}.d^{-1}$. Viswanath, P. et al. [6] achieved the production of biogas to 0.600 $m_N^3.kg_{VS}^{-1}$ in single-stage mesophilic digestion of fruit and vegetable, the hydraulic residence time was very short (20 days) and very high load (40 $kg_{TS}.m^{-3}.d^{-1}$). Authors generally confirm that the anaerobic degradability of fruit and vegetables is good, with the semi-continuous digestion is most of yield of methane reached up to 12 hours after dosing to the digester.

2. MATERIALS AND METHODS

2.1. Laboratory model

The test of semi-continuous low-solids anaerobic mesophilic digestion was performed in a cylindrical suspension model digester on a circular plan (diameter 400 mm, height 500 mm) provided with a continuously running low-speed scoop-stirrer (24 min^{-1}) for sufficient homogenization of reactive substances in the whole volume. The reaction volume of anaerobic digester was 0.06 m^3. The model was complemented with a drum gas meter Ritter TG05 for recording daily production of biogas and two electric heaters for keeping the fermentation temperature of 40 ± 3 ° C. The composition of biogas was measured by a portable analyzer GeoTech BIOGAS every working day and verified at the gas chromatograph Agilent every week. The model is illustrated in Figure 1.

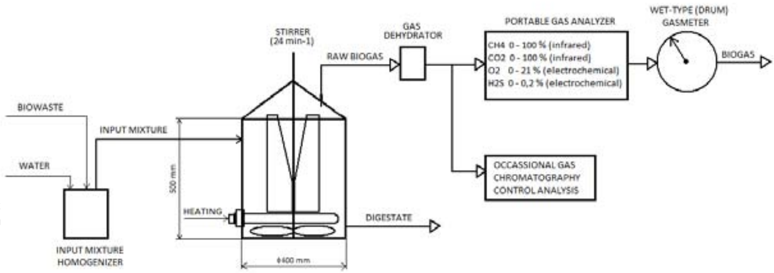

Figure 1: Laboratory physical model

2.2. Feedstock

The biological waste generated from sorting fruits and vegetables before the distribution to retail networks (supermarkets, hypermarkets) was tested. The biological waste was delivered by Hortim International, Ltd. Co. It is a mixture of commonly grown fruits and vegetables from the European Union (e.g.: apples, carrots, onions, cabbage, etc.)

with citrus fruits and bananas. Biowaste with content of solids average of 10 % wt. contains a minimum of anaerobic indecomposable substances. The materials was shredded of meat grinder to particles <10 mm due to the enforcement to the model reactor and stored without air for up to 7 days. After these days was prepared a new stock of materials. Figure 2 shows the biological waste in its original state and in a state after crushing.

Figure 2: Biowaste and its mechanical pre-treatment

As inoculum for the incorporation of the model was chosen liquid cow manure which was obtained from a dairy farm Zemspol Studenka, Inc. with an average total solids content of 8 % wt. and the average pH of 7.2. The cow manure wasn´t adjusted before the test, the large floating particles (corn stalks) were only removed. The parameters of the test substrate and inoculum are shown in Table 1.

Table 1: Parameters of the test substrate and inoculum

Substrate used	***Unit***	***Biowaste "HORTIM" (fruit and vegetable)***	***Cattle slurry (inoculum)***
Enterococci	KTJ/g of dry matter	$< 5.10^1$	$1{,}04.10^7$
Salmonella Sp.	-	negative	negative
Total number of microorganisms	KTJ/g in the original mass	$< 3{,}2.10^5$	$< 3.10^7$
Mesophilic microorganisms	KTJ/g in the original mass	$< 1{,}7.10^5$	$< 3{,}6.10^7$
Psychrophilic microorganisms	KTJ/g in the original mass	$< 8{,}7.10^4$	$< 3{,}1.10^7$
Thermophilic microorganisms	KTJ/g in the original mass	$< 5.10^3$	$< 9{,}6.10^6$
Arsenic	mg/kg of dry matter	< 0,50	< 0,50
Cadmium	mg/kg of dry matter	1,10	0,20
Chromium	mg/kg of dry matter	5,66	14,90
Copper	mg/kg of dry matter	17,60	411
Iron	mg/kg of dry matter	3360	-
Mercury	mg/kg of dry matter	0,008	0,022
Molybdenum	mg/kg of dry matter	< 0,50	2,61
Nickel	mg/kg of dry matter	5,04	7,43
Lead	mg/kg of dry matter	< 2,50	< 2,50
Zinc	mg/kg of dry matter	14,3	238
Calcium	g/kg of dry matter	4,86	24,1
Magnesium	g/kg of dry matter	1,59	7,47
Potassium	g/kg of dry matter	21,30	20,6
Phosphorus	g/kg of dry matter	1,80	6,25
Total solids (dry matter) 105 °C	%	10,70	8,17
Ignition loss 550 °C	% of dry matter	92,7	82,6
COD_{Cr}	mg/dm^3	95000	80000
Ammoniacal nitrogen	mg/kg of dry matter	3270	22900

Nitrogen nitrate	mg/kg of dry matter	253	632
Nitrogen total	% of dry matter	1,38	4,80
Total sulphur	g/kg of dry matter	1,36	3,24
Total organic carbon	% of dry matter	40,80	40,2
Total carbon	% of dry matter	40,80	40,9
Lactic acid	mg/kg in the original mass	< 100	< 100
Acetic acid	mg/kg in the original mass	842	< 100
Acid propionic	mg/kg in the original mass	< 100	< 100
Acid butyric	mg/kg in the original mass	< 100	< 100
Fat	% of dry matter	2,08	2,14
Carbohydrates	% in the original mass	4,48	1,85
Fiber	% of dry matter	12,86	17,20
Starch	% of dry matter	1,58	7,05

Note: these are the results of one sample of the material

2.3. Anaerobic digestion test

The model reactor was first filled with inoculum and then was heated at mesophilic temperature of 40±3 °C and was kept for 12 days without dosing. The easily degradable substances were consumed and the anaerobic biomass was stabilized. The production of biogas has decreased to minimum. Then the model was incorporated in semi-continuous regime with daily dosing of 1 dm^3 liquid cow manure for 60 days (excluding weekends and public holidays). Before dosing of digestate was always discharged for maintain the reaction volume of 0.06 m^3.

After incorporation of digester with beef manure have been taken to verify the specific production of biogas and methane from a mixture of fruit and vegetables. At the beginning the load was chosen of 0.6 $kg_{VS}.m^{-3}.d^{-1}$ and it was gradually increased up to 1 $kg_{VS}.m^{-3}.d^{-1}$. The average load of the test was 0.865 $kg_{VS}.m^{-3}.d^{-1}$ for 70 days and the theoretical hydraulic residence time was 100 days. Daily was recorded average temperature of fermentation, the production of biogas, morning methane contents, pH, total solids and dry matter loss on ignition at 550 °C in a mixture of input and digestate. Daily average methane content in biogas was calculated as approximately 0.9x morning measured value of CH_4 (accuracy coefficient was verified during the 24-hour measurements). After the finished test was calculated value of average specific production of biogas and methane.

3. RESULTS AND DISCUSSION

From the results of analysis of samples of biological waste is clear that this is a suitable material for classical suspension fermentation (9 to 11% wt. solids). The solids are largely composed of mono- and oligosaccharides and, the content of fiber probably doesn't exceed 15% solids.

The following Figure 5 shows a production of biogas and methane content in it. After 70 days of test of fermentative digestion at an average temperature of 39 ° C, the average reaction pH of 8.2, an average load of organic substances 0.865 $kg_{VS}.m^{-3}.d^{-1}$ and hydraulic retention time of 100 days was measured the specific production of biogas 0.083 $m_N^3.kg^{-1}$ or specific production of methane 0.537 $m_N^3.kg_{VS}^{-1}$ (expressed as a weight unit of dry matter loss on ignition at 550 °C). The average methane content in biogas was 53% vol. The measured production of methane is somewhat higher than production commonly referred to in the literature (see introduction). It is, however, given the terms of one-stage test that was conducted at low loads.

The results of test of low-solids anaerobic digestion confirmed the suitability of the tested biowaste for production of biogas. Currently the high-solids co-fermentation of these biowaste with other substrates in the digester model which is made of silage bag is tested.

Table 2: The test results of specific production of biogas and methane

Parameters of daily input mixture dosage				***Parameters of digestate***		***Production of biogas and methane***			
Organic loading	pH	TS	VS_{TS}	TS	VS_{TS}	B	B_{VS}	M	M_{VS}
$kg_{VS}.m^{-3}.d^{-1}$	-	% wt.	% wt.	% wt.		$m_N^3.kg^{-1}$	$m_N^3.kg_{VS}^{-1}$	$m_N^3.kg^{-1}$	$m_N^3.kg_{VS}^{-1}$
0,865	3,8	9,1	91,9	5,1	51,0	0,083	0,985	0,045	0,537

Note: semi-continuous anaerobic test was carried out for 70 days, TS=total solids, VS_{TS}=organic solids, B=specific production of biogas, Bvs*=specific production of biogas, M=specific production of CH_4, Mvs*=specific production of CH_4, *expressed as a weight unit of dry matter loss on ignition at 550 °C*

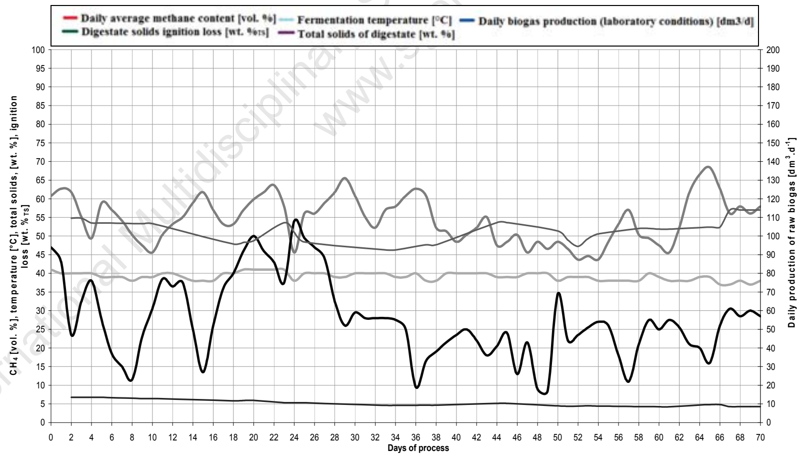

Figure 3: Graphic record of model test

4. CONCLUSIONS

The aim of this paper was to acquaint the public with the results of laboratory test of specific production of biogas and methane from biowaste generated in sorting fruit and vegetables before the distribution to supermarkets and hypermarkets. It was verified that biological waste has only a small proportion of anaerobic indecomposable substances in solids and substrate is very valuable especially for low-solids suspension anaerobic digestion. The result of test was used in the design of new mobile technology for a high-solids anaerobic fermentation in silage bag.

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REFERENCES

[1] Obroučka, K., Rusín J., Odborná zpráva o průběhu prací a dosažených výsledcích projektu v programu TAČR ALFA: Research project supported by the Technology Agency of the Czech Republic, registration number is TA01020959 *"Výzkum procesu suché anaerobní digesce a realizace nového typu fermentačního zařízení pro zpracování zemědělských bioodpadů na bioplyn, s využitím plynotěsného vaku"*, 5.1.2012;

[2] Bouallagui, H., Touhami, Y., Ben Cheikh, R., Hamdi, M. Bioreactor performance in anaerobic digestion of fruit and vegetables wastes (Review), Process Biochemistry, Tunis, 2005, vol. 40, no. 3-4, pp. 989-995;

[3] Garcia-Peña, E.I., Parameswaran, P., Kang, D.W., Canul-Chan, M., Krajmalnik-Brown, R. Anaerobic digestion and co-digestion processes of vegetable and fruit residues: Process and microbial ecology, Bioresource Technology, Mexico, Unit States, 2011, vol. 102, no. 20, pp. 9447-9455;

[4] Lin, J., Zuo, J., Gan, L., Li, P., Liu, F., Wang, K., Chen, L., Gan, H. Effects of mixture ratio on anaerobic co-digestion with fruit and vegetable waste and food waste of China, Journal of Environmental Sciences, China, 2011, vol. 23, no. 8, pp. 1403-1408;

[5] Callaghan, F.J., Wase, D.A.J., Thayanithy, K., Forster, C.F. Continuous co-digestion of cattle slurry with fruit and vegetable wastes and chicken manure, Biomass and Bioenergy, United Kingdom, 2002, vol. 22, no. 1, pp. 71-77;

[6] Viswanath, P., Devi, S.S., Nand, K. Anaerobic digestion of fruit and vegetable processing wastes for biogas production, Bioresource Technology, India, 1992, vol. 40, no. 1, pp. 43-38.

DEVELOPMENT OF MUNICIPAL AND SOCIAL RESILIENCE UNDERSTANDING: STAKEHOLDER COMPLEMENTARY TRAINING ON COASTAL GOVERNANCE AND COMMUNICATION

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ABSTRACT

Environmental communication case studies in the Latvian local coastal governments have served as pilot research into the potential and possibilities afforded by the proposed four-dimensional (environmental information - environmental education - public participation - environmentally friendly behaviour) environmental communication model. This research has yielded positive results as to the model's practical applicability in environmental communication process initiation and facilitation, stimulation of target group/stakeholder self-activation for co-operation, dialogue and increased participation in building a complementary municipal and social resilience based sustainable local community. The integration of the proposed environmental communication model into municipal documents has been on-going already and shall be seen as a further achievement towards the effective application of this valuable instrument on the local level and possibly even beyond. In order to facilitate its full-fledged and comprehensive planning and implementation, environmental communication could be developed as a separate sector in environmental management.

Keywords: information, education, participation and behaviour based communication model, coastal communication, stakeholder collaboration, complementary training concepts and modules

INTRODUCTION

In the beginning we shall outline general approaches to the environmental communication as a concept and theory as well as to approach environmental communication research in Latvia, by introducing shortly our work to date on coastal governance and particularly on directly related coastal communication and so to provide background information on environmental/coastal communication in Latvia.

Environmental communication is an essential environmental governance instrument along with the legal, economic, planning, administrative and infrastructural instruments [1, 2, 4] in preventing environmental degradation, in ensuring sustainability and in achieving a change in **understanding, attitude and behaviour.** It is an efficient instrument in search for sustainable solutions and in environmental policy planning and implementation, and it has an enormous potential for targeting key environmental objectives as building environmental awareness, **sustainable lifestyles and environmental collaboration** [3, 4, 6, 10] among all parties involved as exactly we all are looking for in order to develop necessary advantages towards municipal and social resilience building and performing.

Environmental communication is first and foremost an interdisciplinary science as it stems and derives its theories from a number of different sciences, i.e., communication science, sociology, social psychology, cultural anthropology and others [6, 10]. When looking at the environmental communication approaches applied by key environmental communication scholars and research institutes in research and practice, theories and models in other sciences such as the ones mentioned above can often be found. Environmental communication experts, coming often as they do, from the field of communication, tend to focus on the specific sub-categories of environmental science such as environmental rhetoric and discourse, environmental mediation, environmental journalism, and campaigning [2, 3] rather than on communication as a complex system of elements interacting within a specific territory, e.g., a local municipality.

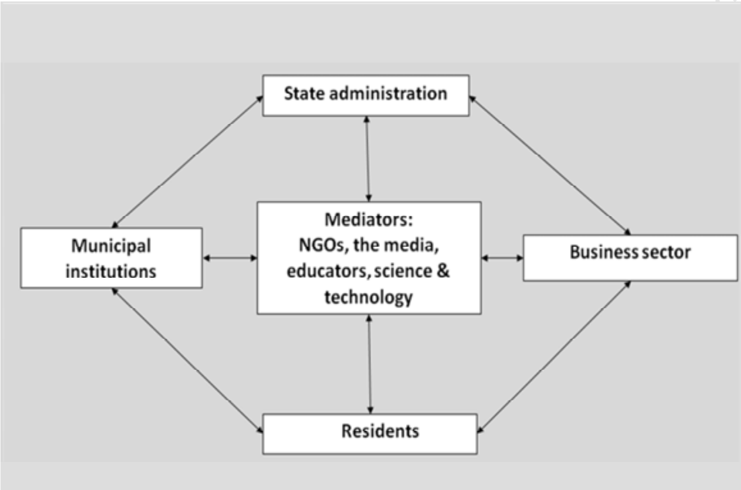
Risk communication, aiming to improve collective and individual decision making, helps better understand the risks and risk-related decisions for both decision makers and especially for all general public interest groups. This relates to all general thematic areas and also their interrelatedness in coastal risk and its communication, incl.: natural disaster threats; technogenic catastrophe threats; human health and social threats.

In search of a holistic, comprehensive and systemic approach towards environmental communication that would possess the greatest potential of achieving a change in understanding, attitude, motivation and behaviour on the way to sustainability, the Department of Environmental Management (DoEM) at the University of Latvia Faculty of Economics and Management came up with a new environmental communication model (**Collaboration Communication Model** – R. Ernsteins [4]), which has to this day already served not only as a basis for a number of environmental communication case studies, but also for formal planning in Latvian local governments (Cesis – 2005, Roja - 2007, Ventspils – 2009 and Liepaja - 2012 among others) carried out as co-operation projects between selected local governments and the Department (R&D projects & products [5-7]).

The developed model can be considered the most comprehensive systemic approach towards environmental communication as it pools into a coherent system all of the key elements (or dimensions) that form a joint communicative environment - **environmental information, environmental education, public participation and environmentally friendly behaviour** [4, 6, 11]. No such pooling has been offered by other communication models. Thus, it aims at illuminating the interaction of the four notions (often disengaged both in theory and municipal practice) and discarding the traditional information-focussed approach. The model also insists that the potential of the combined force of these four communication dimensions can only be utilised to the full extent through ensuring co-operation and partnership among all target (stakeholder) groups involved. Thus, this model is based on the imperative of two complementarities: the complementarity of the **four environmental communication dimensions**, and the complementarity of **all target groups** [11] working in partnership - local inhabitants, municipal and state institutions, business sector as well as mediators, NGOs and the media, educators and experts (see, Fig.1).

As in any other territory, the interests of nature and the social and economic interests of man often collide, and the more so in the coastal area with its ecological, cultural and historical specifics and appeal. In addition, there are often land and sea conflicts in the coastal area, and man is in the middle of this conflicting environment. Communication is the channel through which these conflicts can be resolved. Coastal communication for sustainable development can be defined as **starting from information exchange up to real collaboration among all actors and parties** with the aim of ensuring a balanced development of the three pillars of sustainable development – the social environment, the economic environment and the natural environment – in the coastal territory as a single area with systemically integrated [5, 7] characteristics.

Fig.1 Main stakeholders constellation (R.Ernsteins).



The situation assessment in the coastal municipalities was carried out not only in each of the three dimensions of sustainable development, but also and especially within fourth dimension - an additional separate dimension called the **governance environment [7-9]**, which is to be considered the unifying horizontal element encircling all the three SD pillars. Within the governance environment, both internal and external communication is including environmental/coastal communication, particularly essential.

Local governance planning and management is based on the key principles of quality management cycle, transforming it into the **4P environmental governance cycle model** [4, 7]: problem analysis (1P); policy definition (2P); policy planning (3P); programming (4P). The model contains the following key components: policy values and intentions, aim and principles, declaration; planning preconditions and resource basis; objectives, instruments and indicators; action programme, its implementation and review.

The model embodies a comprehensive systemic approach towards environmental communication as it pools into a coherent system all of the key elements (or dimensions) that form a joint communicative environment - environmental information, environmental education, public participation and environmentally friendly behaviour.

Thus, it aims at illuminating the interaction of the four notions (often disengaged both in theory and municipal practice) and discarding the traditional – information flow-focussed communication approach. The model also insists that the potential of the combined force of these four communication dimensions can only be utilised to the full extent through ensuring co-operation and partnership among all target (stakeholder) groups involved. Environmental communication is thus to be seen as multi-stakeholder understanding and co-operation enhancement process, by complementarily involving all four dimensions mentioned, but above all - by pooling the values, intentions and opinions of all key target groups, i.e. local inhabitants, municipal and state institutions, NGOs and the media, businesses, etc. Environmental communication could be developed as a **separate sector** in environmental management [6, 9, 11].

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RESEARCH BACKGROUND

The DoEM case study research initiatives on environmental communication and management have been carried out in Latvian local municipalities in search of a holistic, comprehensive and systemic approach towards municipal environmental management and development processes that would possess the greatest potential of achieving change – through a change in understanding, attitude, motivation and behaviour, which all are a pre-requisite on the way to sustainability.

The goal of the collaboration research projects (apart from situation assessment and problem identification) was twofold:

1 - applied goal: to produce a real applicable end-product in the form of a locally tailored environmental communication (or in some cases – environmental collaboration) policy plan and/or action programme proposal;

2 - momentum-building goal: to give an initial boost to the further local environmental communication process development, broaden the outlook of the target groups so as to reveal the unacknowledged vast potential of environmental communication in building local environmental awareness, facilitating participation, expanding the usual confined frameworks of co-operation, breaking the traditional perceptions and stimulating new innovative approaches [5-7].

Methodology applied:

- University-community research initiatives and the case studies have been carried out as collaboration projects between the DEM and the local governments.
- Case study research (CSR) methodology (incl. municipal planning and regulatory document studies, interviews, surveys, focus group discussions) – a comprehensive study of all municipal target groups (local administration - public and educational institutions -residents and NGOs – business sector – the media)
- 4-P environmental management cycle analysis: problem analysis (P1) → policy definition (P2) → policy planning (P3) → programming (P4)
- Collaboration Communication Model (Ernsteins 2003)

The two training modules (TM) as the main training product and also complementary resource materials that have been developed by our team at the

University of Latvia on the topics of Integrated coastal management and communication (TM-1) and on Coastal communication for sustainable development (TM-2) were designed and intended to serve for both:

- the so-called **train-the-trainers training** program and resource material as well as

- hands-on optional resources for them for their everyday further local coastal training utilisation, with the aim of providing an opportunity of sharing both theoretical backgrounds and approaches and, of course, practical experiences on coastal governance and communication innovation among different types of **local coastal stakeholders-educators/mediators** (nature schools, universities, libraries, NGOs, museums etc.) in order to serve and encourage for local development **participatory actions** all the main coastal stakeholders and general public.

All these educators will have the possibility to select those parts and/or sub-parts etc of the whole material of the both prepared training modules which best suit their interests and needs and to include them into their own educational-training programmes and thereby broadening – we hope - the thematic and methodological scope of their educational and facilitation work. Thereby, these modules serve to achieve our key objective – **to create models of collaboration** in the field of coastal governance and communication between all stakeholders, esp. municipal and general public, being facilitated by involved and trained mediators in order to strengthen the connection between the sources of environmental/coastal and risk **knowledge and users** at the coastal areas-municipalities.

COMPLEMENTARY TRAINING MODULES FOR MUNICIPAL COASTAL STAKEHOLDERS: BACKGROUND AND MODELS

Main final product to be designed, elaborated, tested and prepared to public use were two complementary training modules (TM) and there are taken into account following concepts and Latvia practice applications.

Training module 1 on **Integrated coastal management and communication** focuses on coastal management implementation at the local municipal level and comprises activities by all key interest groups and scope of their interests, emphasizing in particular on two key target groups interacting and should have been complementary engaged and oriented towards coastal collaboration: **municipality management on one side**, selecting development planning and integrated coastal management (ICM) approach, and **general public/resident (household) action development** on the other side - acting both in their internal environment and also affecting and participating in maintaining the external environment.

Subsequently in studying this interaction of the **top-down and bottom-up** approaches, three main concepts are realised in TM-1 module:

-1 **collaboration governance** – participatory and adaptive environmental management concept and approaches as well as municipal action development and **ICM;**

-2 **household** (residents)environmental management (HEM - completely new approach emphasized) ;

-3 and governance instrument - **indicators** – how to mutually assess progress of actions on every level (resident, municipal) and, particularly, on their interaction towards sustainability;

-4 as well as there are to be stressed also, so called, specific thematic cases – climate change adaptation and risk management case studies carried out in a particular municipality, and recommendations are given to municipality on further development.

Training module 2 on **Coastal communication for sustainable development** aims at providing an overview of both theory and practice of environmental communication in general, and municipal environmental communication in particular and to present best practice of coastal communication in Latvia. It emphasizes the **communicative environment** as the primary driving force in successful implementation of environmental governance and in ensuring sustainable development of a territory, as well as the imperative of **systemic municipal coastal communication governance** as a prerequisite for sustainable coastal development. The theoretical basis of coastal communication consists of following basic concepts: **coastal communication** for sustainable development is seen as a thematic subtopic in environmental communication aimed at the efficient governance of interaction between the natural and socio-economic environments; **collaboration among all actors** and interested groups is considered to be the focal element of coastal communication and environmental communication in general.

TM-2 on Coastal communication for sustainable development focuses on environmental communication management implementation at the local level and comprises activities, particularly, collaboration imperative, by all key interest groups and scope of their interests, emphasizing in particular on two key target groups in their communication: municipality communication management on one side, selecting integrated and/or disciplinary planning and management approach, and resident (household) communication development on the other side.

Therefore studying this interaction of the top-down and bottom-up approaches, again three main concepts are realised also in TM-2 module:

-1 environmental communication management concept and approaches as well as municipality communication management by **integrated and/or disciplinary approach**

-2 residents, NGO's etc stakeholders experience for best communication practice;

-3 new **social instruments** and **collaboration communication** prerogative - how to mutually interact and work complementary on both levels (resident, municipal) and, particularly, in their interaction with everyone other stakeholder;

-4 and also specific cases – coastal communication case studies carried out on climate change and coastal risk communications in a particular municipality, and recommendations are given for further development.

The module outlines the concept of environmental communication and existing theoretical framework as well as giving practical examples from municipal experience in environmental communication planning and implementation (incl. guidelines for drafting action programme), key approaches, and describes the principal elements of environmental communication and the key actors (or target groups) in environmental communication.

Contents of Training Modules designed are as follows:

TRAINING MODULE 1.

1. Introduction to sustainable coastal development
2. Environmental management and coastal municipalities: from theories to practice
3. Integrated coastal zone management

4. Indicators for sustainable development – local municipality case
5. Collaboration governance approach
6. Household environmental management
7. Climate change adaptation governance for municipalities
8. ICZM Program: Saulkrasti Municipality case

TRAINING MODULE 2.

1. Introduction to coastal communication
2. Environmental communication – from theory to practice
3. Integrated approach: Environmental communication integration into municipal environmental management and development planning
4. Disciplinary approach: Environmental communication for Liepaja municipality
5. Coastal communication best practice
6. Coastal risk communication
7. Green municipality: Public relations and communication
8. Coastal communication Action program: Saulkrasti Municipality Case

It should be taken into account that the developed materials are basically embedded in the Latvian context, which means that not everything might be appropriate or applicable in the educational /training practice of other countries.

CONCLUSIONS ON R&D DESIGN AND TRAINING

There has been realized following main conclusions and applications:

- A 4-directional model of integrating disciplinary environmental communication into municipal development (Municipality of Liepaja) and environmental communication integration tool-set.
- Key work directions for further development of the environmental governance combined with key capacities for systemic environmental communication.
- A model of integrated environmental collaboration - or an Integrated Environmental Co-Operation Network has been developed
- Mutual integration of sustainability capitals as an imperative.

The Environmental Policy Plan and Action Programme of Cesis town, based on University of Latvia and municipality collaboration project (incl. field studies), was the first ever to be elaborated by applying a full-scale complementary assessment of the two-way integration of environmental capital into social and economic ones and, especially, a return integration as well.

- The environmental communication case studies have served as pilot research into the potential and possibilities afforded by the proposed four-dimensional environmental communication model.
- Research has yielded positive results as to the model's practical applicability in environmental communication process initiation and facilitation, stimulation of target group/ stakeholder self-activation for co-operation, dialogue and increased participation in building a sustainable local community. The four-dimensional collaboration communication model has received positive feedback from the local governments where it has become part of their municipal environmental and development planning mechanism.
- As acknowledged by the environmental experts of these local governments,

the model has given an impetus towards building new partnerships, finding creative solutions, and broadening the scope of activities. Integration of environmental communication into the planning documents, being a political commitment, has facilitated the implementation of these issues into practice and has helped bring them to the forefront when designing specific action programmes and investment projects.

- Over the course of research projects and later on different municipal planning processes, we can recognize that environmental communication is already growing into a separate and vigorous environmental sector along with the traditional environmental management sectors such as waste management etc.

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REFERENCES

[1] Beierle T.C., Cayford J. Democracy in Practice: Public Participation in Environmental Decisions. Resources for the Future, 2002, 158 p

[2] Cox R. Environmental Communication and the Public Sphere. SAGE, 2010, p 455.

[3] Daniels, Steven E. and Walker, Gregg B. Working Through Environmental Conflict: The Collaborative Learning Approach. Westport: Praeger. 2001

[4] Ernsteins R. Environmental communication. Leonardo da Vinci Community Vocational Training Act, Institute for Environmental Science and Management, University of Latvia, 2003, 96 p.

[5] Ernšteins R. Coastal Communication And Partnerships For Municipal Sustainable Development, Proceedings, International conference, Management And Conservation Of Coastal Natural And Cultural Heritage, Aveiro Univeristy, Aveiro, Portugal, 2005a, pp. 21-27

[6] Ernšteins R. Partnerships between Municipalities and Universities as Means to Promote Regional and Local Sustainable Development in Latvia, In Adomssent M., Godemann J., Leicht A.,Busch A(Eds.),Higher Education for Sustainability, Frankfurt, Germany VAS Publishing,2006, pp. 245-250.

[7] Ernšteins R. Local Agenda 21 Process Facilitation : Environmental Communication and Self-Experience Development in Latvia, In Filho L.W., Ubelis.A.,Berzina D(eds.), Sustainable Development in the Baltic and Beyond, Frankfurt, Peter Lang Europaischer Verlag der Wissenschaften, 2006b, pp.305-318

[8] Ernsteins R. Integrated environmental communication management for coastal reģions. A Changing Coast: Challenge for the Environmental Policies, E-Proceedings of the 9th International Conference Littoral 2008, November, Venice, Italy, 2008

[9] Ernsteins R. Municipal Education for Sustainable Development in Latvia: Self-experience and Sustainability Communication Process Prerequisites. Proceedings of the International Scientific Conference "Economics Science for Rural Development" Nr. 22, Resources and Education, Latvian Agriculture University, Faculty of Economics, Jelgava, 2010, pp.123-133.

[10] Michelsen G., Godemann J. Ed. (2007). Handbuch Nachhaltigkeitskommunikation: Grundlagen und Praxis. Oekom, Muenchen, 2007, 940 s.

[11] National Environmental Communication and Education Strategy, Ministry of Environmental Protection and Regional Development, Republic of Latvia, Riga.2000

UNIQUE APPROACH TO LAND RECLAMATION AFTER BROWN COAL MINING

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ABSTRACT

Many areas damaged by mining processes had been afforested or reclaimed for agricultural use; however, the trends of the past decades incline to a more natural way of reclamation or to reclamation with the recreational function. The history of the damaged landscape is an aspect of reclamation that is often overlooked. Post-mining landscape reconstruction with the use of historical data, especially maps, is considered a subsidiarity related to reclamation. Comparison of historical maps, in this case of stable cadastre maps and land-use data going back to the years 1842–1843, are compared with recent maps, and the land-use data provides a picture of the changes in landscape in course of the last 160 years. Knowledge of the historical land-use acreages and an evaluation of the landscape stability should be taken into account during reclamation processes in order to establish functional landscape

Keywords: reclamation, stable cadastre, brown coal mining, land use

INTRODUCTION

One of the many negative consequences of mining activities is the disappearance of native ecosystems. In case of surface mining it represents is a long-term issue of hundreds of years and is devastating the landscape inducing transformation of the landscape matrix. Landscape assessment therefore represents a tool of landscape management respecting also the man's utilization of the concrete landscape.

At present, the landscape degraded by the brown coal mining is recognized as a unique sub type of cultural landscape with dominant production function which suppresses all other functions. The post mining rehabilitation aims at reconstruction of landscape types forming a balanced polyfunctional character.

Reclamation, firstly, should follow basic ecological rules. Even a relatively small part of the landscape can act as a healthy ecosystem, if the communities are linked to the ecological networks. Secondly, it must reflect there is often very negative impact on the social level and stability of society. Environmental indicators that can be used in conjunction with assessing the potential impact of project on the environment are described in [7].

Reclamation practice now reflects the change in public requirements to the future landscape functioning and provides for other land uses than traditional forestry or agriculture. Anthropogenously affected landscape in areas of former quarries is often reclaimed by flooding. In comparison with other methods of reclamation flooding is undoubtedly one of the fastest and most economical methods, which also offers multi-functional land use. Flooded residual pits often attract residents and visitors to the country that was inaccessible for almost half a century. Today's lifestyle demands places for recreation and the reclaimed areas, including the referred Medard-Libík area, are designed to provide for recreation and sports, too. Moreover, in case of the open cast brown coal mining region in North-west Bohemia, this approach returns the water to the landscape in which the water was one of the principal components.

LOCALISATION

The former open cast brown coal mine Medard - Libík is located on the northern boundary of the western part of the Sokolov coal basin between the villages Citice, Bukovany, Habartov and Svatava in West Bohemia, Czech Republic, see Figure 1. The extent is approximately 40 km^2.

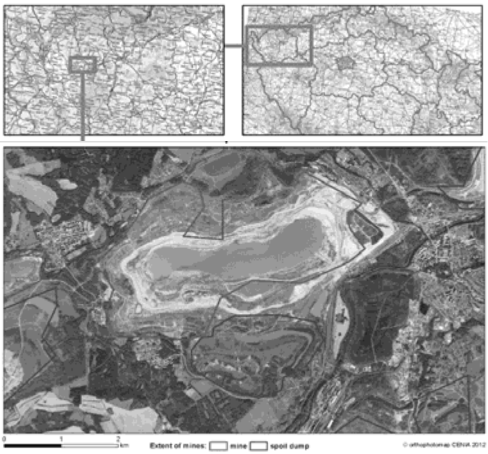

Figure 1. Localisation of Medard mine over the current ortophotomap

The landscape of the Sokolovský district has considerably diverse geomorphology. The lowest levels (excluding the quarry) are situated in Eger valley at an elevation of 400 m, from where the original terrain rose steadily northward to the foot of the Ore Mountains (Krušné hory). Its average altitude of about 600 m above sea. The original diversity of the territory was (and will be) significantly affected influenced by ongoing mining activities. Geological substrate is composed mainly of Tertiary sediments. Over these mother materials pedogenetic processes generated typical acidic soils, which provide very diverse conditions for vegetation.

The original natural condition of the area and its immediate surroundings were fundamentally changed due to intensive opencast mining of brown coal in the 20th century and related energetic industry. Water flows, springing in the Ore Mountains, have been drained into artificial canals and their water has been discharged outside the mining area. The groundwater regime has been affected much.

Coal mining in the Medard - Libík mine was completed in March 2000. From 1999 the reclaiming of the residual pit to level of future flooding has started. Based on a comprehensive assessment of possible alternative solutions for the final hydric reclamation of the residual mining pit a flow-through lake with a depth of about 50 m was selected.

The selected area presented case study covers a rectangular part covering the mine and its dump and stretching out to the contact with the nearest non-devastated landscape, the evolution of which was not driven by mining but similar forces as the whole region.

METHOD

At present, the landscape degraded by the brown coal mining is recognized as a unique sub type of cultural landscape with dominant production function which suppresses all other functions. The post mining rehabilitation aims at reconstruction of landscape types forming a balanced polyfunctional character [3], [5], [6], [7].

Knowledge of historical data on land prior to mining can play an important role in reclamation activities, which aim to restore disturbed areas in such a state that could be fully integrated into the surrounding landscape. The application of the historical development of the landscape can be therefore be used in its reconstruction. The reconstruction of the landscape using historical maps is dealt in detail in [4], [8], and [11].

In finding the approximation of balanced polyfunctional character, analysis of pre-mining situation is frequently used, namely in Europe, where historical sources of information in the form of old maps and photogrammetric aerial images. The comparison of old and present landscape functioning was examined in works of [12], [1], [8], [9], [10] and others.

Monitoring of landscape changes over time is based on observation of individual landscape elements. This method provides a comparison of today's landscape with the landscape 160 years ago and suitable to examine the evolution of river beds, change in the landscape matrix or other processes of landscape evolution.

The historical data were collected from the Stabile cadaster. This map source originally established in 1842-43 to provide evidence on properties for taxation purposes represents a priceless source of historical land use data before the end of 18th century. Now they can be used to reveal the land use of that times. There were altogether 13 distinct land use types registered for the Medard area: roads, major roads, intravilane, arable fields, hop fields, meadows, pastures, wet meadows, orchards, set aside land and rocks, refugees-successional stages, fish ponds, and mines. The land use was vectorised from georeferenced scans of archive maps.

Present land use was determined by field data mapping [2] and classified so that the present and historical land use types match. The present land use was also vectorised for further analyses with the ArcGIS software.

Both polygon data sets of historic and present land use were then used to provide summary data on individual land use type extent and identification of permanent land use structures that occur continuously on the same location [4], [11], [12].

RESULTS AND DISCUSSION

Comparing historical and current data shows current status and trends in the examined years. Especially in landscapes disturbed by mining, as in the case of the Medard mine,

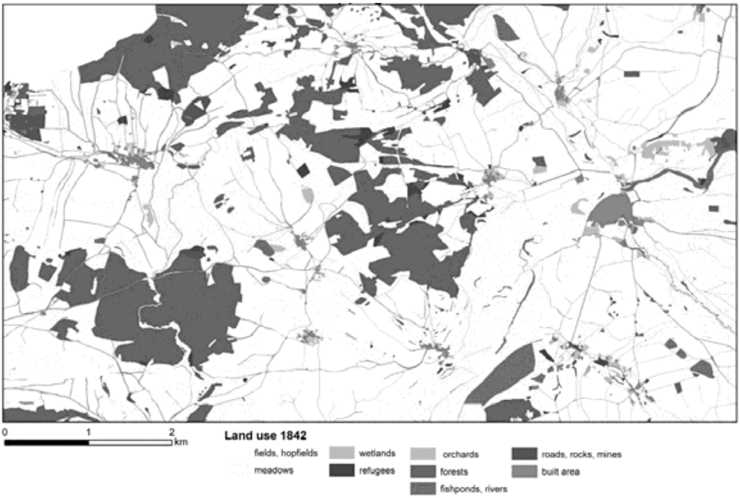

Figure 2. Land use in the case area of Medard mine in 1842-3

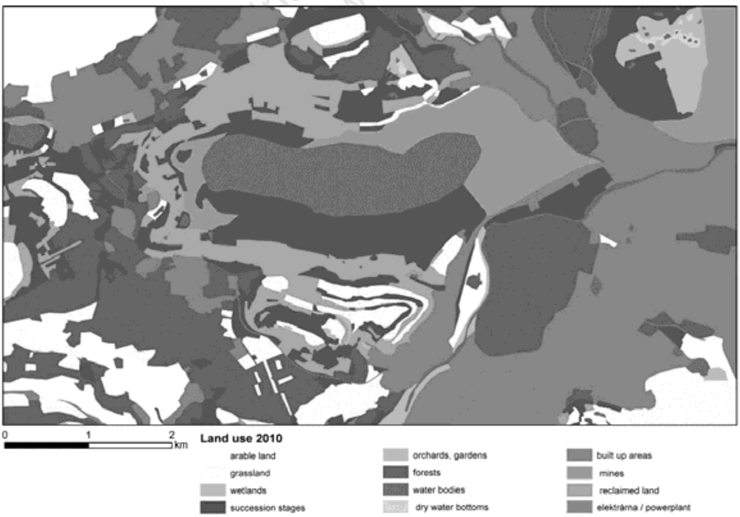

Figure 3. Land use in the case area of Medard mine mapped in 2010

we can assume that the functional use of the landscape over the past more than 160 years has fundamentally changed as seen in Figures 2 and 3. This is clearly confirmed by the results of the processed comparison.

Table 1. Area of land use types in the case study before and after mining activity, extent of permanent land use elements and proportion of former land use types preserved at the same location until now

Land use type	1842 (ha)	2010 (ha)	trend	continuous land use (ha)	% of 1842
intravilane	45,41	998,95	↗	28,24	62,19
meadows, pastures	1412,46	351,57	↘	92,94	6,58
forests	643,96	868,13	↗	238,13	36,98
wetlands	8,81	100,98	↗	0,05	0,55
arable land	1662,41	242,75	↘	126,17	7,59
water bodies	50,46	300,45	↗	3,37	6,69
communications	159,53	41,12	↗	0,54	0,34
reclamation		441,21			
succession stages	38,05	157,30	↘	0,5	1,31
mines	21,93	353,85	↗		
other uses	32,0116	214,4645	↗		

Results presented in the Table 1 show decline in agricultural land and permanent grassland (meadows, pastures), which was caused by industrial development associated with mining activities. The transition away from agricultural land use is also manifested by increase of forests (due to afforestation of unused agricultural land and forest reclamation) and water bodies. Correspondingly with the production function of the landscape present composition is dominated by intravilane, comprising all types of built up areas except for communications (Figure 4).

Similarly important to assessing future functioning of re-established landscape functions are the continuous landscape elements – i.e. the patches of land which either retained their land use and land cover over the period or the previous land use was re-established there (Figure 5). The Table 1 shows these are only minor percentages of former extents of the land use types. Altogether less than approximately 1/10 of the landscape have retained its land use type over the 160 years.

In the future we expect due to the rehabilitation improvement of the overall stability of the landscape.

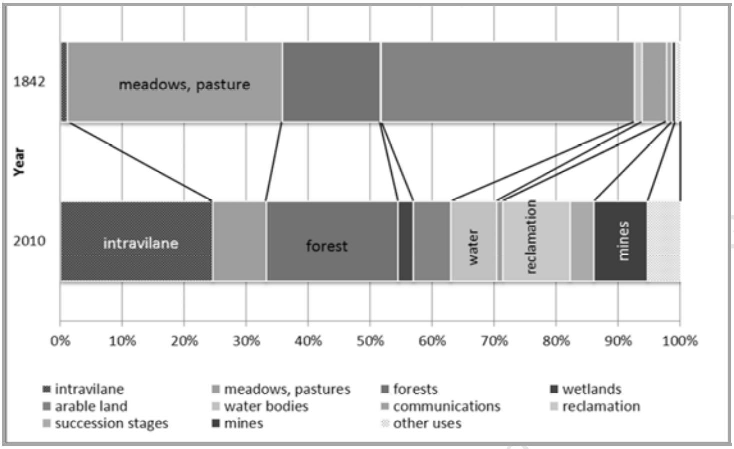

Figure 4. Change in land use proportions in years 1842 and 2010

Figure 5. Continuous land use in the Medard-Libík area.

Reclamation of the majority of the remaining area adjacent to the pit lake will consist of so called “landscaping green”, ie, forest reclamation form of group plantings. The dump plateaus and other selected areas will be afforested by groups of trees so as there can arise a combination of small woods, groups of trees, solitary trees and open (grassed) areas, which when the stands are mature will correspond to similar "natural" sites in the region. The composition of reclamation types used there is presented in Table 2. It is assumed that the open areas near towns and villages Sokolov, Svatava, and Habartov, will fulfill besides landscaping and ecostabilizing functions also an important

Table 2. Proportion of reclamation types within the Medard-Libík mine and its dumps

Reclamation type	Reclaimed area[ha]					Total area affected by mining [ha]
	water	forestry	agricultural	other	total	
Medard-Libík	506,15	532,26	35,19	20,29	1093,89	1183,00

role in short-term recreation. Forests in the eastern and northwestern parts that are in contact with urban areas, will therefore be established so that they aesthetically effective, health improving and accessible as recreational suburban forests shall be. Quality of the environment is the main prerequisite for the optimal recreation. Healthy, quiet, refreshing and aesthetically valuable environment providing for recreation is the part of the natural-like landscape with a high proportion of physically and aesthetically compelling forms of tree vegetation in appropriate combination with other forms of greenery and water.

CONCLUSION

Contemporary economic activity is inevitably associated with a greater or lesser disruption of the environment. The technologies and the scale of production and consumption increasingly threaten the stability of global ecosystems. The importance of economic activity, understood as the efficient use of human and natural resources to produce goods and services that serve the needs of people is essential and necessary. The existence of human society, however, increasingly reflects the quality of the environment. The more consumer's needs are satisfied the less men can benefit from clean water, clean air and undevastated landscape. Therefore it is necessary to continuously and systematically monitor and effectively influence the relationship between economic development and environmental status.

Mining, especially the open cast one, is undoubtedly one of the activities that negatively affect the environment. The most serious impact is the total devastation of the territory in which the mining process takes place. Moreover, devastation extends out by the external dumps, on which overlying soils are saved in the initial phase of mining. These effects are particularly pronounced in areas loaded with other industrial activities, extensive infrastructure and dense population, as in the Sokolov Basin.

ACKNOWLEDGEMENT

This work was supported by project of The Ministry of Education, Youth and Sports of The Czech Republic under contract No. 2BO 8006 SP2 New approaches to research on effective practices for reclamation and rehabilitation of devastated land and by project of The Ministry of Agriculture of The Czech Republic under contract No. NAZV QH 82106 Reclamation as a tool for recovery of the water regime of surface mining of brown coal.

REFERENCES

[1]BASTIAN, O., KRÖNERT, R., LIPSKÝ, Z.,: Landscape Diagnosis on Different Space and Time Scales - A Challenge for Landscape Planning. Landscape Ecology, 21: 3: 2006: 359-374

[2]BODLÁK, L., VINCIKOVÁ, H., NEDBAL, V., HAIS, M., SÝKOROVÁ, Z., CHMELOVÁ, I., NĚMCOVÁ, J., PECHAR, L., STARÁ, L., ŠŤASTNÝ, J., HAVRÁNEK, J., PECHAROVÁ, E. A collection of special thematic maps and methods used to determine functional aspects of the land for distrikt of Horní Stropnice and Nové Hrady. (in Czech) Kostelec nad Černými Lesy, Lesnická práce, s.r.o., 2008, p. 80

[3]GILLAROVA HRAJNOHOVA,H., KAZMIERSKI,T., PECHAROVA,E., MARTIS,M.: What can offer us reclaimed landscape surrounding future lake Medard. . In: SKLENICKA,P., SINGHAL,R., KASPAROVA,I. 12th international symposium on environmental issues and waste management in energy and mineral production - SWEMP 2010 pp. 190-198

[4]GILLAROVÁ, H., TRPÁK, P., TRPÁKOVÁ, I., SÝKOROVÁ, Z., PECHAROVÁ, E.,: Landscape memory as a solution of the ecological stability of the territory after mining. Gospodarka surowcami mineralnymi-mineral resources Management. Volume 24, Issue 3, Part 1, 2008 pp. 289-298.

[5]LICKOVÁ, V., HOUDEK, K., MARTIŠ, M. 2008: Evaluate of scenarios of renewal Lake Medard. in: Mineral and Energy Economy Research Institute of Polish Academy of Sciences. 21st World Mining Congress New Challenges and Visions for Mining, Risk management &subsidence engineering, Sustainable development in mining industry Vol. 24, issue 3., Poland, Cracow, pp. 239 – 248

[6]PECHAROVA,E., HAIS,M., SVOBODA,I. Changes in landscape energy balance as a result of different land use during three time periods. Ekologia Bratislava Volume 25, Issue 3 SUPPL., 2006, pp. 205-214

[7]PECHAROVÁ, E., HRABANKOVÁ, M. A concept for reconstructing the post-mining region under the Lisbon strategy. Ekologia Bratislava 2006: Volume 25, Issue 3 SUPPL., pp. 194-204.

[8]TRPAKOVA,I., TRPAK,P., SKLENICKA,P., SKALOS,J., ENGSTOVA,B. Reconstruction of historical land use of the Sokolov Region as the basis for the recovery of land affected by surface mining. In: SKLENICKA,P., SINGHAL,R., KASPAROVA,I. 12th international symposium on environmental issues and waste management in energy and mineral production - SWEMP 2010 pp. 545-552

[9]SKALOŠ,J., WEBER,M., LIPSKY,Z., TRPAKOVA,I., SANTRUCKOVA,M., UHLIROVA,L., KUKLA,P. Using old military survey maps and orthophotograph maps to analyse long-term land cover changes - Case study (Czech Republic). APPLIED GEOGRAPHY Volume: 31 Issue: 2 pp. 426-438

[10] SKALOŠ, J., ENGSTOVÁ, B. Methodology for mapping non-forest wood elements using historic cadastral maps and aerial photographs as a basis for management. Journal of environmental management Volume: 91 Issue: 4 pp: 831-843

[11] SKALOŠ, J., KAŠPAROVÁ, I. Landscape memory and landscape change in relation to mining . Ecological Engineering, 2011, in press, corrected proof, s. 1-10. 2011

[12] SKLENICKA, P., CHARVATOVA, E. Stand continuity — a useful parameter for ecological networks in post-mining landscapes, Ecological Engineering, Volume 20, Issue 4, September 2003, Pages 287-296,

URANIUM IN SOILS, WATERS AND PLANTS OF THE AN ABANDONED URANIUM MINE (CENTRAL PORTUGAL)

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ABSTRACT

Samples of soil, water and plants (terrestrial and aquatics) were collected in the vicinities of the old uranium (U) mine of Sevilha (Tábua, Central Portugal). Fluorometry was the methodology that was adopted for the determination of the U content in samples. Current U soil contamination on the Sevilha mine ranges from 8 to 560 mg/kg. In the most abundant families of terrestrial plants, the results show that the Compositae and Ericaceae families have the highest concentrations. For the Composiatae, an average of 4.91 mg/kg and a maximum of 13.12 mg/kg was found in *Helchrysum stoechas* and an average of 4.07 mg/kg and a maximum of 10.52 mg/kg was recorded in *Hypochaeris radicata*. In *Erica umbellata* an average of 1.70 mg/kg and a maximum of 7.50 mg/kg were obtained. Even though the concentrations obtained in this later species are not high it is particularly interesting because it has a high bio-productivity. Although the U concentrations in waters did not surpass 13 µg/L we have verified that in the vicinities of the mine drainage area, the U concentrations in aquatic plants are higher than in the surrounding water bodies. For these species proved to be uranium accumulators with maximum concentrations: *Riccia fluitans* (50.59 mg/kg), *Lemna minor* (52.98 mg/kg), *Callitriche stagnallis* (55.53 mg/kg) and *Lythrum portula* (32.93 mg/kg).

Keywords: bioaccumulation, contaminated soil, phytoremediation, Sevilha mine

INTRODUCTION

The old uranium (U) mine of Sevilha (Tábua, Central Portugal) (Fig. 1) is one of several small mines exploited by ENU (Portuguese Uranium Company). After the removal of the main ore body, the site was filled with the mine wastes and a reclamation process was initiated. This action was somewhat unsuccessful because the selected allochthonous plant species (*Lupinus* sp.) did not survive.

We decided to evaluate the U accumulation potential of the native species. Samples of soil, water and terrestrial and aquatic plants were collected in the vicinities of the study area. In the present work we report the screening results and the species that proved to have greater potential for ongoing phytoremediation projects in U contaminated sites. In addition we discuss the possibility of using aquatic macrophytes as biological filters of contaminated waters.

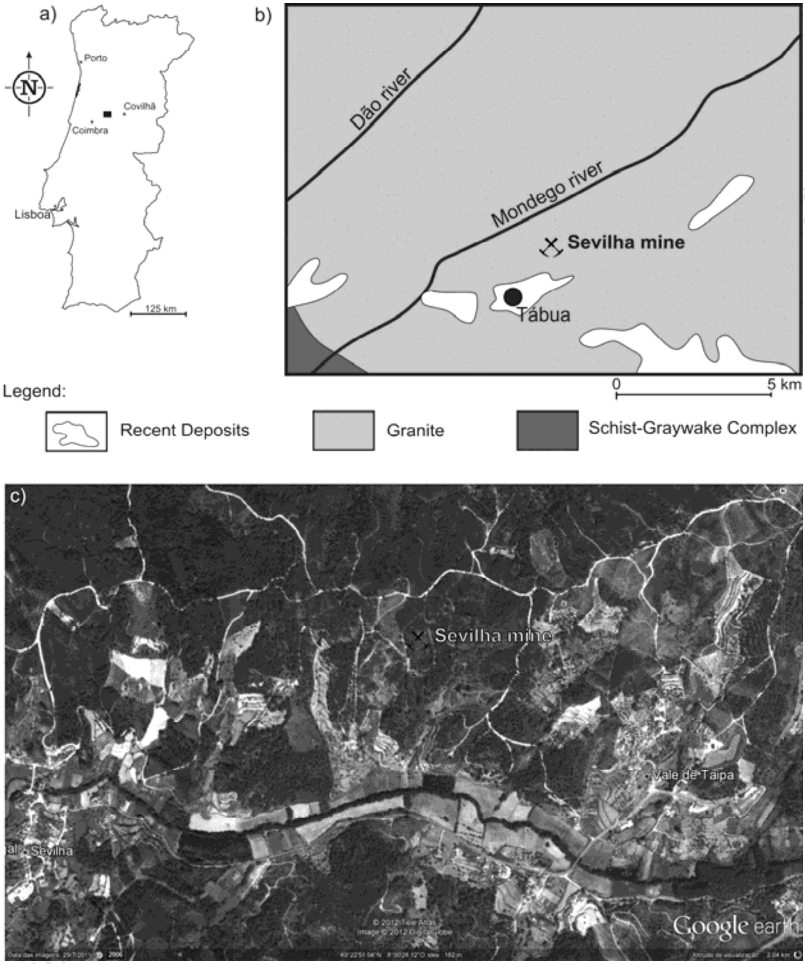

Figure 1 – Location of the study area on the map of Portugal (a); simplified geological map (b); and aerial photography of the Sevilha mine surrounding area (c).

METHODOLOGY

Field sampling

In the Sevilha mine, samples of soil, water and of plant species have been collected. The plant survey did not follow a regular pattern to take into account the dispersion of the species and to sample all the units of the plant community. It was intended to obtain a global view of the response of the vegetation to the accumulation of U. This implied sample collection in the biogeochemical background and within the anomaly. As a result 82 different species we identified and sampled. These species belong to 32 families, five of which are aquatic.

Sampling treatment

All samples were processed at the Chemistry Laboratory of the Earth Sciences Department of University of Coimbra.

The waters were filtered and acidified. The plants were identified and then they were cleaned in running water to remove particles bounded to the surface. Afterwards they were left to dry in an oven at 60 ºC. Once dried, they were ground and crushed for later chemical analysis. The soils were dried and sieved at 125 µm for chemical analysis.

Analytical procedures

For determination of mass concentration of U in samples of natural water, soils and plants, it was used the "Fluorat-02-2M" analyzer (Lumex, Russia). This device measures the concentration of U in solution by the intensity of the fluorescence of the uranyl-ions (λ = 530 nm). The water samples were analyzed by a standard fluorimetric analysis [1]. The detection limit for U in the water samples was 0.1 µg/L. Certified reference material from the National Water Research Institute of Canada (reference TMDA-62) was used to validate the results. Fluorometry was the methodology that was adopted for the determination of the U content in the plants and soil. The plant samples were dry ashed at 450 ºC, which was followed by dissolving the ash in 2.5 M nitric acid that was saturated with aluminium nitrate. The U was extracted into ethyl acetate. The ethyl acetate was then destroyed by ignition, and the residue was redissolved in 0.005% nitric acid [2, 3, 4]. The detection limit for U in the plant samples was 0.02 mg/kg. Certified Virginia tobacco leaves (reference CTAVTL-2, Polish certified reference material) were also analyzed to validate the experimental procedure.

RESULTS AND DISCUSSION

Current U soil contamination on the Sevilha mine ranges from 8 to 560 mg/kg. In the most abundant families of terrestrial plants, the results show that the Compositae and Ericaceae families have the highest concentrations (Fig. 2).

For the Composiatae, an average of 4.91 mg/kg DW and a maximum of 13.12 mg/kg DW was found in *Helchrysum stoechas* and an average of 4.07 mg/kg DW and a maximum of 10.52 mg/kg DW was recorded in *Hypochaeris radicata* (Fig. 3). In *Erica umbellata* (Ericaceae) an average of 1.70 mg/kg DW and a maximum of 7.50 mg/kg DW were obtained (Fig. 3). Even though the concentrations obtained in this later species are not high it is particularly interesting because it has a high bio-productivity.

This accumulation potential might be intensified if uptake enhancement strategies, such as addition of citric acid, are adopted. A restoration program can be applied to the soils of Sevilha by adopting revegetation with endemic species allied to a process of continuous phytoremediation that avoids dispersion of U into the streamlets.

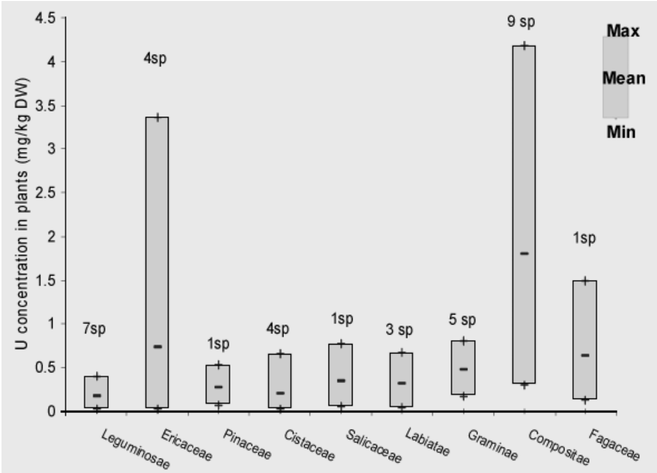

Figure 2 – Comparison between the uranium concentrations on aerial parts found on the more abundant families (number of species = sp).

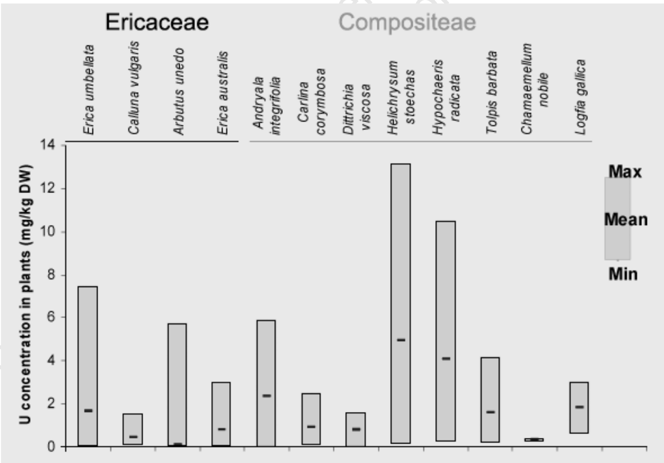

Figure 3 – Uranium concentrations on aerial parts (leaves and stems) of plants from Compositeae and Ericaeae families.

Four of the analyzed aquatic species proved to be U accumulators and, as a result, they are potential candidates for water decontamination phyto-systems. The measured average concentrations were: *Riccia fluitans* (29.19 mg/kg DW), *Lemna minor* (15.47

mg/kg DW), *Callitriche stagnallis* (9.97 mg/kg DW) and *Lythrum portula* (15.52 mg/kg DW). For these species, the observed maximum values were 50.59 mg/kg DW, 52.98 mg/kg DW, 55.53 mg/kg DW and 32.93 mg/kg DW, respectively (Fig. 4).

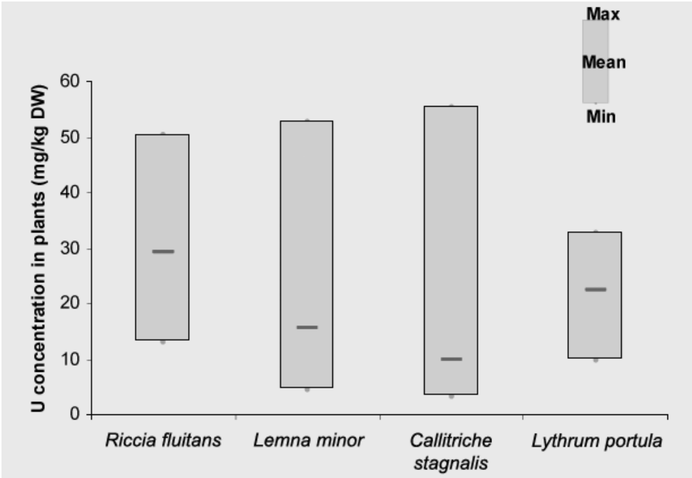

Figure 4 – Uranium concentration on aquatic macrophytes found in ponds and streams in the vicinities of Sevilha mine.

The water contamination in the vicinities of Sevilha mine results from the natural lixiviation of the wastes used to fill the open pit. The U minerals are being lixiviated and, consequently, they are being dispersed into underground and superficial waters.

Although the uranium concentrations in waters did not surpass 13 µg/L (EPA limit: 30 µg/L) we have verified that in the vicinities of the mine drainage area the U concentrations in plants are higher than in the surrounding water bodies, suggesting that they may be used as uranium biofilter in artificial wetlands (Pratas *et al.*, 2012).

CONCLUSIONS

The unsuccessful restoration program at the Sevilha mine led us to search for phytoremediation alternatives for the reclamation of U mines. Even though the soils and waters in this mine are not highly contaminated, the lixiviation of refilling materials has been responsible for the dispersion of U into ground and superficial water bodies. These waters are being used on subsistence agriculture and, therefore, the population risk to contamination can be acute, due to food chain accumulation. The plant survey revealed that some of the native plant species are well adapted to U contamination in soils and water and, therefore, they are metallotolerants. Their phytoremediation potential has to be evaluated.

Minimizing dispersion of U into the streamlets can be obtained by a strategic combination of terrestrial and aquatic plant phyto-systems. Revegetation with *Helchrysum stoechas*, *Hypochaeris radicata* and *Erica umbellata* will allow fixation of U in the plants and a consequent reduction in its dispersion. In addition, building a small wetland with aquatic plants will take care of the mine spills. This place can become an excellent prototype for the restoration of other mines in Portugal where levels of contamination are a matter of concern (e.g. Urgeiriça).

ACKNOWLEDGMENTS

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REFERENCES

[1] Lumex. Method for determination of mass concentration of uranium in samples of natural and drinking water and sewage through luminescent method by means of "Fluorat-02–2M" liquids analyzer, Lumex Ltd, Russia, 2000.

[2] Huffman C.J. & Riley L.B. The Fluorimetric method – its use and precision for determination of uranium in the ash of plants, U.S. Geol. Survey Prof. Paper, 700-B, pp 181-183, 1970.

[3] Van Loon J.C. & Barefoot R.R. Analytical methods for geochemical exploration, Academic Press, USA, 1989.

[4] Pratas J., Favas P.J.C., Paulo C., Rodrigues N. & Prasad M.N.V. Uranium accumulation by aquatic plants from uranium-contaminated water in Central Portugal, International Journal of Phytoremediation, 14: 221-234, 2012.

UTILIZATION OF COALBED METHANE AS AN ALTERNATIVE FUEL FOR PROCESSES OF DIRECT IRON REDUCTION AND SMELTING REDUCTION WITH THE RESPEKT TO THE ENVIRONMENT

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ABSTRACT

Coal is the biggest source of fossil carbon on the Earth and its share in world consumption of primary energy sources is 23,5 %. Nowadays, there has been reopened the question of coal bed mining in Frenstat, Czech Republic. In case of initiation, the gas is possible to use as a natural gas alternation for an alternative pig iron production such as DRI (direct reduction iron) or smelting reduction. Moreover, the gas is possible to use for blast furnace operation, too. All to all, the alternation of natural gas by coal bed methane gas results in lowest environmental burden because unexploited methane releases into the air contributing to the greenhouse effect.

Key words: coalbed methane, environment, alternative fuels

INTRODUCTION

Coal deposits constitute a special case when the same deposit is a coal resource as well as a gas reservoir. In the plant residues coalification process, so-called carbon gas (identified as coalbed methane- CBM) was created, the main component of which is methane.

The methane release that accompanies the coal mining from the coal deposits is a risk factor, because this mixture is explosive at the concentration of 5 to 15 % of methane mixed with air. Therefore, the mixture of air with methane (degazation gas) is exhausted during the underground exploitation of coal. The importance of the mining operations degazation consists not only in reducing the explosion risk, but also in preventing emissions of methane to the atmosphere. Besides carbon dioxide emissions, methane is the second most significant component of emissions causing the greenhouse effect. Coal methane exploitation is a broadly positive process, which significantly reduces the burden on the environment.[1]

COALBED METHANE

Coalbed gas is retained in coals in the following ways:

1) adsorption upon internal surfaces (in micropores);

2) absorption into the molecular structure of coal;

3) as free gas in voids, cleats, and fractures;

4) as a solute in groundwater present within the coal seam [2] (Rice, 1993)

Gas adsorption upon the internal surface area of the coal is considered, by far the most important mechanism for gas retention. [3]

The growth of the carbon gas exploitation is also supported by the possibility of increasing the exploitation thereof by forcing the carbon dioxide through vertical wells to the coal deposit (Fig. 1).

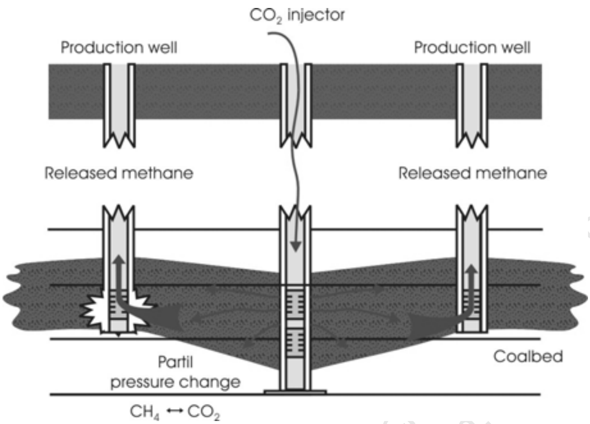

Fig. 1. Scheme of carbon gas forcing from coalbed by forcing CO_2 in [1]

Foreign studies [4], [5] document that the annual methane emissions accompanying coal exploitation reach 23.10^6 t on a world-wide scale, of which only 7 % is captured and utilized.

Coalbed methane in the Czech Republic

In the Czech Republic, a lot of attention was paid to the problems with securing carbon gas exploitation after 1992 [6]. In 1994, the vertical wells into productive carbon with well completion and hydraulic partitioning of promising stratum horizons verified the workable reserves of coal methane [7].

The content estimete of methane in the coal extracted in the Czech Republic has been based on data concerning the amount of gas released from coal mines in 1990 and the quantity of extacted coal in the same year. Estimate of coalbed methane in Czech Republic $510,79.10^9$ m^3. [8]

Black coal stock of the Beskyds' area, Czech Republic has been investigated since 1945 when exploratory wells from the surface verified that in the area Karvina colayers are located. Habitable bank of coal is 3,6 – 5 meters thick and is in the depth of 900 – 1300 meters. On the basic of these exploratory wells the habitable space of 6317 ha was determined and divided into five facilities. In 1981 the construction of Mine Frenštát was initiated. Two exploratory wells were drilled and connected in 590 meters. First coal was taken up on 12nd April in 1988. In 1989 the habitable space Trojanovice was determined but mining was not initiated. In 1991 work in Mine Frenštát was finished and the mine was conserved. [9]

The habitable space of Mine Frenstat is 63,2 ha large and is situated in the area of Frenstat city. The total black coal stock is in two deposits: Frenstat – west, Frenstat – east. The reserve of black coal was calculated about 1,6 mild. ton.

The company OKD, a.s. tends to finish preparation work on Mine Frenstat and to initiate mining. It is supposed to mine 2,2 mil. ton of coal. The mine lifetime is supposed 40 years with possibility of prolongation. Exploitable reserve is about 309 mil. ton. [10]

The area of the habitable space Franstat interferes into protected area of the Beskyds. This natural locality is involved in Natura 2000. In case of mining the environment is damaged resulting in irretrievable changes in the landscape. The mining of coal bed methane does not result in irretrievable changes in the landscape and could be a possible way of mine exploitation. [11]

As a reducing gas can be used in metallurgy, both the classical blast furnace technology, so at any of the methods of alternative technologies for the production of iron.

BLAST FURNACE PROCESSES

The principle involved in blast furnace ironmaking is the thermo-chemical reduction of iron oxide ore by coke into liquid iron. The unwanted materials are removed in the form of liquid slag by addition of suitable fluxes [12], [13]. Raw materials are changed from blast furnace top and hot air is sent up from the bottom resulting in these thermo-chemical reactions. Coal in the form of coke dominates the blast furnace process. Necessary coke properties are commonly known but the quantification of individual data relates closely to the economy of preparing the coal mixture and its constituents. In blast furnace department the decrease of total costs of production is possible mainly by decrease of the costs of fuel [14].

An injection of coalbed methane into a tuyere of blast furnace has been verified already in practice. The injection of 30 cubic meter of coalbed methane per ton of raw iron needed to increase hot blast temperature by 75°C or reduce additional moistening of blast by 8 grams per each cubic meter of the hot blast.

Preliminary prognoses were made also for utilization of coalbed methane for iron ore materials pre-reduction before the materials are processed in blast furnace. Here, the coalbed methane has been converted on a special converting device before its utilization. This option is based on the idea of utilization a small cutoff furnace as a shaft reactor and adjusted cutoff hot blast stove as a reforming apparatus.

Specific consumptions of reduction gases used for partial premetallization of available pellets were calculated through application of kinetic reduction model and results of laboratory tests of reducibility (Fig 2). Afterwards, it is possible to infer an amount of coalbed methane or other original gases then by a simple calculation (with reference to stechiometric proportions during reforming).

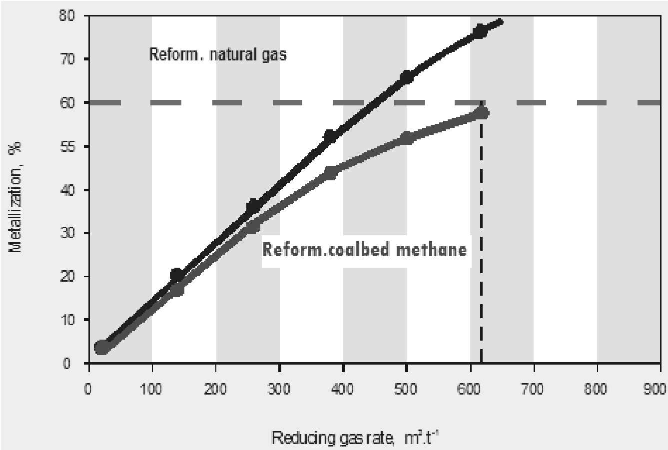

Fig. 2. Utilization of coalbed methane for pre-reduction

The conventional route for making steel consists of sintering or pelletization plants, coke ovens, blast furnaces, and basic oxygen furnaces [15] [16].

ALTERNATIVE PROCESSES

High cost and environmental problems concerning the production of metallurgical coke and the expected deficit of quality scrap for newly developed mini steel works, they both lead to the development and implementation of alternative technologies, although the most of the steel production still come to pass in traditional metallurgical plants.

Alternative methods of iron production can be divided into processes of direct reduction (DRI) and smelting reduction (SRI). Processes of direct reduction of the iron reduction from its carriers run from the solid state and product is in the solid state as well. Particularly DRI (Direct Reduction Iron) methods producing sponge iron are becoming a part of iron production because sponge iron can be replaced by scrap iron [17].

Smelting Reduction Processes

Direct coal employment is characteristic for processes that have been summed up under the term of smelting reduction. The characteristics of representative processes (COREX, Gridsmelter,Romelt, DIOS, CCF, HIsmelt, Tecnored, Plasmasmelt, Redsmelt, IronDynamics, Fastmet/Fastmelt, IFCON) is obvious from the illustration of Fig. 3.

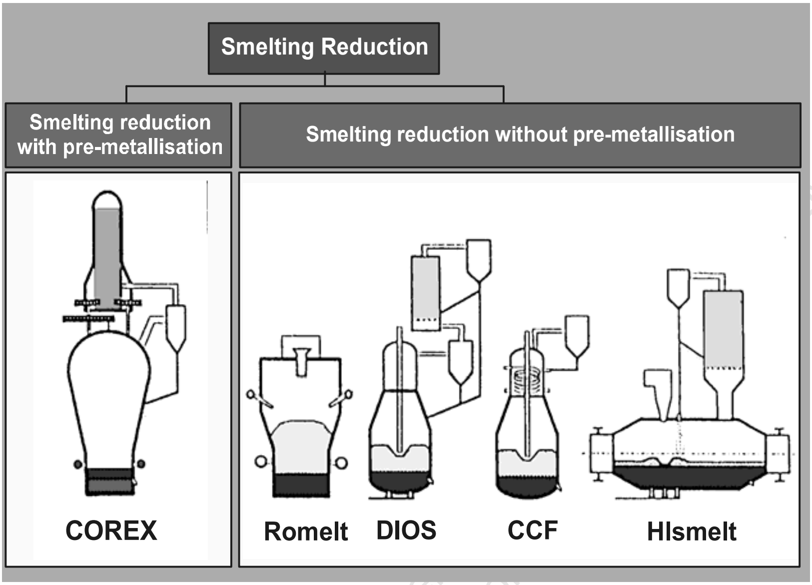

Fig. 3 Structuring of smelting reduction processes [8]

The processes can be fundamentally structured in smelting reductions with or without pre-metallisation.The principal difference of these processes vis-à-vis blast furnace constitutes a complete exclusion of metallurgy coke from the process of liquid metal production.

Preliminary prognoses were made also for utilization of coalbed methane for smelting reductions with pre-metallisation.

Direct reduction processes

Direct reduction, an alternative route of iron making, has been developed to overcome some of these difficulties of conventional blast furnaces. DRI is successfully manufactured in various parts of the world through either natural gas or coal-based technology

Direct-reduced iron (DRI), also called sponge iron, is produced from direct reduction of iron ore (in the form of lumps, pellets or fines) by a reducing gas produced from natural gas or coal. Direct reduction is the removal of oxygen from iron ore without melting.

The MIDREX technology is a typical representative of this processes.

The MIDREX Direct Reduction Process is the leading technology for converting iron ore into a high-purity direct reduced iron (DRI) product for use in steelmaking, ironmaking and foundry applications [18]. The MIDREX typically uses natural gas as the reductant and fuel.

Preparation of reduction gas in conversion equipment is specific for the production of sponge iron. Natural gas is usually an input gas for conversion and it is transformed through CO_2 or H_2O at the presence of catalyst.[19]

Midrex equipment uses natural gas that could be replaced by coalbed methane under the Czech conditions.

CONCLUSIONS

Coal methane exploitation is in Czech Republic a broadly positive process, because the captured methane may reduce the high costs of the natural gas import, the coal reserves free of coalbed methane will be more secure for the prospective mining, as it will eliminate the possibility of creation of the explosive methane-air mixture a portion of the non-exploited coal methane would necessarily have to get to the air in the coal mining process, where it would contribute to the greenhouse effect. Nevertheless, the coal methane is not only a source of energy and reduction gas. Coalbed methane non-controlled leakages to surface mean a threat for a safety of people and cause a significant source of air pollution. A complete, continual and above all effective utilization of the gas would solve the problems.

ACKNOWLEDGMENT

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REFERENCES

[1] ROUBÍČEK, V. et al. Decreasing CO_2 Emissions in Metallurgy. In *METALURGIJA*, vol. 46 br.1, Zagreb, January 2007, s. 53–59, ISSN 0543-5846.

[2] RICE, D.,D. Hydrocarbons form Coal. 1993, *AAPG Studies in geology*. Vol. 38, pp. 159-185

[3] MASTALERZA, M. et al. Carbon dioxide and methane sorption in high volatile bituminous coals from Indiana, USA. *International Journal of Coal Geology* 60 (2004) 43– 55

[4] Coalbed Methane Outreach Program : *Promoting Coal Mine Methane Recovery and Use*. EPA- United States Environmental Protection Agency, 2011, 8 p.

[5] http://www.eia.gov/coal/annual/

[6] NĚMEC, J., OSNER, Z.Methane in coal deposits – significant source of present energy, *Coal-Ores* 2 (1993), 1, 3-10

[7] HEMZA, P. OKD Exploring Territories, DPB Paskov a.s. for combustible natural gas bound to coalbeds (CBM). *Coal, ores, geological research*, 2000, 8, 19-20

[8] ROUBÍČEK, V., BUCHTELE, J. *Utilization of coal trends towards development.* OVŠB – TU Ostrava 1998, 50 p., ISBN 80-7078-594-2.

[9] MARTINEC, P.,SCHEJBALOVÁ, B. History and environmental impact of mining in Ostrava-Karviná coal field (Upper Silesian Coal Basin, Czech Republic). *Geologica Belgica*, 2004, 7/3-4. s. 215-223.

[10] http://www.dulfrenstat.cz

[11] http://www.nasebeskydy.cz/solid_page

[12] BARICOVÁ, D, DEMETER, P. New trends in utilizing of slags from ironmaking processes. In SGEM 2010: *10th International Multidisciplinary Scientific GeoConference*: 20. - 26. 6. 2010. Albena, Bulgaria [CD-ROM]. p. 887-892. ISBN 80-85988-48-8.

[13] BARICOVÁ, D., MIHOK, L., MAREK, P. Recycling of oxygen converter flue dust into oxygen converter charge. In: *Metalurgija.* vol. 41, no. 3 (2002), pp. 242. ISSN 0543-5846.

[14] KARDAS, E. A TECHNICAL AND ECONOMIC ANALYSIS OF PIG IRON PRODUCTION. In THERMEC 2009 *: 6th International Conference on Processing and Manufacturing of Advanced Materials* : 25.-29.8.2009. Berlin, GERMANY**.** PTS 1-4 Book Series: Materials Science Forum , Vol. 638-642 p. 3291-3296.

[15] LEGEMZA, J. et al. Emissions CO and CO(2) in the sintering process. In SGEM 2010: *10th International Multidisciplinary Scientific GeoConference*: 20. - 26. 6. 2010. Albena, Bulgaria [CD-ROM]. pp. 567-572. ISBN 80-85988-48-8.

[16] PRIBULOVA A.BARICOVA, D. et al. POSSIBILIETES OF PELLETIZING AND BRIQUETTING OF FLY DUSTS FROM STEEL AND CAST IRON PRODUCTION. In SGEM 2010: *10th International Multidisciplinary Scientific GeoConference* : 20. - 26. 6. 2010. Albena, Bulgaria [CD-ROM]. pp. 901-907. ISBN 80-85988-48-8.

[17] KURUNOV, I. F. The direct production of iron and alternatives to the blast furnace in iron metalurgy for the 21 st century. *Metallurgist,* Vol.54, No.5-6, 2010.

[18] http://www MIDREX 2010 Forecast SEAISI. pdf

[19] PUSTĚJOVSKÁ, P., BROŽOVÁ, S., JURSOVÁ, S. Measures to reduce CO_2 emissions in metallurgy according to processes in blast furnace. In METAL2011 : *20th Anniversary International Conference on Metallurgy and Materials:* 18.-20.5.2011, Brno, Czech Republic, pp. 32-37. ISBN 978-80-87294-24-6.

UTILIZATION OF SEWAGE SLUDGE WITH THE RECEIPT OF COMMERCIAL PRODUCTS

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ABSTRACT

The main stage of the treatment of domestic and oil waste water is an aerobic biological treatment. Exploitation of biological wastewater treatment plants is accompanied by the generation of waste - sewage sludge (SS), utilization which is the complex environmental and technological problem.

Keywords: sewage sludge, destruction, heavy metals, the sorbent used in the bioremediation of oil-contaminated soil, mineral fertilizers, low-temperature pyrolysis.

It is known that SS is a complex organic complex, which contains nutrients - phosphorus and nitrogen, in amounts that allow to consider waste as organic mineral fertilizer. The main barriers to the use of SS as a fertilizer is a high content of heavy metals (HM) and other toxic components.

In Table 1. represented by the average composition of the SS generated during biological treatment of wastewater.

Table 1. The average composition of the SS

Indicators	Significance	Indicators	Significance, mg/kg dry. arr.
Moisture content,%	85 - 87,15	*Concentrations of heavy metals in the form of gross*	
Mass fraction of organic compounds,%	62 - 66	Iron	12000-15000
Ash content,%	34 - 38	Cadmium	11,2
Total nitrogen,%	5,5 – 5,8	Copper	200-230
Mass fraction of total phosphorus (P_2O_5),%	5,2 – 5,6	Manganese	900-950
pH of salt extract	6,8-6,9	Arsenic	6,0-8,0
pH of the aqueous extract	6,5-6,6	Nickel	75-77
$(PO4)^{3-}$, mg/kg	400-410	Mercury	0,830-0,954
Chloride ion, mg/kg	10000-10500	Lead	34,7
Chemical oxygen demand of aqueous extract (1:5), mgO2/l	3000-3500	Chrome	305-310

Indicators	Significance	Indicators	Significance, mg/kg dry. arr.
The sulfur content, mg/kg	4000-4500	Zinc	870
Petroleum products, mg/kg	140 – 180	*Concentrations of heavy metals in mobile form*	
Silica, mg/kg	8900 - 15600	Zinc, mg/kg	489,0
Aluminum	14000 -17000	Chromium, mg/kg	6,0
Calcium	7333- 8257	Lead, mg/kg	3,8
		Copper, mg/kg	2,6

Currently the main way of recycling is to place on cards of sludge . This method does not meet modern environmental and technical requirements, leads to a long and often irretrievable alienation of land, with the pollution of groundwater in the areas of waste storage.

There are various ways and methods recycling of SALT, but their use is often not economically feasible. Developing innovative approaches to waste management that not only reduce the load on the environment, but also get an additional economic benefit from the use of processed products, is an urgent problem to be solved. An analysis of scientific and technical information, preliminary studies have shown the possibility of thermal processing of sewage sludge to produce marketable products - organic fertilizers and sorbents [1-5].

The purpose of this work is to conduct studies of two ways:

1) recycling of sewage sludge biological treatment plants by incineration in the presence of a reagent to produce the mineral phosphate fertilizers;

2) SS detoxication followed by low-temperature pyrolysis to produce material having sorption properties.

For the solve the problems to used range of modern methods of experimental research, including the conduct of field, laboratory, computational, experimental and statistical methods of research: Analytical studies were carried out using the methods of thermogravimetric analysis, the component structure of the mineral residue produced was determined by X-ray microanalysis, formed by the decomposition gases were analyzed by FT-IR spectroscopy. To obtain images of the structure of the samples (organic composition) used the method of scanning electron microscopy, which was conducted with a scanning electron microscope HITACHI S-3400N with a resolution of 3 nm (high vacuum) and 4 nm (at 270 Pa).

Thermal recovery of sewage sludge in the presence of a reagent to produce the mineral phosphorus fertilizer

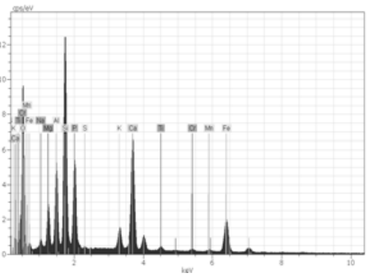
Currently, more common method of thermal recovery of SS is their incineration. The combustion of SS formed the ash, in which highly concentrated HM, which limits its further use for economic purposes, and demands disposal in landfills of industrial waste. In this context, relevant to provide a method of thermal recovery of SS, which allows the process of destruction to extract them from the HM and receive a product with consumer properties.

The effect is achieved by treatment SS calcium chloride and / or potassium chloride followed by thermal degradation of the organic part of SS, and the chlorides of HM are formed in the form of aerosols pass into the gas phase, and phosphorus-containing compounds of SS - in the phosphate calcium or potassium.

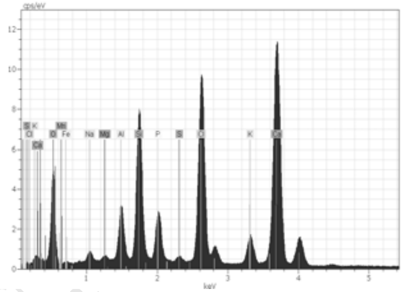
On the basis of temperature volatility of chlorides of heavy metals determined the optimum temperature of the combustion process, which amounted to 900 - 1000 ^{0}C:

$PbCl_2$	$MnCl_2$	$MgCl_2$	$ZnCl_2$	$CaCl_2$	$CuCl_2$	$CrCl_3$
501	650	713	730	772	954	1152

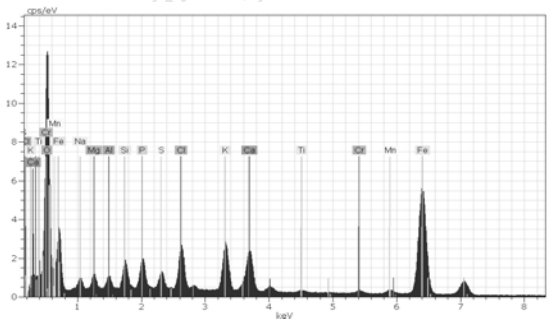
The resulting samples were subjected to the mineral balance of X-ray microanalysis, based on which the concentrations of the main elements that make up the ash. The results of X-ray analysis are presented in Fig. A.



a)



b)



c)

Fig. 1 - The results of X-ray analysis of the mineral residue:

a) SS - initial, b) SS treated potassium chloride, c) SS treated with calcium chloride

Established that burning of SS in the presence of reagents leads to a significant reduction of heavy metals in the mineral residue, as well as the formation of calcium phosphate and potassium, which are part of the fertilizer. The results on the efficiency removal of heavy metals (zinc, copper, manganese, chromium) in the thermal utilization of SS in the presence of reagents are shown in Fig. 2.

Based on studies justified the choice of the reagent and the optimum process conditions. The highest removal efficiency of TM observed by burning the samples in the presence of potassium chloride, and at the optimal dose of the reagent chromium content is reduced by 1.6 times, copper - by 1.4 times, and manganese - 2 times, zinc - 9.3 times, and iron - in 1766 times. The greatest effect is achieved for zinc and manganese, which is caused by low temperature volatile chlorides of zinc and manganese (730 and 650 ^{0}C, respectively).

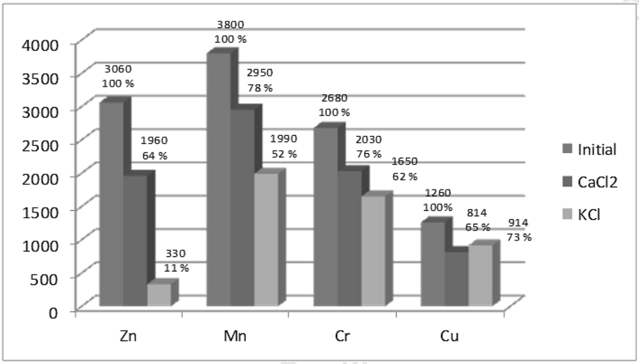


Fig. 2 - Efficiency of extraction of heavy metals during incineration of SALT in the presence of reagents

Based on the analysis of elemental composition of mineral balances calculated their composition, shown in Fig. 3.

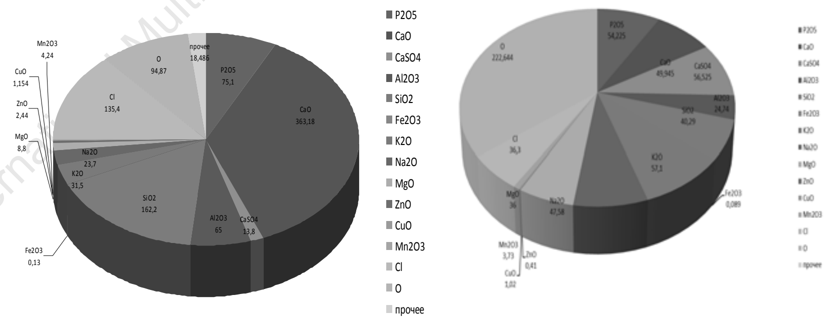


Fig. 3 - The composition of the mineral residue obtained by thermal treatment of the SS a) calcium chloride, b) potassium chloride

The residue contains oxides of aluminum, silicon, iron, phosphorus, 5-7% in terms of P_2O_5 and can be used as a fertilizer for acid and podzolic soils.

The most expedient to carry out the process of thermal degradation of SS in the presence potassium chloride. In this case the resulting mineral residue contains soluble phosphate fertilizer - potassium phosphate, potassium chloride and biogenic minerals.

Based on studies developed principal technological scheme of the process of thermal utilization SS containing HM and petroleum products, including processed SS potassium chloride solution by heating, followed by thermal degradation of the organic part of SS in the air. In the first stage temperature is maintained at 350 ^{0}C, which provides the decomposition of phosphorus-and sulfur-containing organic compounds to form calcium phosphate and sulfate, in the second stage the temperature rises to 900 ^{0}C that allows you to transfer generated aerosols in the chlorides HM. Flue gases are cooled after removal of 1% solution of hydrochloric acid to extract the HM aerosols and CO_2. Heat exhaust gases can be used to heat the oven at the first stage of the process.

Environmentally safe technology for producing material with absorption properties and liquid fuels.

For recycling SS is used a method of low-temperature pyrolysis. Pyrolysis is a complex heterogeneous multi-stage process, which resulted in the formation of pyrolysis gases, some of which is capable of cooling to condense with the formation of hydrocarbons with a boiling temperature of 200 – 440 ^{0}C and form a new solid phase – pirokoks.

To determine the optimal conditions for the process of thermal degradation of samples SS conducted thermogravimetric studies. Tests were performed on derivatograph Q-1500 D in the medium of helium, carbon dioxide at a heating rate of 10 deg/min in the temperature range 25-800 ^{0}C. As a reference sample using active alumina. During heating of the sample recorded the integral (TG) and differential (DTG) curves of mass loss as a function of temperature and differential (DTA) curve of thermal effects in comparison with the reference sample. Processing of the derivatograms performed by standard methods [4-5]. Figure 4 shows Derivatogram of a sample dehydrated SS (moisture content 87 %) in carbon dioxide environment.

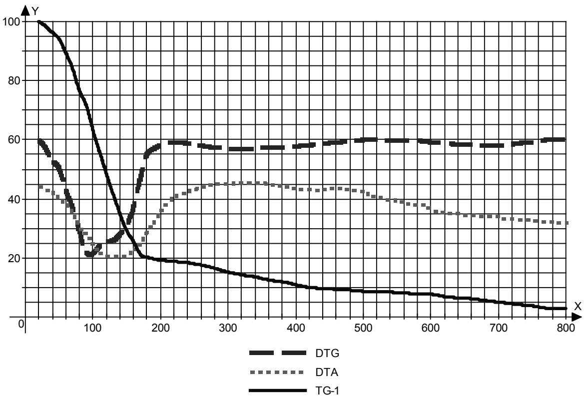


Fig. 4. Derivatograms samples of sewage sludge in the environment of carbon dioxide

During heating the sample there are three main stages of decomposition SS. The first phase (the temperature range 20 – 215 ^{0}C) is associated with the removal of water and light fractions of organic compounds, as evidenced by the split peak on the DTG (peak at 95 ^{0}C and 130 ^{0}C). The second stage of decomposition is observed in the temperature range 215-490 ^{0}C with a maximum at 310 ^{0}C and is characterized by the expansion of the bulk organic matter SS. The third stage of decomposition is observed in the range 500-610 ^{0}C with a maximum at 570 ^{0}C. At this stage there is a further decomposition of the organic part of the SS, accompanied by the release of CO, CO_2, and the destruction of carboxyl, hydrogen-containing groups with separation hydrogen and deposition of ash on the surface of pyrolytic carbon. For the first stage of decomposition weight loss is observed - 80.3%, for the second phase of mass loss of - 10.7%, for the third - 2.4%. The total mass loss at 800 ^{0}C is 95%. The full process of degradation of the sample is observed at 480-510 ^{0}C.

Thermogravimetric analysis of samples SS allowed to establish temperature conditions of their thermal destruction. Complete decomposition is achieved at a temperature of 520 ± 10 ^{0}C, while the output of solid residue (organomineral compositions - OMC) is 7-8% (Figure 2).

It should be noted that formed during the pyrolysis of the solid residue OMC collected HM, which limits the use of the material.

Preliminary detoxication SS will reduce the environmental risk of both the pyrolysis of SS, and the products formed.

Analysis of the patent and scientific information has shown that neutralization of SS and reducing the amount of heavy metals used calcium-soluble compounds - calcium carbonate (chalk), $SaSO_4$ (gypsum) and CaO (lime)), a dose-dependent introduction of the composition and physico-chemical properties of waste [6-7]. In the work to determine the optimal dose of the reagent investigated in detoxification SS (humidity 92-98% and 85%). Efficiency of detoxication the samples of SS was evaluated by the residual content of mobile heavy metals in the form of dry matter in the solid phase. The dose of reagents ranged from 0.5 to 1.5%. The interaction of calcium-containing products with samples of SS with stirring ion exchange processes take place in the structure of HM of SS on Ca^{2+} and the transition of HM ions in the liquid phase. It is established that the treatment of poorly soluble calcium salts of SS, the optimal dose is 1%.

Pretreatment of SS lime leads to significant decrease moisture content of samples and a decrease in the concentration of heavy metals in sludge per unit mass, the efficiency of detoxication to an average of 70%. In the presence of calcium-containing reactant in the pyrolysis of SS is the binding of gray-and chlorine-containing compounds in sulfide and calcium chloride, which significantly reduces emissions of toxic components.

Analysis of the composition of pyrolysis gases by infrared spectroscopy with Fourier transformation, resulting from the thermal degradation of the sample SS (obr.1) and the sample treated with CaO (sample 2) showed that the spectra of sample 2 decreases the intensity of the absorption bands of chlorine-and sulfur-containing compounds 58.4%. (Fig. 5).

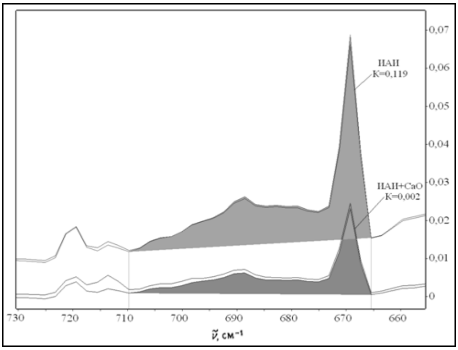


Figure 5 - infrared spectra of sulfur-and chlorine-containing compounds in the pyrolysis gases

To investigate the physico-chemical and sorption properties of OMC has been accumulated experimental batch of samples. The main physical and chemical characteristics of carbonizate are presented in Table 2.

Table 2. Physical-chemical characteristics of the organomineral compositions

Indicator	Units of measure	The value of the indicator
The content of pyrocarbon	%	40-45
The mineral part	%	55-60
The main fraction	mm	5-8
The bulk density	g/dm^3	385
Mechanical resistance to abrasion	%	50

The basis of the OMC of 40% pyrocarbon (organic component) and the mineral part of 60% (oxides of aluminum and silicon (22% and 25% respectively), sulfides, carbonates and chlorides of calcium). Considerable amount of pyrolytic carbon in the samples OMC suggesting the presence of their sorption properties. To determine the sorption capacity was investigated surface conditions of sorption materials analyzed using the scanning electron microscopy.

It was found that the structure is similar to OMC and carbonizate and sorbents obtained by pyrolysis of peat, charcoal, or sorbents derived from plant materials [8]. OMC had a "loose" structure and is characterized by a macroporous layered structure of the surface similar to peat sorbents and contains a zone with small amorphous inclusions. Also on the OMC sample were clearly visible capillary pores that are exempt from filling up their previous agents, suggesting a partial activation of OMC obtained in the presence of residual moisture before destruction. It is known that carbon-containing materials, including non-activated, are used as sorbents of petroleum and petroleum products [9].

To determine the possibility of using OMC as a sorption material for oil spill response defined its main sorption characteristics, namely, the total pore volume at field capacity and oil capacity. The results are compared to BAU activated carbon grades, and AG-3, as well as semi-peat (Table 3).

Table 3. - Sorption characteristics of carbonaceous materials

Indicator	Name of the sorbent			
	AG-3	BAU	OMC	Peat char
The total volume of pore moisture content, cm^3/g	0,8	1,6	0,67-0,72	0,55
Oil intensity, mg/g	900-1200	1300	650	620
Mechanical strength,%	75	60	50	50
Bulk density, g/cm^3	400-500	240	385	400

The comparative analysis of the properties of carbonaceous materials on the oil intensity has shown the possibility of using OMC as a sorption material for oil spill response in the areas of technology companies. Oil intensity, defined according to the method determines the mass of oil in the ability to absorb the volume of pores of the sorbent. In reality, due to adhesion of oil on the surface of oil retained on the sorbents, both natural and synthetic repeatedly increased.

We have carried out studies on the possible use of OMC in refineries in two main areas:

• for oil spill response and oil platforms in the process;

• for local wastewater from oil companies.

On the basis of tests conducted using the technology of OMC for oil spill response and oil on technological platforms with solid and unpaved refinery. The spent sorbent, OMC, saturated with oil, and has a high calorific value can be utilized together with SS thermal methods.

Conclusions:

A. Found that the burning of SALT at 900oS in the presence of chemicals - calcium chloride or potassium chloride to reduce heavy metal content which is formed auto mineral residue, which contains oxides of aluminum, silicon, iron, phosphorus, 5-7% in terms of P2O5, and trace elements. The composition of sediment corresponds to the composition of fertilizers and can be recommended for use on acid and podzolic soils.

B. On the basis of the experiments established the possibility of thermal recycling of SALT by low-temperature pyrolysis to produce products with trademarks properties, the optimal technological parameters of the process to produce commercial products: the liquid fraction of pyrolysis gas, which is a calorie fuel oil, non-condensable pyrolysis gases and organo-mineral composition. Identified areas application of organomineral compositions as a sorbent for the local emergency dispensing petroleum and petroleum products, as well as for local treatment of wastewater from oil and organic matter.

REFERENCES:

[1] A. Yakovlev, S., T. Karyuhina Biochemical processes in wastewater treatment. - Moscow: Stroiizdat, 1980.-200C., IL. - Environmental protection;

[2] Evilevich AZ, MA Evilevich Disposal of sewage sludge. L.: Stroiizdat, Leningrad. department, 1988.-248s., IL. - Environmental protection;

[3] Turov, IS Treatment of sewage sludge. - 3rd ed., Revised. and add. - Moscow: Stroiizdat, 1988.-256;

[4] Patent RU № 2174964 Method of extraction of heavy metals from excess activated sludge;

[5] American Petroleum Institute (1992). Technical Data Book - Petroleum Refining (5th ed.). Washington: American Petroleum Institute;

[6] Briesen, H., & Marquardt, W. (2003). An adaptive multigrid method for steady-state simulation of petroleum mixture separation processes. Industrial & Engineering Chemistry Research, 42, 2334-2348. DOI: 10.1021/ie0206150;

[7] Uendland W. Thermal methods of analysis. - Springer-Verlag, 1979, 526;

[8] The methodological framework for studying the kinetics of chemical reactions in a programmable heating / AG Merzhanov, VV Barzykin, A. Steinberg, VT-Gontkovskaya. Chernogolovka: OIHF, 1979. – 37;

[9] Q-derivatograph. Instruction Manual. Budapest: Hungarian Optical Works. In 1976. 91;

[10] Uendland W. Thermal methods of analysis. - Springer-Verlag, 1979, 526.

VIBRATIONS ASSESSMENT IN THE CAR INTERIOR

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ABSTRACT

Comfort on the car seat is combination of static and dynamic factors. Static factor can be evaluated using standard ergonomic technique. Dynamic comfort is usually assessed by vibrations measurements on the surface of car seat. The major portion of automotive vibrations enters the body through the seat. Currently, the most popular method used to evaluate dynamic seat comfort is the Seat Effective Amplitude Transmissibility (SEAT) value.

Keywords: vibrations, car, seat, acceleration

INTRODUCTION

Most of the vibration experienced by passengers in a vehicle is transmitted to the body through the car seat. The vibration environment, the seat dynamic response and the response of the human body to vibration combine to determine the seat's dynamic comfort. The optimum seat is one that minimises unwanted vibration responses of the passenger in the relevant vibration environment [3]. Dynamic comfort is usually assessed by making vibration measurements on the top of car seats using methods based on ISO 2631:1997 and other national standards [2]. This is done using a seat-pad accelerometer or accelerometer installed on the seat that measures the vibration at the seat occupant interface.

METHODS OF ASSESSMENT

Currently, the most popular method used to evaluate dynamic seat comfort is the seat effective amplitude transmissibility (SEAT) value. This value can be calculated directly from measured data obtained by driving a vehicle on a test track or in a laboratory conditions. It is defined as the ratio of the vibration on the seat and the vibration on the floor and accounts for human sensitivity to vibration [1]. SEAT value is defined as:

$$\mathrm{SEAT\%} = \frac{\text{Vibration on the seat}}{\text{Vibrations on the floor}} \times 100$$

MEASUREMENT REALIZATION

Measurements was realized in passenger car due the reason that owner had trouble with vibrations of the car seat. Measurement was realized during engine was running but without move. Measurement was realized in three points. First measurement was placed on the car floor and other measurement was placed on the driver and co-driver seat fig. 1. Measured values are acceleration in axis x, y, z and overall acceleration tab. 1. By using these values was counted SEAT values for driver and co-driver seat.

Fig. 1 Accelerometer installed on the car seat

Tab. 1 Results of measurements

M	Measurement	Acceleration x-axis a_{xweq} [m.s^{-2}]	Acceleration y-axis a_{yweq} [m.s^{-2}]	Acceleration z-axis a_{zweq} [m.s^{-2}]	Overall acceleration a_{vweq} [m.s^{-2}]
M1	Floor of the car	0,02	0,03	0,08	0,09
M2	Driver seat	0,07	0,59	0,22	0,63
M3	Co-driver seat	0,04	0,15	0,32	0,35

SEAT value for driver seat is 7 (700%) and for co-driver seat 3,9 (390%). Next fig. 2-4 presents measured values of accelerations in addiction on the frequency for axis x, y and z. Critical values of the acceleration was found in the frequencies 0,315- 0,8 Hz and 20 Hz.

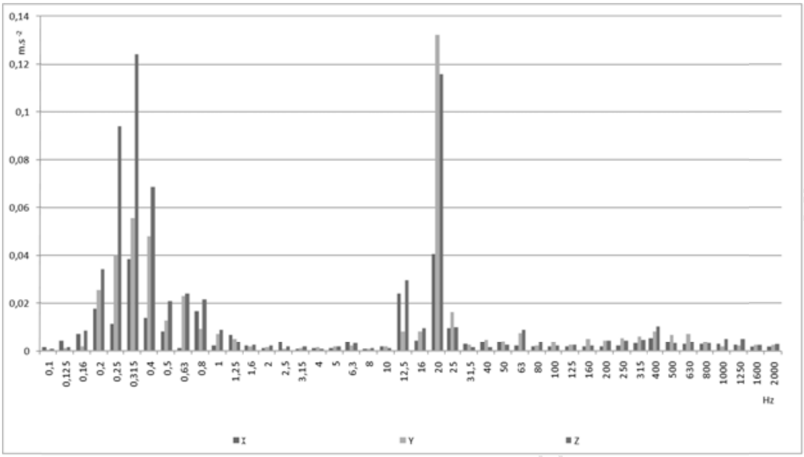

Fig. 2 Result of vibrations measurement on the car floor

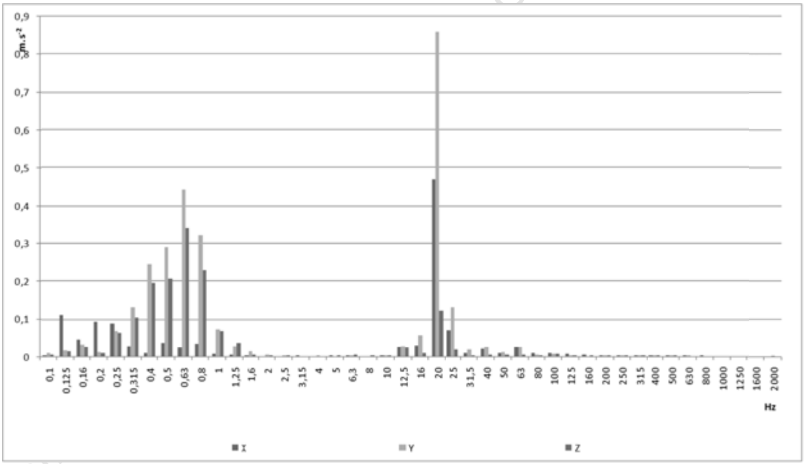

Fig. 3 Result of vibrations measurement on the driver car seat

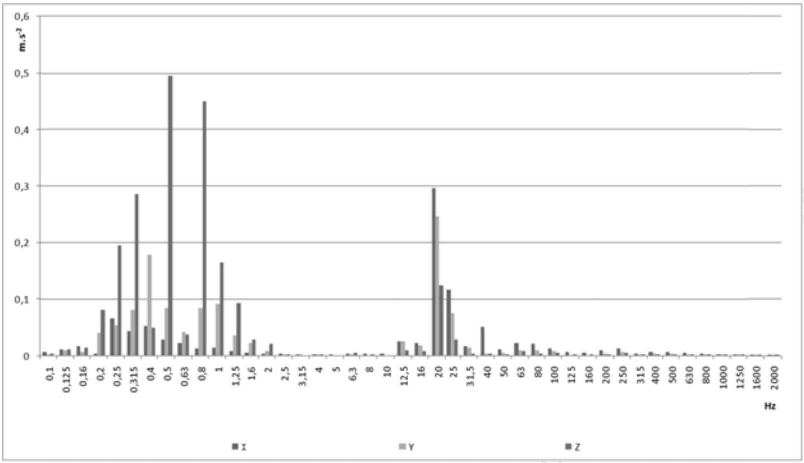

Fig. 4 Result of vibrations measurement on the co-driver car seat

CONCLUSION

On the base of the measured and counted values we note that:

- Acceleration on the driver and co-driver seat are higher than accelerations on the car floor,
- On the car seat was found critical frequencies in the range 0,315-0,8 Hz, the range to which is human body very sensitive,
- SEAT value was set for 700% for driver seat and 380% for co-driver seat,
- Generally values on the seat should be lower than on car floor.

SEAT value should be in the range under 100 %. In other cases it shows something wrong with car seats. It could be caused by the incorrect installation or by using unsuitable construction and seat materials.

Reduce the transmission of vibration to the worker by engineering the equipment or work place more effectively.
For example:

- improving vehicle suspension,
- altering the position of the seat within the vehicle,
- mount equipment on springs or compression pads,
- maintain equipment properly (i.e., balance and replace worn parts),
- proper engineering of seating,
- use materials that generate less vibration.

Seat in the cars and other vehicles are important element for human comfort and also in industrial vehicles. Seat has to minimize transmitted vibrations to human body, but in many case it is no true.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Mansfield, N.J. N.A. Localized vibration at the automotive seat-person interface, International Congress and Exhibition of Noise Control Engineering, The Hague, The Netherlands, INCE:49.134, 27–30 August 2001.

[2] Griffin, M.J. Handbook of Human Vibration, Human Factors Research Unit, Institute of Sound and Vibration Research, The University of Southampton, Academic Press Limited, England, London (1990)

[3] Westhuiyen, A. & Niekerk, J. Verification of seat effective amplitude transmissibility (SEAT) value as a reliable metric to predict dynamic seat comfort, Journal of Sound and Vibration, Volume 295, Issues 3–5, 22 August 2006, Pages 1060–1075, 2006.

VULNERABILITY ASSESSMENT OF THE SEVESO INDUSTRIAL SITES IN ROMANIA USING MULTI-CRITERIA RANKING METHODS

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ABSTRACT

The methods currently used in Romania to assess the level of risk related to a Seveso industrial site do not consider their vulnerability, which is a major deficiency. From this perspective, the paper proposes the resort to logical and consistent approach for assessing the vulnerability of Seveso industrial sites in Romania, using a multi-criteria ranking method (the Saaty method). In the paper are detailed the steps to be taken to build the index of vulnerability: studied system description and definition of an objective; analyzed system's characterization; building hierarchical structure that allows logical ordering of the elements that describe the system; matrix representation and development of the questionnaire related to achievement of assessments; vulnerability index formula determination; obtaining the weighting factors. Construction of the hierarchical structure is a key-element of the Saaty method, being grounded on a thorough description of the studied area (targets typology, types of physical and impact effects). These data are structured hierarchically, to quantify the vulnerability of targets exposed to the effects of a major accident. To meet this objective we used two levels of analysis: first level consists in the classification of targets categories importance (human, environmental and material targets) according their physical effects (overpressure, thermal flow, gas toxicity and liquid pollution toxicity); the second level corresponds to quantify the importance of target types, for a given category of targets and in terms of a physical effect given by the three types of impact (on the integrity, economic and psychological). Saaty method allows the construction of the vulnerability function and determination of weighting factors that express the vulnerability of each type of targets, based on processing the assessments made by a group of experts and collected through a questionnaire designed for this purpose.

Keywords: vulnerability, major accident, Seveso Directive, multi-criteria ranking methods

INTRODUCTION

Assessing the risk of a Seveso industrial site can be achieved by using a method based on indices. To develop the indexes a model was developed composed of three entities [1]: the source of danger which corresponds to the location, danger flow propagation that characterizes major environmental accidents and targets likely to be affected. Source of danger is assessed using the severity index that is specific to the hazardous substance involved, quantity of substance and its employing characteristics. Propagation flow is measured by an index that depends on thresholds and effect distances for each type of major accident. For the last index, representing targets vulnerability, we appealed a method of multi-criteria ranking (Saaty method) [3], [4] based on a specific way of organizing data that characterize the environment of an industrial site (giving the target typology, the physical effects and impacts arising from major accidents). The Saaty method of multi-criteria ranking, if compared to other methods of this kind (e.g., ELECTRE, PROMETEU [2], [6]), presents the advantage of quantitative approach to vulnerability by setting the weighting factors specific to each type of target.

The first part of this paper is addressing the notion of decision-making and the algorithm of Saaty method. In the second part of the work, Saaty method is applied to quantify vulnerability issues regarding existing targets in the vicinity of an industrial site of Seveso type. In this purpose, the studied system is described and structured to determine the weighting factor and the vulnerability function.

SAATY MULTI-CRITERIA RANKING METHOD

The method of multi-criteria ranking developed by Saaty in 1980 [3] has become a reference method in multi-criteria decision, although it was criticized both theoretically and practically. Later, in 1994, the author agrees to the amendment proposed by Belton and Gear in 1983, that each column of the matrix of decisions to be shared with the maximum element of that column (change of fourth hypothesis), calling the new algorithm Ideal Mode AHP [4]. This eliminates inconsistencies ordering alternatives when introducing a new alternative identical to an existing one.

Saaty method of multi-criteria ranking provides answers two main technical problems: how to determine the relative weights of a multitude of options and how we transpose numerically to compare two versions when we consider a qualitative criterion.

Saaty multi-criteria ranking method allows specification of a complex situation through structuring and creating a hierarchy of levels of detail. By default, level of detail called "high" meets the general objective, and those called "low" correspond to solutions or measures proposed.

Saaty multi-criteria method of ranking is based on completing the following three key steps: constructing hierarchies, setting priorities, logical consistency provision.

In general, SAATY method can be considered as a holistic approach to a complex situation that allows ranking elements, taking into account their interaction.

APPLICATION OF SAATY MULTI-CRITERIA RANKING METHOD FOR VULNERABILITY INDEX DETERMINATION

In order to apply the SAATY multi-criteria method of ranking to the construction index of vulnerability should be taken the following steps [5]:

- studied system description ond objective definition;
- studied system characterization;
- building the hierarchical structure that allows logical ordering of the elements that describe the system;

- matrix representation and development of questionnaire associated with the implementation of assessments;
- setting formula for the vulnerability index;
- obtaining weighting factors.

Objective definition

The objective consists to obtain function that allow target vulnerability quantification present around an industrial site and, specifically, in the study area defined in advance. In the study area are three types of targets (human, material and environmental) for which we aim quantifying vulnerability.

Targets characterization

To characterize the study area it is necessary, first, to be described the three categories of targets have been proposed. Each of the three categories of targets is in turn subdivided into several types of targets.

The main limitation of the Saaty multi-criteria ranking method lies in the large number of judgments to be made by experts. As the number of targets is greater, the greater is the number of assessments. Therefore, to obtain consistent assessments the number of targets was set to four targets for each category.

Human targets (H)

The typology of human targets is based on four categories of targets. Categories chosen, allowing a complete description of human targets, are [1], [7], [8]:

- site staff (H_1): this corresponds to targets likely to be affected severely by the effects of major accidents; indeed, the potential danger is near its maximum value, because the targets are located very close to the source of danger;
- sedentary local population (H_2): this target population consider the distribution depending on the variable "population density in an inhabited area";
- persons in public institutions and economic units working with the public (H_3): this target is specific, because these locations list, in general, a large number of people;
- users of the communication routes (H_4): this latter type of target is characterized by variable "traffic density".

Environmental targets (E)

Environmental targets can be classified into four categories [1], [7], [8]:

- agricultural land (E_1): land for farming and animal breeding;
- natural areas (E_2): land occupied by diverse vegetation (excluding protected areas);
- protected areas (E_3): land occupied by protected areas;
- aquatic environments (E_4): targets involving a water environment.

Material targets (M)

Material targets can be classified into four categories [1], [7], [8]:

- the industrial site (M_1);

- public utilities and infrastructure (M_2): public security services, communications, gas, electricity, roads, rail, river and air, parking areas, railway stations, airports, ports, bridges, tunnels, equipment designed to ensure drinking water;
- buildings and private structures (M_3): individual homes, buildings;
- buildings and public structures (M_4): monuments, churches, castles, museums, government buildings, education, research, leisure, shopping areas, hospitals, clinics, nursing homes.

Criteria to characterize the vulnerability

Quantifying vulnerability requires characterization of their targets by objectives. To achieve this goal there are two terms used to link targets to potential threat set in the previous stage, finally settling only vulnerability. These are physical effects caused by major accidents, type of impact. The physical effects are the number four:

- overpressure;
- thermal flow;
- gas toxicity;
- liquid pollution toxicity.

The impact type characterizes the importance of physical effects on targets. Of particular interest for the decision maker is not the influence of a physical effect on the target, but the influence of physical effect on the target through impact.

The impact may manifest as one of three forms:

- economic impact: effect expressed as loss of production or cost associated with rehabilitation;
- psychological impact: effect expressed as the exerted influence on a group of people;
- impact on the integrity: effect on structure of the targets.

Hierarchical structure development

Building a hierarchical structure is based on a description of the area studied (giving targets, impacts and physical effects). These data are structured hierarchically, to quantify the vulnerability of targets exposed to the effects of a major accident.

To meet this objective it is proposed to use two levels of analysis [1]:

- first level is the importance of target categories classification based on physical effects induced;
- the second level corresponds to quantify the importance of types of targets, for a given category of targets and in terms of a physical effect given by the three types of impact; finally, taking into account three categories of targets, we obtained 12 hierarchical structures.

As and example, in figure 1 is represented the hierarchical structure allowing to classify the importance of different types of targets based on physical effects, to obtain overall vulnerability.

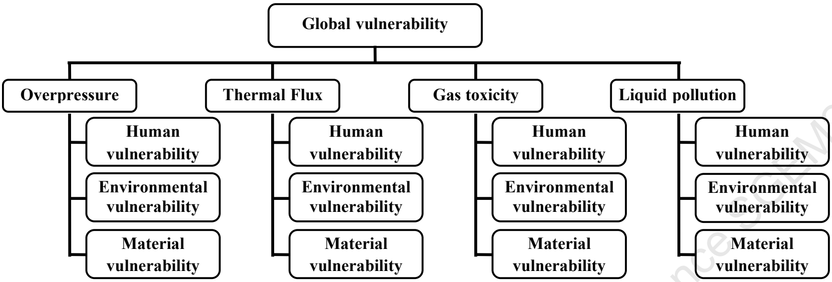

Figure 1. Hierarchical structure for global vulnerability assessment

The ensemble of 52 matrixes which is transposing the 12 hierarchical structures is presented in [1].

Establishing relationship for vulnerability index calculation

According to Saaty multi-criteria ranking method structure and way of work, each matrix corresponds to the calculation of a vulnerability relationship (global - V_G, human - V_H, environmental - V_E, material - V_M, human/environmental/material in relation to a given physical effect - $V_{(H,E,M)/(op,tf,tox,poll)}$, human/environmental/material in relation to a given physical effect for a given type of impact- $V_{(H,E,M)/(op,tf,tox,poll)(Int,Ec,Psy)}$, etc.)

As an example, will be presented the relations for calculating [1]:

- global vulnerability :

$$V_G = \alpha \cdot V_H + \beta \cdot V_E + \gamma \cdot V_M \tag{1}$$

where: α, β and γ are weighting factors of overall vulnerability function, mathematically speaking it's own vector corresponds to a matrix 1.

- human vulnerability:

$$V_H = \alpha_1 \cdot V_{H/op} + \alpha_2 \cdot V_{H/tf} + \alpha_3 \cdot V_{H/tox} + \alpha_4 \cdot V_{U/poll} \tag{2}$$

where: α_1, α_2, α_3 and α_4 are weighting factors of human vulnerability, each of these weighting factors signifies the importance of an effect of the four types of effects considered (overpressure - op, thermal flux - tf, gas toxicity - tox, liquid pollution toxicity - poll) to a human target.

- vulnerability of human targets in relation to a pressure effect for the three types of impacts considered (on the integrity - Int, economic - Ec and psychological - Psy).

$$V_{H/op} = x_1^H \cdot V_{H/opInt} + y_1^H \cdot V_{H/opEc} + z_1^H \cdot V_{H/opPsy} \tag{3}$$

where: $V_{H/op}$ is human vulnerability in relation to an overpressure effect; $V_{H/opInt}$ - human vulnerability in relation to an overpressure effect, for the impact on the integrity; $V_{H/opEc}$ - human vulnerability in relation to an overpressure effect, for the economic impact; $V_{H/opPsy}$ - human vulnerability in relation to an overpressure effect, for the psychological impact.

Matrix representation and associated questionnaire to carry out assessments

Hierarchical structures obtained by transposing matrices allow to takeover the assessments made by experts to assess the weighting factors. The matrix form of representation is the most synthetic, but it is quite faded. Indeed, because the matrices expressed appreciation to be made in a schematic manner, and experts have to rebuild a phrase to represent each assessment, significantly increases the time required to complete the set of matrices. To limit this drawback was developed and presented for consideration by experts a multiple-choice questionnaire [1].

Binary comparison scale used and how levels are defined is presented in Table 1. For reasons related to the simplification of the assessment process were retained only five levels (5, 3, 1, 1/3 and 1/5) of the commonly defined in the Saaty multi-criteria ranking method.

Table 1. Binary comparison scale for the development of vulnerability index

Significance	Definition	Comment
1	Equal importance of both elements	The two elements have identical contribution
3	Greater importance of an item in relation to other	Experience and personal appreciation favors an element relative to other
5	Large determinant importance of an element relative to other	Experience and personal appreciation strongly favors an element relative to other
1/3, 1/5	Reverse comparisons	

Weighting factors determination

Setting the weighting factors values involves an independent consulting as many experts as possible. Experts' consulting has been achieved through the questionnaire presented in [1]. The questionnaire was distributed to complete by total number of 20 experts, 12 of them completed questionnaires providing the indications provided. Assessments contained in valid questionnaires were processed by making their geometric mean. Weighting factors were evaluated by calculating the eigenvectors of each matrix.

Experts consulted can be classified in the following professions:

- inspectors (councilors) of the secretariats of risk Seveso activities organized at county, regional or national level;
- commissioners of the commissariat of the National Environmental Guard (at county, regional or national level);
- fire and civil protection officers specialized in chemical hazards in the territorial units of the General Inspectorate for Emergency Situations;
- researchers, scholars and teachers working in the field of industrial risk;
- external experts accredited by specialized commission on risk Secretariat of the National Environmental Protection Agency.

In accordance with Order no. 132/2007 of the Ministry of Interior [8], the Plan of Risk Analysis and Hedging (PRAH) is prepared by the county committee of emergency

Bucharest, namely the local emergency committees and approved by County Council/General Council Bucharest respectively by local councils, according to administrative units that are covered. Prefects, Bucharest general mayor and mayors are in charge for provision of the necessary conditions for PRAH development. These statutory provisions require further consultation to take into consideration also the judgment of prefects, mayors and local/county councilors. This possibility has been provided in the questionnaire used to determine the vulnerability index.

Consultation of operators who operate/own a site or facility subject to the provisions of the Seveso II Directive is and remains a controversial topic. The main argument supporting the exclusion of the operators of the consultation process is the subjectivity of their assessments of vulnerability of different types of targets, since they are directly involved in the risk management process. This direct involvement can be also an argument in favor of consultation operators, since they best know the risks associated to processes that they manage. Consequently, the decision to exclude or achieve the co-option of operators in the consultation process can be based on evaluating the bias of assessments issued by them. This paper aims not to find an answer to this problem, as it will be solved in the future. Despite these issues to be elucidated, the possibility of consulting the operators was provided in the questionnaire used to determine the vulnerability index.

The survey used to determine the vulnerability index is preceded by collection of data regarding the position or job, training and experience and institution/company in which respondents operate. These data allow an analysis of assessments made by respondents, both by training and professional experience, and depending on the institution/company in which they operate. This analysis can be extremely useful, since the interests of stakeholders involved in risk management for a Seveso site can be divergent, which affect the objectivity of assessments on vulnerability of different types of targets.

The higher number of experts consulted, the greater the degree of validity of results. Each response should be treated in a specific manner to synthesize results and be able to evaluate the eigenvectors corresponding to the weighting factors of vulnerability function. For this purpose, two approaches can be considered [3], [4]:

- the first approach consists in pooling their expertise and consultation in a team, summarizing the assessments are carried out after discussions within the team built for this purpose (a single questionnaire is completed expressing opinion by consensus of the entire team of experts consulted);
- the second approach involves independent of each consulting expert, assessments are processed by creating a geometric mean of each type of assessment (questionnaires to complete are in a number equal to the number of experts).

The first approach has the advantage of reaching consensus regarding all assessments but on the other hand, has the disadvantage that it allows people who have more influence because of their experience and training, to impose their views. In certain situations this can lead to exceeding the permissible degree of subjectivity.

For operational reasons and to collect the largest possible number of opinions of experts it has been chosen the second approach which is to individually consult the experts. The results are the weighting factors who were introduced later in the relations for calculating the vulnerability index.

CONCLUSIONS

Using Saaty multi-criteria ranking method for assessing the vulnerability of Seveso industrial sites in Romania emerged as an imperative that ordinary, given the requirements of national and Community legislation providing for its analysis in the whole industrial system, i.e. simultaneously taking into account the industrial site and its environment, both as a driver of major accidents and the target.

Using vulnerability assessment methodology presented in this paper, together with a GIS tool for mapping vulnerability allow the correlation of management tools used in urban planning and the level of risk associated with industrial Seveso sites, taking into consideration all socio-economic issues involving a strong territorial and environmental impact.

REFERENCES

[1] Băbuţ, M.C., Risk analysis and assessment methods for Seveso industrial sites (in Romanian), Focus Publishing House, Petroşani, Romania, 2011.

[2] Roy, B., Multicriteria Methodology for Decision Aiding, Kluwer Academic Publishers, Dordrecht, Netherlands, 1996.

[3] Saaty, T.L., The Analytic Hierarchy Process, McGraw-Hill, New York, USA, 1980.

[4] Saaty, T.L., Fundamentals of Decision Making and Priority Theory with the AHP, RWS Publications, Pittsburgh, USA, 1994.

[5] Tixier, J., Dandrieux, A., Dusserre, G., Bubbico, R., Mazzarotta, B., Silvetti, B., Hubert,E., Rodrigues, N., Salvi, O., Environmental vulnerability assessment in the vicinity of an industrial site in the frame of ARAMIS European project, Journal of Hazardous Materials, vol. 130, Issue 3, pp. 251-264, 2006.

[6] Vincke, P., Multicriteria Decision-Aid, John Wiley & Sons, Chichester, UK, 1992.

[7] * * *, ARAMIS: Accidental Risk Assessment Methodology for Industries in the framework of SEVESO II directive-User guide, E.C. Project EVG1-CT-2001-00036, 2004.

[8] * * *, Order no. 132/2007 of the Ministry of Interior to approve the Methodology of the risk analysis plan and hedging and Structure Framework of Plan of risk analysis and hedging, Official Journal of Romania, part I, no. 79/01.02.2007.

WATER QUALITY AND MANEGEMENT STRATEGIES OF ESEN RIVER (MUGLA-TURKEY)

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ABSTRACT

To determine the water quality of Eşen River, seven sampling points were selected and seven water quality determination methods were performed. Of the performed water quality methods, two were physicochemical and five were biological, based on benthic macroinvertebrates. SI, FBI, BMWP, ASPT, BBI biotic indices and EPT/*Chironomus sp.* ratios were the applied on Esen River. A total of 111 benthic macro invertebrate taxa consisting of 48 genera and 63 species, which belong to classes Turbellaria, Gastropoda, Bivalvia, Hirudinea, Crustacea and Insecta were identified and used. Of these, %86, 84 (96 taxa) belong to Insecta. It was determined that, *Gammarus sp.*,was dominant on upper zones while *Chironomus sp.* was dominant on lower zones of Esen River. No significant difference was evident between the biodiversity and physicochemical parameters.

According to the obtained data, it was evident that there are no intensive pollution pressures on Eşen River. However, moderate pollution was found among sampling points of the lower river basin. Management strategies especially about the effect of fish farms on Esen River should be developed immediately.

Keywords: river water quality, management, biotic indices

INTRODUCTION

Rivers are important ecosystems for the flow of energy, matter and organisms through the landscape. Various activities at the catchment areas may cause to environmental deterioration of rivers. However, the assessment of the changes in river communities as the result of the impact of pollution is a particularly interesting issue within the framework of aquatic ecology, since running waters is becoming increasingly affected by anthropogenic discharges [1]. To assess the quality of running waters, many biotic indices based on macroinvertebrates have been proposed [2], [3], [4], [5], [6], and [7]. In Turkey, running waters have received much less attention from limnologists than lakes, and the assessment of water quality is based mainly on physicochemical variables. But, analyses of river water quality based on macroinvertebrates together with physical and chemical variables have recently been conducted in Turkey [8], [9], [10], [11]. The biotic indices are based on the different sensitivity of some taxa of macroinvertebrates to the pollution. For this purpose, the presence or absence of some taxa is used as an indicator of the pollution level of the water body; in some indices, the level of relative abundance or diversity of the taxa were also taken into account.

Eşen River is one of the most important aquatic systems of the South western Anatolia and flows into the Mediterranean Sea. In order to estimate the pollution level and to evaluate biotic community, seven water quality determination methods were performed.

THE STUDY SITE AND METHODS

Eşen River with a length of 146 km originates from the Çaldağı and Kızılcadağ mountains and discharges into the Mediterranean Sea (Figure 1). It can be considered as a middle-sized river. There attractive historical and touristic places like Yakapark (Tlos), Kınık (Xanthos), Kumluova (Letoon) and Patara in the study area. There are two important hydroelectric dams, each has a power of 16,5 MW and flow rate of 12 m^3/sc. There are fish farms with a total capacity 1500 tons/year on the second sampling point of the Eşen River.

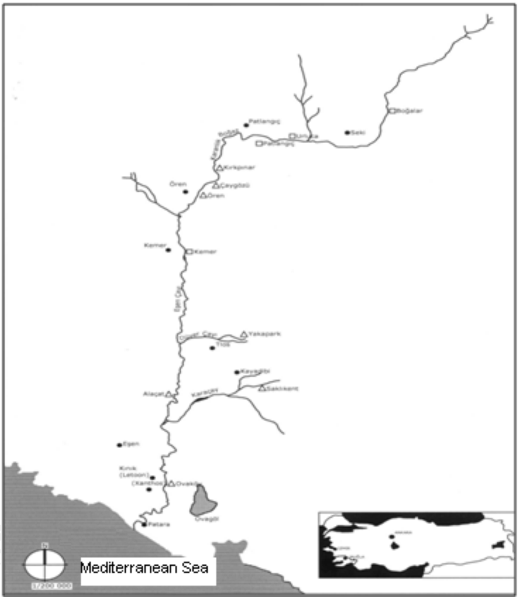


Figure 1. Study Area

The distribution of physicochemical parameters and nutrients of surface waters of the river Eşen were studied monthly intervals from June 2003 to June 2005 at seven sampling stations. At each site, water samples were collected at a position nearer to the bank, with polyethylene bottles.

Of the physicochemical parameter, pH, conductivity, dissolved oxygen were measured in the field with HQ40d portable Multi-Parameter Meter. Biological oxygen demand (BOD_5) was measured after five days. The determination of nitrogen and phosphate nutrients in the water was carried out spectrophotometrically using the methods described in APHA [12]. Benthic macroinvertebrates were collected according to Plafkin et al., [13] with standard D-frame dip net, 500 µ opening mesh, and 0, 3 m width by checking the substratum 100 meters to the upstream [14].

The physicochemical water quality classifications were performed according to Klee [15] and The Book of Instruction for Water Pollution Management (SKKY) [16]. Saprobe Index (SI) [17], Family Biotic Index (FBI) [18], Biological Monitoring Working Party Score System (BMWP) [19], Average Score per Taxon (ASPT), [19], Belgian Biotic Index (BBI) [2] indices, based on benthic macroinvertebrates, were performed.

RESULTS

The complexity of natural ecosystems requires the use of a number of variables for water quality assessment. Nutrients and biological oxygen demand contents of the water are considered as the most significant parameters in pollution studies. In figures sampling points were shown as SP, minimum level as Min, average level as Av and maximum level as Max. Dissolved oxygen (Figure 2) varied between 4, 7 mg L^{-1} and 13, 8 mg L^{-1}. The highest biological oxygen demand (Figure 3) was measured in sampling point five (5, 04 mg L^{-1}). Conductivity ranges between 145 μScm^{-1} and 622 $\mu S\ cm^{-1}$ (Figure 4). The average of pH values were similar among the sampling points and ranged between 7, 05 and 8, 64 (Figure 5). The highest ammonium nitrogen (NH_4-N) was measured in sampling point seven as 4, 35 mg L^{-1}, but the highest average was measured in sampling point six as 1, 73 mg L^{-1} (Figure 6). The highest average nitrate nitrogen (NO_3-N) was found in sampling point six as 5,97 mg L^{-1}, but the highest nitrate nitrogen value was measured in sampling point seven (Figure 7). The average nitrite nitrogen (NO_2-N) was high in sampling points three, six and seven but the highest level was measured in sampling point three and six as 0, 0329 mg L^{-1} (Figure 8). The highest level of phosphorus (PO_4-P) was measured in sampling point three as 2, 32 mg L^{-1} (Figure 9).

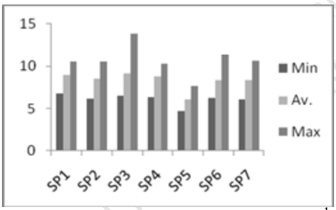


Figure 2. Dissolved oxygen (mg L^{-1})

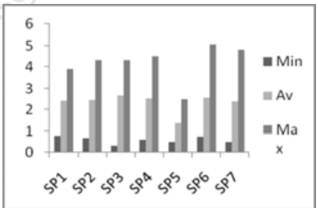


Figure 3. BOD_5 (mg L^{-1})

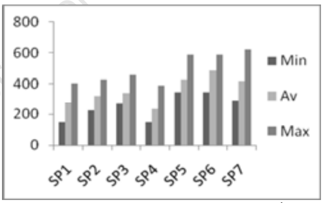


Figure 4. Conductivity (μScm^{-1})

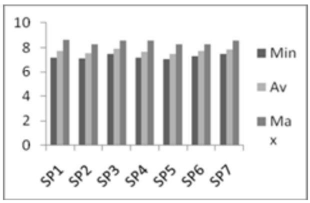


Figure 5. pH

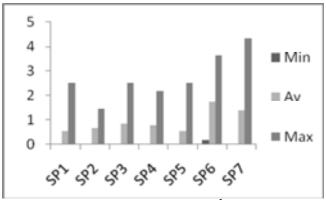


Figure 6. NH_4-N (mg L^{-1})

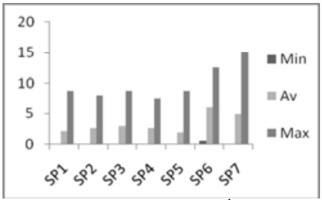


Figure 7. NO_3- N (mg L^{-1})

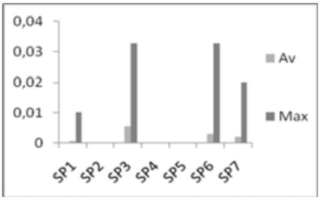


Figure 8. NO_2-N (mg L^{-1})

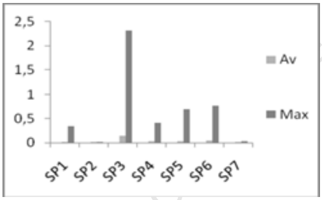


Figure 9. PO_4-P (mg L^{-1})

According to the physicochemical data and a total of 111 identified taxa belonging to Turbellaria, Gastropoda, Bivalvia, Hirudinea, Crustacea and Insecta, water quality classes of Eşen River were determined (Table 1).

Table 1. Water quality classes of Eşen River

	SP1	SP2	SP3	SP4	SP5	SP6	SP7
SKKY	**I**	**I**	**I**	**I**	**I**	**II**	**I**
	High quality	High quality	High quality	High quality	High quality	Slightly polluted	High quality
Klee (1991)	**I-II**	**I-II**	**I-II**	**I-II**	**I**	**II**	**I-II**
	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Not polluted	Moderate polluted	Slightly polluted
Saprobe Index	**I-II**	**I-II**	**II**	**I-II**	**I**	**II**	**II-III**
	Slightly polluted	Moderate polluted	Moderate polluted	Slightly polluted	Not polluted	Moderate polluted	Critically polluted
FBI	**II**	**II**	**II**	**II**	**II**	**II-III**	**II-III**
	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Critically polluted	Critically polluted
BMWP	**III**	**III**	**III**	**III**	**III**	**V**	**V**
	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Polluted	Polluted
ASPT	**I**	**I**	**I**	**I**	**I**	**III**	**II**
	Not polluted	Not polluted	Not polluted	Not polluted	Not polluted	Moderate polluted	Slightly polluted
BBI	**II**	**II**	**II**	**II**	**II**	**III**	**III**
	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Slightly polluted	Moderate polluted	Moderate polluted

On Eşen River, sampling points six and seven has a lower water quality. The members of Baetidae family of Ephemeroptera order were abundant at these two sampling points.

The following abundant order was Diptera at theses sampling points. Stribling et al., [20] has reported that, the taxa belonging to Diptera order especially the members of Chrinomidae family have cosmopolite distribution from high quality to the heavy polluted sampling points. Plafkin et al., [13], Metcalfe [19], Meyer [21], Bode et al., [18] have reported that the members of Plecoptera order are sensitive to the pollution. The obtained data in this study about the members of Plecoptera order were parallel with the previous studies. The members of Plecoptera order were abundant at the sampling points which have high quality classes. When the physicochemical and biological water quality results were compared, it was seen that the physicochemical results were relatively one or two level higher than the biological results. It was observed that, the river substratums were destructed by sand and gravel quarries and the benthic macroinvertebrates living on substratum were affected. The ratio of EPT/ *Chironomus* sp. (Ephemeroptera, Plecoptera and Trichoptera order members) were in accordance with the water quality results. Plafkin et al., [13] has reported that EPT taxa are sensitive to the pollution and by the increase of pollution level, their number and species richness decrease. And the number of *Chironomus* sp. increase by the increase of pollution level. The highest average level of EPT/ *Chironomus* sp. was found at sampling point five where the water quality class was high.

As a result it was observed that there is not an intensive pollution pressure on Eşen River. Fish farms in which *Oncorhynchus mykiss* **(**Walbaum, 1792**)** were cultured are important pollution sources on Eşen River. The second important pollution source is sand and gravel quarries that destruct the substratum. And the pesticides and fertilizers used for getting more products in farming are another important pollution source. The precautions should be taken urgently to protect Eşen River. River basin management model should be activated. All responsibilities and authorities should be managed by one public agency.

REFERENCES

[1] Bate G, Smailes P, Adams J A. Water quality index for use with diatoms in the assessment, Water SA Vol. 30 No. 4: 493-498, 2004.

[2] De Pauw N and Vanhooren G. Method for biological quality of water courses in Belgium. Hydrobiologia 100: 153–168, 1983.

[3] De Pauw N, Ghetti PF, Manzini P and Spaggiari R. Biological assessment methods for running water. In: Newman P, Piavaux A and Sweeting A (eds) River Water Quality - Ecological assessment and control. EUR.06EN-FR: 217–246, 1992.

[4] Iliopoulo-Georgudaki, J., Kantzaris, V., Katharios, P., Georgiadis, Th. and Montesantou, B. An Application of Different Bioindicators for Assesing Water Quality; A Case Study İn The Rivers Alfeios and Pineios (Peloponnisos, Greece), Ecological Indicators, Vol:2, 345-360, 2003.

[5] Ghetti PF and Ravera O. European perspective in biological monitoring. In: Loeb SL and Space A (eds) Biological monitoring of aquatic systems. C.R.C. Boca Raton, Fl.: 31–46, 1994.

[6] Simić, V. and Simić, S. Use of the River Macrozoobenthos of Serbia to Formulate a Biotic Index, Hydrobiologia 416: 51-64, 1999.

[7] Lorenz, A., Hering, D., Feld, C. K., and Rolauffs, P. A New Method For Assesing The İmpact of Hydromorphological Degradation on The Macroinvertebrate Fauna Of Five German Stream Types, Hydrobiologia, 516: 107-127, 2004.

[8] Kazancı, N, Girgin, S., Dügel, M., & Gökçe, D. Researches on inland waters of Turkey II. Biotic index method for assesment of environmental quality of running waters. Özyurt Printing House, 100 pp Ankara (in Turkish with English summary), 1997.

[9] Kalyoncu, H., Çiçek, N.L., Akköz, C., Yorulmaz, B. Comparative performance of diatom indices in aquatic pollution assessment, African Journal of Agricultural Research Vol. 4 (10), pp. 1032-1040, 2009.

[10] Kalyoncu, H., Barlas,M., Yıldırım, M. Z., Yorulmaz, B. Gastropods of Two Important Streams of Gökova Bay (Mugla, Turkey) And Their Relationships With Water Quality, International Journal of Science & Technology (IJST), 3, No 1, 27-36, 2008.

[11] Uyanık, S., Yılmaz, G., Yesilnacar, M. I., Aslan, M., and Demir, Ö. Rapid Assesment of River Water Quality in Turkey using Benthic Macroinvertebrates, Fresenius Environmental Bulletin, Vol 14, No 4, 268-272, 2005.

[12] APHA. Standard Methods for the Examination of Water and Wastewater. 16th edition American Public Health Association, New York, 1985.

[13] Plafkin, J. L., Barbour, K. D., Gross, S. K. and Hughes, R. M. Rapid Bioassesment Protocols for use in Streams and Rivers, Benthic Macroinvertebrates and Fish, EPA/444/4-89-001, Office of Water Regulations and Standards, U.S. Environmental Protection Agency, Washington, D.C., 1989.

[14] Environmental Protection Agency (EPA). AQ Review of the EPA Red Book Quality Criteria for Water, USA, 311 p, 1979.

[15] Klee, O. Angewandte Hydrobiologie.- G. Theieme Verlag, 2. neubearbeitete und erweiterte Auflage, Stuttgart-New York, 272 p, 1991.

[16] Council of Environment The Book of Instruction of Water Pollution (SKKY), Ankara, Turkey, 1988.

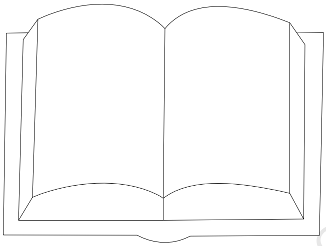
[17] Sladecek, V. System of Water Quality from the Biological point of View.- Arch. Hydrobiol. Beih. Ergebn. Limnol. 7, 1-218, 1973.

[18] Bode, R. W., Novak, A. M. and Abele, L. E. Methods for Rapid Biological Assessment of Streams. NYS, Depertment of Environmental Conservation, Albany, NY. 57 p, 1991.

[19] Metcalfe, J. L. Biological Water Quality Assessment of Running Waters Based on Macroinvertebrate Communities: History and Present Status in Europe, Environmental Pollution., 60, 101-139, 1989.

[20] Stribling, J.B., Jessup, B.K., White, J.S., Boward, D., Hurd, M. Development of a Benthic Index of Biotic Integrity for Maryland Streams, Report no. CBWP-EA-98-3, 62 p, 1998.

[21] Meyer, D. Makroskopisch- Biologische Feldmethoden zur Wassergütebeurteilung von Flieβgewässern, 3. Auflage, A.L.G., 6, 3000, Hannover, 140 p, 1987.



Section ENVIRONMENTAL LEGISLATION, MULTILATERAL RELATIONS AND FUNDING OPPORTUNITIES

CERTIFICATION OF AN ENERGY BY-PRODUCT AS A PRODUCT – CASE STUDY IN THE CZECH REPUBLIC

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ABSTRACT

In many processes occurs formation of voluminous by-product, which can be moved off the force of waste legislation, because as a demanded product can be used in various ways, for example for reclamation of abandoned mining sites or other construction work. This approach supports strongly Sustainable Consumption and Production principles, as it saves primary resources from exploration and does not allow storing of the by-product as a waste. Because the by-product is a part of production process, it has an obligation to be identified, evaluated and registered for its chemical characteristics also in the frame of REACH resolution (1907/2006 EC). Before the by-product is ready for use, it must be assessed according to its physical/functional characteristics and necessarily also from the environmental point of view. In this moment must be found the compliance to several legislative obligations. For the use as a certified construction product another set of tests must be provided, to fulfil the requirements of Czech branch specific norms. After all these procedures the by-product can be certified as a suitable for construction use. There is not common European approach for assessment of such by-products and if the product certified for the use in Czech Republic would be exported to any other country, new assessment with different (local) rules must apply. This seems to be ineffective and whole process should be harmonized across the EU states to avoid additional costs.

In the text is described the process of certification of energetic by-product for construction use as a material for abandoned mining sites recovery according to Czech legislation requirements.

Keywords: energetic by-product, certification, REACH, hazardous properties, sustainable consumption and production.

INTRODUCTION

Our planet, as the supplier of raw materials with which products are manufactured to bring certain comforts and conveniences to our society, is undoubtedly overburdened by our exploitation of its resources. Mining of the requisite raw materials and the manufacture of numerous products have significant effects on the environment. Behind all this there are economic factors, since economic activities require sources, such as energy, material, and land. Further, economic activities produce materials which enter the environment as waste and emissions. The crucial question is what influences these activities have on the exploitation of natural resources and the generation of contamination, and how many more sources the Earth is capable of providing and how much more contamination it is able to absorb. [1]

These apprehensions brought a need to analyse the state of global ecosystems. It has been found that in the past 50 years people have changed ecosystems, in order to satisfy their demand for foodstuffs, fresh water, wood, fuels, etc., much faster and more intensively than in any other comparable epoch in human history, causing significant and irreversible losses to life diversity on Earth. [1]

Meeting the needs of humankind is connected with a considerable generation of waste which is landfilled, incinerated, or recycled. Industrial society forms excessive quantities of waste due to mass consumerism. Agricultural society in the past used up everything and the generation of wastes was negligible. [2] Because of the rapid growth of the global population, and of the production of waste, it is obvious that society will never completely eliminate waste. Thus it is necessary to provide certain sustainability in the production and to exert effort to replace primary raw materials with waste materials.

Sustainable production and consumption is defined as the utilisation of services and products which meet the basic needs of a society and improve the quality of life, but at the same time minimise the consumption of natural resources, the use of toxic substances, and the production of wastes and pollutants within the whole lifecycle of the service or product, so that needs of future generations are not endangered. [3] Sustainable consumption and production should not present an obstacle for economic development. On the contrary, it should represent a challenge and opportunity for the entrepreneurial sector to optimise the production process in terms of energy and material demand, and to manufacture products with competitive advantages for the increasingly conscious consumer market of the European Union – products with emphasis laid on quality, health, and environmental protection. Sustainable production shall include the replacement of primary raw materials with secondary ones – wastes. These raw materials may be utilised, for example, in the building industry or in the revitalisation of brown-fields, mining regions, etc.

This publication brings an analysis of the obligations applicable to producers who would like to use as a product a raw material generated in the course of their production as a secondary raw material. This material is not produced purposely but as waste, yet demand for this raw material is formed on the market and there are possibilities of its utilisation. Thanks to this, wastes may be utilised as secondary raw materials, promoting a strategy of sustainable production and consumption, and deintensifying the exploitation of primary raw materials and thus their destructive effect on global ecosystems.

2. GENERAL DESCRIPTION OF CERTIFICATION

At the beginning of the process it must be determined whether the given waste is really waste, whether there is some demand for the raw material on the market, or whether it may be reused. If there is such a demand, the waste becomes a by-product and is excluded from the obligations specified by the waste directive [4], but must comply with special legal regulations specified below. For use in the building industry, such a product must be certified.

The product certification is a process validating the compliance of its properties with technical specification, i.e. validating its quality on at least the so-called usual level. The certificate attests that requirements on usable properties and product safety, required by given technical specification, have been met. [5]

If a product is intended to be certified, it is necessary to know what type of product it is, what components it consists of, and for what purpose it should be used. Upon these facts the manufacturer shall find technical specifications corresponding with the intention planned.

Within the certification process, necessary analyses of the proposed use of the product shall be conducted. The scope of these analyses is given in the technical specifications of a technical building institution which acts also as an authorised person issuing the certificate. [6] Technical specifications comply with the Government Decree on the technical requirements on products. [5] Apart from the analyses, an application shall further include a company standard containing details of the product, its production technology, and other data.

2.1 RELATED LEGISLATION

Czech national regulations are based on and comply with European regulations and are integrated in the requirements on the determination of the technical compliance of a product [7, 8] and its subsequent certification as specified in Government Decree no. 163/2002 Coll. [9], determining technical requirements on selected building products and dividing products into various categories for assessing their compliance with technical specifications. Regulation 305/2011/EC includes a list of products for the compliance assessment, but it does not include products listed in Government Decree no. 163/2002 as special materials, products, structures, and equipment. According to Government Decree no. 163/2002 Coll., a product is determined for the compliance assessment by an authorised person in the Czech Republic and certificates issued are valid only for the use of the product in the Czech Republic. Its export outside the country is subject to the control of documents, or new testing conducted by authorised persons in countries to which it is imported. Each EU member state has its own rules for putting such products on its market, and some building products determined acc. to the Gov. Decree no. 163/2002 are not defined as determined in some EU member states.

The obligatory analyses include not only the assessment of properties related to usable values, such as shearing strength, volume mass, granularity or moisture content, but also the assessment of the chemical elements present in a water extract, ecotoxicity, etc., due to the evaluation of possible environmental impacts. [10] Ecotoxicological tests are referred to the water act, which include specified standards according to which the tests shall be conducted. At present, negotiations are being conducted to decide whether obligatory annexes to the certification should include also verification of the registration of the components of a product or the product itself, according to the current legislative tool in the management of chemical substances – the REACH Regulation. [11]

As already mentioned, each EU member state has its own rules for putting products on the market. Currently there is no other member state with procedures for the compliance assessment and certification of products belonging to the special product category similar to those valid in the Czech Republic. This product category is not even specified in Regulation 305/2011/EC. Due to this fact certificates issued are valid only for the use of such products in our country and their export is subject to the control of documents, or new testing conducted by authorised persons in the countries concerned. This process appears ineffective because individual member states may include different requirements in their risk assessment of building products. Harmonisation of this process seems to be a purposeful and effective way to provide identical requirements on products in all EU member states.

3. EVALUATION OF PRODUCTS AND SECONDARY RAW MATERIALS ACC. TO REACH REGULATION

Regulation of the European Parliament and the Council (EC) no. 1907/2006 of 18 Dec 2006, known under the abbreviation REACH, represents a crucial legislative tool in the risk management of chemical substances. The abbreviation itself specifies the basic principles of the Regulation, i.e. registration, evaluation, authorisation, and restriction of chemical substances. These rules shall provide a high level of protection of human health and the environment, and the free movement of substances within the common market, together with increased competitiveness and innovation. These rules shall be applied to the production, import, marketing, and use of the substances as such or contained in mixtures and articles. The REACH Regulation is based on the principle that manufacturers, importers, and downstream users must ensure that they produce, import, market, or use only those substances for which risks to human health and the environment have been assessed. [12]

The REACH Regulation applies generally to all chemical substances put on the market in a quantity of over 1 ton per year. However, it applies not only to these substances, as frequently misinterpreted, but also to substances contained in mixtures classified as hazardous. The registration duty applies also to substances formed during production as secondary raw materials and put on the market following demand (such as flue-ash, cinder, synthetic gypsum, etc.). [13] The REACH Regulation requirements are obligatory for all EU member states and for importers into the EU. Rules for the registration of substances are specified explicitly, i.e. hazardous properties shall be determined and risks evaluated appropriately in the same way, according to Regulation 440/2008/EC [14].

In meeting these requirements, manufacturers may participate in the so-called SIEF, a forum for the exchange of information on substances where manufacturers of the same substance can share data. This should reduce the number of necessary tests to be conducted for the identification of risks in the form of hazardous properties, and to split the costs of registration and testing between individual manufacturers.

4. CASE STUDY

The practical part has been elaborated with a case study of the certification of a mixture consisting of two energy by-products. The mixture (product) is intended for recultivating landscapes affected by the mining of raw materials and brown-fields. The product belongs to the category of special materials, products, structures and equipment, and a group of products containing solid remains of solid fuel incineration [10], in this case flue-ash. For mixtures containing flue-ash, which may be used for recultivating landscapes or for construction, five technical specifications are available, out of which the specification 09.14§5 was selected for the case study. This specification is the least demanding for manufacturers and does not require ecotoxicity tests to be conducted, although products used for recultivating landscape are required not to exhibit hazardous properties.

4.1 CERTIFICATION PROCEDURE

If the manufacturer intends to have a product (belonging to by-products) certified and selects a procedure according to the technical specification (see above), the procedure is as follows. The manufacturer shall elaborate a company standard containing data on the product, the technological process of its production, planned usage, and properties to be assessed. These properties shall include physical properties such as shearing strength or granularity, resulting analyses of an extract and Ra^{226} activity.
Complete documentation, with a certification application and product sample, shall then be submitted to an authorised person who shall subsequently perform an evaluation of the product's compliance with the technical documentation. If the limit values of indicator and other particulars are met, a certificate for the product is issued.

4.2 COMPLETION ACCORDING TO REACH

Regarding the technical procedure mentioned it may be stated that REACH ensures better control of materials in terms of their hazardous properties, since in the future this assessment may not be based solely on an extract. Within the obligatory registration of product components, the components must be tested to exclude the presence of hazardous properties. An inconvenient aspect of the REACH certification seems to be the obligation to register a component or a product according to REACH. Subsequently, the registration period will end in 2018, presenting a disadvantage for those producers who will manufacture a given product in a quantity below 100 tons per year.

4.3 SIGNIFICANCE FOR THE ENVIRONMENT

The unification of requirements on the risk assessment under REACH, which determines obligations for all EU member states and importers to the EU, signifies that these requirements shall be identical. This Regulation should affect the actual certification process of a product, laying down also obligatory registration acc. to REACH, which presents a positive impact on the environment. A particular example may be the case study within the certification procedure, in which only heavy metal extracts and radioactivity assessment were determined out of the required properties related to hazardous aspects. The exclusion of hazardous properties upon ecotoxicity was not specified at all. The obligation to register components means that components will have to be tested in a scope defined for each tonnage level. This should provide necessary data to determine whether a particular component has any hazardous properties.

5. CONCLUSION

Sustainable production and consumption brings pressure to replace primary raw materials with secondary ones. The production of wastes which may be easily reclassified to products and subsequently reused continues to increase. The usual manner of waste-disposal is environmentally unsound compared to the utilisation of those same wastes as secondary sources of raw materials. Within this sphere it is necessary to unite the technical requirements related to physical and chemical properties and to toxicological and ecotoxicological properties on an international level. The REACH Regulation provides an opportunity for a single, one-off classification of the environmental impacts of chemical substances contained in secondary raw materials and the registration of such waste substances in order to assess the impacts of the newly certified secondary raw materials. From the EU's point of view it would be suitable to unify the certification procedures of by-products through REACH registration, and thus simplify the whole process, enabling the use of by-products on an international level.

REFERENCES

[1] Assessing the Environmental Impacts of Consumption and Production Priority Products and Materials, United Nations Environment Programme, 2010. ISBN: 978-92-807-3084-5.

[2] Lennart Nilsson at all. Cleaner Production Technologies and Tools for Resource Efficient Production, The Baltic University, Uppsala, 2007. ISBN 91-975526-1-5.

[3] Bohumil Beneš, Soňa Beroušková at al. Rámec programů udržitelné spotřeby a výroby České republiky. Ministerstvo životního prostředí, Czech Republic, 2005. ISSN 1213-3393.

[4] Directive 2008/98/EC of the european parliament and of the council of 19 November 2008 on waste and repealing certain Directives, Article 5 (1).

[5] NAŘÍZENÍ VLÁDY č. 163/2002 Sb. ze dne 6. března 2002, kterým se stanoví technické požadavky na vybrané stavební výrobky, ve znění nařízení vlády č.312/2005 Sb. ze dne 13. července 2005.

[6] Technical and Test Institute for Construction. Available at: http://www.tzus.cz/content/english-version

[7] Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products.

[8] Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC Text with EEA relevance

[9] Technical Manuals. Technical and Test Institute for Construction. Available at: http://www.tzus.cz/technicke-navody/27

[10] Special materials, products, structures and equipment. Technical and Test Institute for Construction. Available at: http://www.tzus.cz/technicke-navody/35

[11] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.

[12] Steffen Foss Hansen, Lars Carlsen, Joel A. Tickner. Chemicals regulation and precaution: does REACH really incorporate the precautionary principle, Environmental Science & Policy, Volume 10, Issue 5, August 2007, Pages 395-404

[13] Lars Koch a, Nicholas A. Ashford. Rethinking the role of information in chemicals policy: implications for TSCA and REACH, Journal of Cleaner Production 14, 2006, Pages 31-46.

[14] Council Regulation (EC) No 440/2008 of 30 May 2008 laying down test methods pursuant to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (Text with EEA relevance).

CLIMATE CHANGE ADAPTATION INTEGRATION INTO COASTAL MUNICIPAL DEVELOPMENT: GOVERNANCE ENVIRONMENT AND COMMUNICATION PRECONDITIONS

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ABSTRACT

There was realized university-municipality research and development project by the case study research methodology, with the aim of performing an interdisciplinary situation audit on the climate change adaptation local policy existing practice conditions and development possibilities for coastal municipality of Salacgriva (Latvia), and as the result, relevant governance guidelines were elaborated [12]. Besides auditing and further on developing climate change integrations into three main sustainability dimensions, there is necessity to work with additional and separate dimension, the so called governance environment, which is to be considered the unifying horizontal element encircling all the three vertical sustainability dimensions and intentionally is to be the called "integrating medium" as well and subsequently separately studied, planned and managed. Further work was organized by North Vidzeme Biosphere Reserve administration and municipality and after public/expert hearing documents were transferred into very first municipal climate change adaptation strategy in Latvia.

Keywords: governance environment model, green municipality and development planning, climate change adaptation, integration, climate communication

INTRODUCTION

The Department of Environmental Management (DEM), in the 2010 performed collaboration research project on local municipal level climate change adaptation in partnership with Salacgriva County Municipality and the North Vidzeme Biosphere Reserve (Ministry of Environment). Project was realized as research and development (R&D) project and particularly by the case study research (CSR) methodology, (including field studies in this coastal region) with the aim of performing an interdisciplinary situation audit on the local climate change adaptation policy existing practice conditions and development possibilities, as well as, to draft, as a result, relevant policy planning (governance) guidelines [12]. This was done as our university contribution for start-up of the EU project „Climate Change: Impact, Costs and Adaptation in the Baltic Sea region" (BaltCICA) in the Salacgriva municipality. Municipality has been working further on in closest collaboration with North Vidzeme Biosphere Reserve (Salacgriva municipality is one part of the area covered by this UNESCO initiated environmental management and sustainable development approach and instrument) and during 2011 the Climate change adaptation strategy was discussed wide and approved by municipality's Council.

Some particular results of this R&D project were translated and elaborated for EU Interreg project "Cobweb" as designed and implemented for coastal municipalities and main stakeholders to be involved, but main credit goes to the contribution of the "Theseus" research project on coastal risk management and communication -"The

support of the European Commission through FP7.2009-1, Contract 244104 - THESEUS ("Innovative technologies for safer European coasts in a changing climate"), is gratefully acknowledged".

There are to be seen various national and also regional and local climate change adaptation strategies especially in the nearby EU Nordic region and sectorial approach used for analysis and later on planning is dominating, however also more interdisciplinary based approaches are complementary slowly step-wise applied as opposite to this mono- or as best multi-disciplinary based works. For example, in the Danish strategy for adaptation to a changing climate we can see stress on the eleven main individual sectors recognized as priority for action: coastal management, (dikes, ports etc.); buildings and infrastructure; water supply; energy supply; agriculture and forestry; fisheries; nature management; land use planning; health; rescue preparedness; insurance aspects (2008) – actually all main development sectors since impacts are wide spread and/or straight interconnected between sectors. This also means, that climate change specifics introduced into development planning actually do cover all sectors and shall be integrated into all of them and as interlinked as possible, however, that's task still mainly ahead of planners, both because lack of necessary interdisciplinary-integrated planning/management knowledge (as we can see, unfortunately, still for several decades to be developed integrated coastal zone management (ICZM) approach) as well as also since some missing research proves, different range of climate change impacts in practice and, of course, due to financial reasons.

At the regional/local municipality level sectors prioritized do vary as since traditionally mainly impacting ones like energy, emergency, agriculture etc are complemented by regional/local specialisms recognized. In the regional climate strategy of region Zealand (Denmark) we can see the following eight individual sectors for action to be planned now: the regional energy system; agriculture; industry and technology; transport; towns and buildings; open land; health care and emergency management; management of internal business (2009). A kind of generally similar approach, after introducing basic study models to work with and climate change audit performed, was used for this very first municipal case in Latvia we started [12], however there are some particularities we would stress out as very crucial according to our previous R&D results/products.

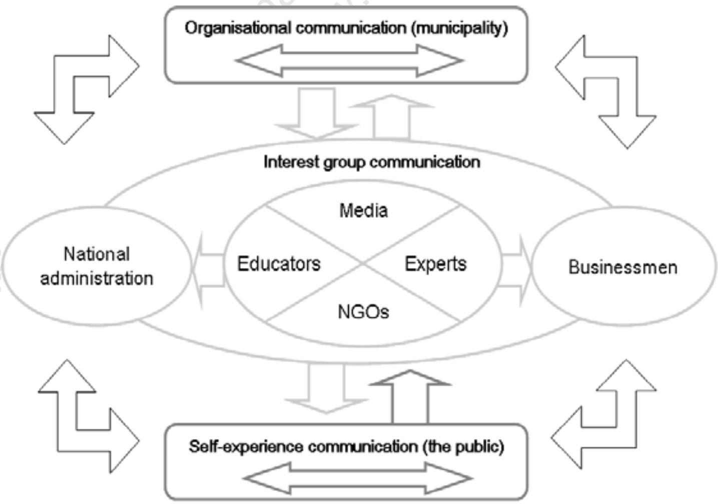
GOVERNANCE ENVIRONMENT - PRACTICE IMPERATIVE AND MODEL

The situation assessment/audit in the Salacgriva coastal municipality as for the first municipal case in Latvia has been carried out applying both sectorial analysis and especially very purposely also their integration attempt in each of the three pillars of sustainable development (SD) – i.e., natural environment, social environment and economic environment. But our research approach priority was also with an additional separate research and planning/management area, often in planning processes still being almost not recognized and so not sufficiently studied or forgotten/neglected or at least only partially mentioned/described and used as planning/management instrument mainly, however in reality being "a living organism by itself" as an additional **separate sector/dimension** [3,4,5,12] to be managed sustainable as well. And this management is to be done in both ways - directly **disciplinary and integrative** as obviously crucially interlinked and deciding on to other three sustainability dimensions. We are calling this additional and separate sector model (R.Ernsteins, 2002) as the **governance**

environment (*parvaldibas vide* – in Latvian**),** which, if summarizing, is to be considered the unifying horizontal element encircling all the three vertical SD sectors and intentionally is to be the called "integrating medium" as well. Also as most importantly for any organization/institution, also municipality, this sector is to be separately studied, planned and managed as simply speaking do includes the local administration structure and content, all interaction process for decision making preparation and taking, within particular administrative/working environment, and, as the result of all this mentioned, also all related municipal products and services development.

To conclude for this governance environment model building as we do propose for all municipal research and development (R&D) projects [3,4,6-9,11] and also for this climate change adaptation project especially and particularly there is to be stressed and importantly expanded especially nowadays important governance component – the communication and in both directions as traditionally known internal (vertical and horizontal) communication and external all stakeholders communication. The latter one inter alias includes mainly local society interest groups oriented communication and as we would like to introduce here the so called **self-experience communication** [4,11] - the mutual practical self-experience exchange and learning, and, of course, participating and acting/behaving communication from/between environmentally and sustainable already experienced inhabitants/families, groups/organizations (see Fig.1). Within this project there should have been included also both content/topic communication approaches as environmental and climate change communication, and different sub-approaches within those as particularly essential ones for current specialisms.

Fig.1. Interaction of organisational, interest group and self-experience communication for municipal development [4,11]



In the governance environment assessment process, **collaboration communication model** (R. Ernsteins, 1999) was applied [6,8], which contains four complementary key components - environmental information, environmental education, public participation and environmentally friendly behaviour – oriented towards collaboration expansion and, so obviously embraces all key actor groups - local inhabitants, municipal and state institutions, business sector as well as all wide range of mediators (also seen from us as **mediative environmental management**)- NGOs and the media, educators (formal and here especially non-formal ones, like libraries, culture/tradition centres, museums etc) and experts/science, being nowadays particularly requested not only for new information valuing/sharing, but also demo cases facilitating and enhancing environmental friendly behaviours.

Climate change (environmental) communication approach, developed system and practical needs [1,2,10] are to be included into municipal planning documents and process (and products) both through **disciplinary and integrated approaches**, and tailored to the working specifics of specific target groups [6,8]. When implementing the communication activities, the first steps would be [4,5] to work on understanding development and above all – provide opportunities for climate change communication target groups to realise their roles and self-organise as well. Also a transparent and long-term co-operation mechanism needs to be established among the municipal administrative structures and the other target groups, especially **mediators (media, NGO's, educators and experts),** which would involve all present and future co-operation partners (target groups) into climate change adaptation problem-solving processes, and starting with very local everyday life based practice cases. Importance of related application of the climate change adaptation **demonstration projects** could not be overestimated e.g. alternative energy resources already in use.

METHODOLOGICAL APPROACH - R&D COLLABORATION PROJECTS

Municipal climate change adaptation study and first planning outline for Salacgriva was initiated and realized as R&D project – the bulk research was done by extended group of master students from DoEM, University of Latvia as field work practice. Besides application of R&D approach the work has been realized as **University-municipality collaboration research** – as joint activity done in partnership and regular collaboration [5,9]. For this practice DoEM has decade long rather positive experience jointly preparing various municipal planning documents, guidellines, procedures/handooks etc., being later used with various degree of efficiency, but also including official municipal sectoral environmental/development plans prepared, being adjusted and later approved by municipalities.

Every particular coastal planning case has been realizied according to the **case study research** (CSR) methodology traditionally consisting of the list of complementary and integrative selection of traditional sociological research methods:

- document analysis (incl. all procedures, work task planning for managers etc);
- field observations, evaluations/assessments and
- sociological research in case territories, including interviews (40-60 persons) of experts and municipal officials as well as mandatory representatives of all main target groups, and questionnaires for local residents (100-400 persons).

The drafted Climate change adaptation guidelines (strategy) for Salacgriva municipality were based on the key elements of the **4P environmental governance**

cycle implementation [6,8,9]: P1 – problem analysis, P2 – policy formulation, P3 – policy planning, P4 – (action) programming. This strategic governance cycle usually contains the following key components: starting with cross-sectorial/horizontal and vertical thematic and management audit, target group's assessment; policy values and intentions, aim and principles; planning preconditions; objectives, instruments and indicators; implementation and review resource basis [3-5].

Governance environment and collaboration communication practice based concepts applied as central ones have been mentioned above and there could be add only general definition developed (Ernsteins R., Lontone A.), to describe five main components. Governance environment is the working conditions for public administration, which ensures an institutional and processural framework for the co-ordination of everyday work of administration employees and groups in an adequately organised and equipped working environment, with the aim of developing, adopting and implementing - through an internal and external stakeholder communication process - governance services and products required for the development of the public and the territory in line with the municipality's overall development objectives.

Decision to start such first municipal climate change adaptation project in Latvia has certain all three collaborating stakeholder's experience pre-history and obviously has not been based only on former university-municipalities collaboration projects performed in coastal areas in Latvia since 1999 by our institution and our encouragement to turn international experience and our academic interests into practice based R&D project application. Long time and successful participatory approaches based efforts on not only nature protection development as for all nature protection institutions, but particularly on sustainability concept promotion (according to the unique UNESCO Man and Biosphere program) in this North Vidzeme territory has been performed by the North Vidzeme Biosphere Reserve (Ministry of Environment) staff (directed by A.Urtans) since its establishment in 1997. Also successful work of this governmental agency at coastal regional level could be recognized as approximate prototype agency of coordinating and collaborating activities to be performed towards necessary ICZM model – integrated coastal zone management – introduction and implementation in the coastal territories of the Europe, according to the EU related requirements. Local Salacgriva municipality (directed by D.Straubergs) do have also certain positive CV of realization environmental management projects organized by municipality directly or subordinate bodies like local schools, museum etc institutions having environmental activities, also NGO's, particularly a number of such very local villages based projects etc.

CLIMATE CHANGE ADAPTATION POLICY DESIGN AND PLANNING

Different manifestations of both climate change impacts itself and related municipal adaptations are already observable also in Salacgriva municipality including more frequent storms and floods that cause real loss both to nature and economics. However, if tackled correctly, the challenge of climate change can give a municipality also a number of **possibilities for innovation and development.** Salacgriva municipality is looking further for synergy from existing and in preparation being green energy projects:

- local municipalities' energy system is basis for its sustainable development. The heating system in Salacgriva is already based on renewable recourses and is moving

towards reducing the use of fossil fuel even more to ensure independent and stable power supply. That is to be achieved with the help of sea heat pumps and use of biomass in power supply;
- municipality has also introduced innovative solution for street lighting by equipping children playground with hybrid (wind and solar energy) electricity generating lighting lamps;
- also North Vidzeme Biosphere Reserve located in Salacgriva town and responsibly covering the whole territory of the municipality and much further beyond that do play the role of innovation catalyst in Salacgriva, e.g. choose to use solar energy and ground heat pumps in Environmental education and information centre in Salacgriva town also supposed to be a demo centre.
- local entrepreneurs_are main executors also of green energy projects as well as initiators in many cases - good example of renewable resource use is wind generators in Ainazi village and recreation center "Kapteiņa osta" that uses heat pumps and has all environmental sectors related (and to be demonstrated) environmentally friendly business model for coastal hotel complex and re-development of local small fisherman harbor.

All the green energy projects mentioned above serve also as basis for development of environmentally friendly municipality behavior and the public image too – green municipality (see below). After conducting this initially mentioned energy/climate audit at full scale and the whole sustainability audit, this collaboration R&D project between the DEM and Salacgriva municipality concluded with elaboration of the **climate change adaptation policy planning guidelines** (Strategy) for Salacgriva district as coastal municipality. The main work directions should be done in the following eleven sustainability sectors [4]:

- **Nature environment sector** – biodiversity; water resources and waste management; coastal protection and development;
- **Economic environment sector** – energy management and industry development; agriculture, forestry, fishery management and tourism development as well as, transport and infrastructure;
- **Social environment sector** – inhabitant's life quality; human resource adaptive capacity;
- **Municipal governance and communication sector** – governance system and process adaptation; environmental and climate change adaptation communication development.

Of particular importance and urgency in Latvia should be mentioned last sector – including further importance for the development of **collaboration governance** and especially also climate change communication work direction.

GOVERNANCE ENVIRONMENT AND COLLABORATION GOVERNANCE

The structure for the climate change adaptation governance guidelines development for Governance environment sector ought to be developed [4,8,9] complementary introducing two general approaches - i**ntegration and disciplinary** approaches. This complementary realization of both is to be seen as following:

1- disciplinary approach – at least temporally new **governance sector** development since starting completely new issue for all municipal stakeholders: Chapter 1-

climate change adaptation policy planning and Ch.2- internal resource development.

2- integration approach - climate change adaptation relevant integration into existing municipal development planning and particularly into following three main work directions: Ch.3- integration development into **institutions/sectors, process and products/documents**; Ch4 and Ch5 correspondingly - climate change adaptation **collaboration communication** development realized as public relations development and also target group participation and collaboration development; Ch6- climate change **adaptation-friendly action** development for both municipal internal target groups (**staff, inner working environment)** and external target groups;

Necessary preparations done and further development of both approaches shall be leading towards climate change adaptation governance system and process towards collaboration governance practice, being particularly depending also on collaboration communication.

The **climate change communication system** (basically, but not only along the same work directions as environmental communication) that would ensure all communication needs to be planned strategically, to be co-ordinated, systemically integrative, proactive and interactive, and human-oriented. The structure for the climate change adaptation governance guidelines development for Communication sector ought to be developed alike Governance sector structure main elements - [4,6,7,9] complementary introducing both general approaches - i**ntegration and disciplinary** approaches as well as particularly issue specific additional two main work directions:

1- integration approach - climate change adaptation communication relevant integration into existing municipal development & environmental communication system and planning system: Chapter1- **communication integration development;**

2- disciplinary approach – at least temporally since starting completely new issue for all municipal stakeholders: Ch.2- **integrated environmental communication sectorial approach** (incl. climate change communication components)**;** as well as each of separate environmental communication instruments [6,8] in the row, e.g. Ch.3- **environmental information** development; Ch.4**- environmental education** development; Ch.5- **public participation and co-operation** development; Ch.6- Promotion of **environmentally friendly action;**

3- target group development and collaboration (also see ch.2 for general target groups): Ch.7- **self-organisation** and participation development of **mediator groups (**educators, NGOs, media, science)**;**

4- and particularly into following two specialized and also complementary work directions: Ch.8- Climate communication **as science communication** development and Ch.9- application of **environmental marketing** in climate change adaptation communication/policy.

Importantly also should be mentioned our project recommendation done for Salacgriva municipality to consider employment of the still new for Latvia but eventually influential municipal environmental management instrument – environmental (green) declaration as formal municipal green work pledging as well as green public relations introduction. Salacgriva municipality has been working on this initiative and in August 2010 the Council of the municipality has approved the **Declaration of the Green**

Municipality – nationwide first such guideline manifest for public and target groups' and, as particularly stressed, for individual inhabitant's involvement towards environmentally friendly municipal governance and management.

Further on the Declaration and the whole University-municipality reasearch project on Climate Change Adaptation Policy Planning for Coastal Salacgriva Region, producing eleven main municipal work directions for intensive adaptation activities required has got also Salacgriva municipality requested continuation in order to elaborate now also the whole work spectrum for Environmental Governance. Similar university-municipality R&D project „Environmental Governance Guidelines for Coastal Salasgriva Region"[3] has come to the the conclusion on necessity to take care on following sixteen work directions and last three are subsequently particularly devoted again to the governance environment: 1.Natural resource and landscape ecological management; 2. Forest resource management; 3. Ecotourism, nature protection and sustainable development; 4. Sustainable water management in coastal municipalities; 5. Integrated beach and dune area management; 6. Household waste management, processing and recycling; 7. Ensure sustainable urban environment; 8. Ensure environmentally friendly mobility; 9. Develop an environment promoting sustainable business; 10. Sustainable energy management; 11. Sustainable tourism development; 12. „Green" living; 13. Environmentally friendly and healthy food in Salacgrīva county; 14. Green thinking and everyday action by local administration; 15. Ensure good governance in coastal municipal management; 16. Environmental communication in Salacgrīva county.

REFERENCES

1. Daniels, Steven E. and Walker, Gregg B. Working Through Environmental Conflict: The Collaborative Learning Approach. Westport: Praeger. 2001
2. Dolan H. Climate Change, Coastal Communities & Health // Presentation for the 2006 Coastal Community Health Summit "Coastal Community Health: A Social Crisis", 2006: 20 pp.
3. Ernsteins R. (Ed), Environmental Governance Guidelines for Coastal Municipalities: Salasgriva Region, University-Municipality reasearch project, University of Latvia, Riga, 2012, 286 p.
4. Ernsteins R. (Ed), Climate Change Adaptation Policy Planning for Coastal Municipalities: Salasgriva Region, University-Municipality project, University of Latvia, Riga, 2010, 248 p.
5. Ernsteins R., Kaulins J., Lice E., Štals A. Integrated coastal management for local municipalities in Latvia: sustainability governance and indicator system. International Conference, Coastal Processes, WIT Transaction on Ecology and Environment, Vol 149, WIT Press, 2011. pp. 29-40.
6. Ernšteins R., Kuršinska S., Štāls A., Zīlniece I., Rudzīte – Griķe M., Lagzdiņa Ē. Environmental management Integration into Municipal Development process: Collaboration Communication Imperative. Proceedings,Conference, University of Applied Sciences, Valmiera, 2010. pp. 53-63.
7. Ernsteins R. Sustainable coastal development and management: Collaboration communication and governance. Human resources, Journal of Social Sciences, No. 3, Lithuania, Klaipeda University, Klaipeda, 2010. pp. 247-252
8. Ernšteins R., Sustainable coastal development in Latvia: Collaboration communication and governance imperative. Sustainable Coastal Development: Colaboration Governance, Book, University of Latvia Academic Publishing, Rīga, 2008, 159.-178. pp.
9. Ernšteins R., Partnerships between Municipalities and Universities as Means to Promote Regional and Local Sustainable Development in Latvia, In Adomssent M., (Eds.),Higher Education for Sustainability, Frankfurt, Germany VAS Publishing, pp. 245-250, 2006
10. Michelsen G., Godemann J. Ed. (2007). Handbuch Nachhaltigkeits kommunikation: Grundlagen und Praxis. Oekom, Muenchen, 2007, 940 s.
11. Lubuze M. Green Region Development Communication: Salacgrīva Municipality, Master Thesis (supervised by Ernsteins R.), University of Latvia, Riga, 2011, 158p.
12. ErnšteinsR., KudreņickisI., UrtānsA., AntonsV., KušinskaS., Kauliņš J. Coastal Municipal Strategy for Adaptation to Climate Change in Latvia: Interdisciplinary Audit and Action Guidelines. Proceedings of the international conference, Latvia, Jelgava, 2010

COULD THE EUROPEAN CITIZENSHIP INITIATIVE BE CONSIDERED AN EFFICIENT TOOL OF ENVIRONMENTAL DEMOCRACY

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ABSTRACT

The Aarhus Convention, negotiated under the auspices of the UN Economic Commission for Europe, is the result of the efforts to establish international legal standards in the field of citizens' environmental rights to date. Also, it is the first international document about public participation in environmental matters, developing the principle 10 of the Rio Declaration, which stresses the need for citizen's participation in environmental issues and for access to information on the environment held by public authorities. Public participation, one of the three main pillars provided by Aarhus Convention, could be one of the key factors in involving the citizens in the protection of the environment and strengthening compliance and enforcement of national and European environmental law. Under European Union regulations, the right to participate in environmental decision-making process could be exercise more effectively based on European Citizens' Initiative (ECI) procedure. Therefore, the European Citizens' Initiative (ECI), as introduced by the Lisbon Treaty, allows citizens to request new EU legislation once a million signatures from seven member states have been collected asking the European Commission to do so. This paper explores environmental citizenship within the framework of European Union (EU) environmental law.

Keywords: EU environmental strategies and policy, Aarhus Convention, European Citizens' Initiative, environmental citizenship, public participation

INTRODUCTION

Environmental democracy is one of the main solution to the ecological crisis, [1] and represents o new system of governance concerned with solving environmental problems (i.e. soil erosion, deforestation, water and air pollution, protection of nature parks, biodiversity etc.) through deliberative and participatory institutions. This form of government promotes a new concept of citizen who is able to manage all the problems resulted from the ecological crisis, namely environmental citizen. The term "environmental citizenship" (and the derived word "environmental citizen") was used for the first time by Environment Canada, the Canadian Ministry of the Environment, who emphasized that "as citizens of the world, we do not have a good history of managing our environment well – we have taken our resources for granted and have often abused the resources which we inherited."[2] Therefore, environmental citizens have a "personal commitment to learning more about the environment and to taking responsible environmental action."[3] Most of the environmental theorists address the environmental citizenship as a status containing two types of rights based on the conception of the environment as a "subject about which there is disagreement." [4] Environmental citizens have the substantive right to a healthy environment, to live in an environment adequate to their health and well-being.[5] Also, they have related procedural rights to defend and to campaign for those substantive rights.

In this regard, the 1998 Aarhus Convention is the most representative treaty on environmental procedural rights, providing for citizens (public concerned) involvement in policy-making and decision-making about the environment and enabling them to challenge environmental decisions. [6] Therefore provisions of this convention form the object of the first section of our paper. We have to stress that Aarhus Convention focuses on the role of individuals and neglects the collectivity, as an important actor in environmental decision-making at regional level. Thus, European Union established a very useful mechanism for the direct participation of citizens in European decision making process, namely European Citizens' Initiative (ECI), as will develop in the second section of our paper.

AARHUS CONVENTION

The Aarhus Convention represent a "giant step forward" in matching of rights with duties[7]; and correlates the effects of the present activities with the well-being of future generations. In this regard, as a precondition for the enjoyment of future generation to live in a healthy environment, Convention provides for the procedural rights of present generation to participate in decision-making regarding environmental decisions. [8] Aarhus Convention establishes three procedural rights (known as pillars): the right of information about environmental concerns, right of participation in policy-making and right of access to justice. First pillar regarding the access to information could be understood from two points of view. According to Art.4 of the Convention, public has right to receive information from public authorities, including the obligation of the public authorities to give information after submission. Also, the public authorities have the obligation to collect and disseminate information of public interest without the necessity of any request. This obligation represents an active form of the access to information and is covered by Art.5 of Aarhus Convention.[9] The second pillar represents the right of the public participation, as we will argue below. And the third pillar of the Convention deals with the right to access to justice exercised in three different ways: right to review procedures in relation to information; right to challenge decisions, acts, or omissions subject to the public participation, and right to challenge acts and omissions by any persons, including public authorities which breach environmental laws (based on administrative or judicial procedures). [10]

The second pillar, regarding public participation in decision-making, is the main core of the Aarhus Convention. In order to enforce this pillar, public must be properly informed and have the access to justice in case of breach of the right of public participation (there is a correlation between second pillar with first and third pillars). Also, pillar II involves the "activity of members of the public in partnership with public authorities to reach an optimal result in decision making and policy making."[11] Public participation consists in a set of procedural rules ruled by Articles 6, 7 and 8 of Convention. Because these articles provide for minimal requirements thus Parties of the international treaty have to take additional internal measures to promote and facilitate public participation. First, public participation regards the decisions permitting activities which may have a significant effect on the environment, listed in Annex I of the Convention.[12] The procedure comprises notification, preparation and effective participation by the public, and it must be clear. Public participation must occur as early as possible in the process of taking a decision. Moreover the State has the obligation to provide the public with the relevant information referring to the activity which forms the subject of the decision, free of charge, upon request, as soon as it becomes available. While the public concerned has more rights in relation to notification and examination of a decision, the entire public is entitled to comment, submit information, analyses and opinions during the decision-making process.[13] The last three paragraphs of Article 6 concern the outcome of the decision, which it must be made publicly, in an accessible way. The public authorities must make sure that the decision takes due account of public participation. Second, public authorities have the obligation to set up a transparent and fair framework for public participation in plans, programs and policies relating to the environment. In this regard, it is important to established clear rules for notification, about the quality of information, in determine the participating public. Also parties have to be involved in the process of participation very early in the decision making process. Regarding the policies, public authorities must establish policies to endeavor public participation in policy making to the extent appropriate. The obligation that States guarantee that "due account is taken of the outcome of public participation" means that "there must be a legal basis to take environmental consideration into account in plans, programs and policies."[14] Art.8 of the Convention stipulates the public participation in the executive branch of political power. It regards public participation during the preparation of executive regulations and/or generally applicable legally binding instruments. This provision is "quite novel" and it not concerns private decisions but legislative decisions. [15] According to this article, States must make their best efforts, leave options open and consider involving public when decisions may have potentially a significant effect on the environment. The Convention stipulates the necessity of flexible time frames and flexibility in taking due account of the outcome, as far as possible. It should be noted that this provision is vaguely and it given to States the possibility to apply this article in a different way.[16] Briefly, Articles 6, 7 and 8 cover the principles and procedures to follow in order to implement the Aarhus Convention effectively. It is necessary to ensure that the process does not focus solely on procedure but on the essence of the decisions about the environment. Even that Aarhus Convention carries potential in solving certain democratic deficiencies, at European Union level is developed a new extensive framework which strengthen the link between citizens and European institutions, enhance a more appropriate model of democracy.

EUROPEAN CITIZENS' INITIATIVE (ECI)

Created by European civil society, accepted by the Convention for a future European Constitution and stipulated by article 11, paragraph (4) of the revised Treaty on European Union (TEU), and article 24 of the Treaty on the functioning of the European Union (TFEU), European Citizens' Initiative offers to European citizens the opportunity to get involved directly in European Union (EU) politics, not only in environmental matters. According to above mentioned provisions, two regulations were adopted: Regulation (EU) no 211/2011 of the European Parliament and of the Council on the Citizens' Initiative, [17] and Commission Implementing Regulation (EU) no 1179/2011 laying down technical specifications for online collection systems pursuant to Regulation (EU) no 211/2011 of the European Parliament and of the Council on the citizens' initiative. [18] As it is noted in legal doctrine, ECI are not static instruments, it has to be understood as process that stretches across interdependent stages. This means that each stage has specific objectives and unfolding conditions. In addition, ECI is developed within well-established institutional and political context which decisively influence he outcomes of this "legislative process".[19] The success of the participation of European citizens at the EU's democratic life through ECI largely depends on the extent to which the entire procedure is clear, simple, user-friendly and proportionate to the nature of the issue which need a legislative act. Also, the conditions for supporting a citizens' initiative by the citizens of the Union have to be similar, regardless of the Member State from which they come; ensuring a judicious balance between rights and obligations. Moreover it should ensure as uniform and spread over an area as large signatories, from as many Member States. In this regard, regulation provides the minimum number of signatories coming from each Member States, and the minimum number of states from which citizens must come set at one quarter of Member States. [20] It is particularly important that the participants in citizens' initiative should have the minimum age at which citizens are entitled to vote in elections to the European Parliament. They have to be informed about the conditions in which they can exercise this right of initiative. In order to support an citizens' initiative the citizens of the Union have to complete a statement of support form for that initiative and thus becoming "signatories". In order to successfully carry through a citizens' initiative, it is necessary to establish an organized structure, taking the form of a committee, composed of citizens, as organizers, coming from at least seven different Member States. The members of citizens' committee are responsible for preparing and presenting its initiative the Commission. Moreover, the organisers shall designate one representative and one substitute, who shall be mandated to act on behalf of the citizens' committee and to represent it in front of the institutions of the Union throughout the procedure. In consideration of ensuring the coherence and transparency in relation to proposed citizens' initiatives and in order to avoid a situation where signatures are being collected for a proposed citizens' initiative which does not comply with the conditions laid down in this Regulation, it should be mandatory to register such initiatives on a website made available by the Commission prior to collecting the necessary statements of support from citizens. The procedure of ECI supposes several stages. **First stage** of ECI procedure is detailed in Article 4 of Regulation (EU) no.211/2011 and consists in registration of a proposed citizens' initiative in one of the official languages of the Union, with an online register made available by the Commission. Any ECI shall cumulatively fulfils the specific conditions, such as: a citizens' committee with a contact persons, the necessary information set out in Annex II, in particular on the subject matter and objectives of the proposed ECI, the proposed ECI meets the Commission's powers to submit a proposal for a legal act of the Union for the purpose of implementing the Treaties, and is not manifestly abusive, frivolous or vexatious or manifestly contrary to the values of the Union as set out in Article 2 TEU. If the above conditions are met, the Commission shall register the proposed citizens' initiative under a unique registration number within two months from the receipt of the information set out in Annex II of the regulation. Also, the Commission shall establish a point of contact which provides information and assistance. If the above conditions are not fulfilled, the Commission shall refuse the registration of the proposed citizens' initiative and shall inform the organisers of the reasons for such refusal. **The second stage** of the procedure consist in collecting the statements of support from signatories for a proposed citizens' initiative, which, according to Regulation (EU) no.211/2011, may be done of support in paper form or electronically. In this regard, the organisers shall complete the forms as indicated in Annex III, in one of the language versions included in the register for that proposed citizens' initiative. The information given in the forms shall correspond to the information contained in the register. In case that statements of support are collected online, these shall be electronically signed using an advanced electronic signature and shall be treated in the same way as statements of support in paper form. [21] The data obtained through the online collection system shall be stored in the territory of a Member State, which certify that this system has adequate security and technical features in place. [22] In order to be valid, the signatories of a citizens' initiative shall come from at least one quarter of Member States and they shall comprise at least the minimum number of citizens corresponds to the number of the Members of the European Parliament elected in each Member State, multiplied by 750. Signatories shall be considered as coming from the Member State which is responsible for the verification of their statement of support in accordance with the second subparagraph of Article 8(1).The entire procedure of collecting the statements of support shall be completed within a period not exceeding 12 months from the date of registration of the proposed citizens' initiative. **The third stage** of ECI procedure is verification and certification of statements of support by the competent authorities from relevant Member State, as established by Art.8, par.1 of Regulation. Each Member State shall designate one competent authority responsible for coordinating the process of verification of statements of support and for delivering the certificates provided for therein, and shall forward the identification features of the competent authorities to the Commission. The organisers shall submit collected statements of support to the competent authorities from relevant Member State and shall separate those statements of support collected in paper form, those which were electronically signed using an advanced electronic signature and those collected through an online collection system, using the form set out in Annex V of Regulation. Within a period not exceeding three months from receipt of the request, the competent authorities shall verify the statements of support submitted and shall deliver to the organizers, free of charge, a certificate in accordance with the model set out in Annex VI, certifying the number of valid statements of support for the Member State concerned. **The fourth** and last stage of ECI procedure consists in submission the ECI for examination to the European Commission. For this purpose, the organizers shall submit the citizens' initiative to the Commission, accompanied by information regarding any support and funding received for that initiative, which shall be published in the register. After the Commission received a ECI and the related documentation, it shall publish it without delay in the register. Also the Commission shall receive the organisers at an appropriate level to allow them to explain in detail the matters raised by the citizens' initiative. Within three months, the Commission shall set out in a communication its legal and political conclusions on the citizens' initiative, the action it intends to take, if any, and its reasons for taking or not taking that action. This communication shall be notified to the organisers as well as to the European Parliament and the Council and shall be made public.

CONCLUSIONS

Aarhus Convention provides an important step towards the construction of environmental democracy. However, the application of this Convention in practice encounters an internal obstacles and deficiencies, including the fact that not all provisions are stringent and observed by Parties.

Besides, by developing the ECI mechanism, the European legislator plans to strengthen the institution of European citizenship, improving democratic process within the EU. Based on a careful analysis of the whole procedure, we can identify its key element, namely the way in which the Commission will establish relationships with citizens, and the extent of it intends to exercise the powers conferred in this regard. From this point of view we refer to a high level of decision of the Commission in assessing the opportunity and admissibility of a citizens' initiative. The ECI procedure is conceived as a practical tool for European citizens to improve the already existent political legal structures at regional and national level including to take measures to sustaining the environment as provider of the basic needs of future generations.

REFERENCES

[1] Stein, T.,The Ecological Crisis – A Challenge to Constitutional Democracy? Does the Constitutional and Democratic System Work?, Constellations, vol.4, p.420,1998;

[2] Environment Canada web site http://www.ec.gc.ca/water/en/info/pubs/mountain/-e_intro.htm;

[3] Environment Canada web site http://www.ec.gc.ca/water/en/info/pubs/mountain/-e_intro.htm;

[4] Bell, D., Liberal environmental citizenship, Environmental Politics, vol.14/2, pp.179-194, 2005;

[5] Article 1 of Aarhus Convention (The Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters);

[6] Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, adopted in the United Nations Economic Commission for Europe framework on 25 June 1998 in Aarhus, Denmark, and entered into force in October 2001. (Aarhus Convention) See www.unece.org/env/pp/documents/cep43e.pdf for the full text in English. Its Parties now include most of the countries in Central and Eastern Europe, the Caucasus and Central Asia and nearly all EU member States. Aarhus Convention was ratified by Romania through Law no.86/2000; Governmental Ordinance no.878/2005 - which also transposed the Directive no.2003/4/CE (Aarhus Directive)-; and Governmental Decision no.564/2006 regarding implementation of Article 7 of Aarhus Convention;

[7] Holder J. & Lee M., Environmental Protection, Law and Policy, Cambridge, p.100, 2007;

[8] Nadal, C., Pursuing Substantive Environmental Justice: The Aarhus Convention as a Pillar of Empowerment, Environmental Law Review, vol.10, pp.28-45,2008;

[9] The Aarhus Convention: An Implementation Guide, prepared by S.Stec & S. Casey-Lefkowitz in collaboration with J. Jendorska, (editorial adviser), United Nations, New York and Geneva, p.4, 2000;

[10] F. Marshall, Two Years in the Life: The Pioneering Aarhus Convention Compliance Committee 2004–2006, International Community Law Review, Vol. 8, pp.123–154, 2006;

[11] The Aarhus Convention: An Implementation Guide, prepared by S.Stec & S. Casey-Lefkowitz in collaboration with J. Jendorska, (editorial adviser), United Nations, New York and Geneva, p.85, 2000;

[12] Activities provided by Art.6 are subjected to the environmental impact assessment procedure under the UNECE Espoo Convention on Environmental Impact Assessment in a Transboundary Context.

[13] The Aarhus Convention: An Implementation Guide, prepared by S.Stec & S. Casey-Lefkowitz in collaboration with J. Jendorska, (editorial adviser), United Nations, New York and Geneva, p.108, 2000;

[14] The Aarhus Convention: An Implementation Guide, prepared by S.Stec & S. Casey-Lefkowitz in collaboration with J. Jendorska, (editorial adviser), United Nations, New York and Geneva, p.113-114, 2000;

[15] Lee, M., & Abbot, C., The Usual Suspects? Public Participation under the Aarhus Convention, The Modern Law review, pp.80-108, 2003;

[16] LAERNOES, P.E., The Aarhus Convention :a partial solution for the Environmental and Democratic Crises?, www.igitur-archive.library.uu.nl/student theses/2011... /Master% 20Thesis.pdf

[17] EU Regulation no.211/2011 on the Citizens' Initiative was published in the Official Journal of the European Union, L 65, on 11 March 2011, http://eur-lex.europa.eu;

[18] The Commission Implementing Regulation (EU) no 1179/2011 laying down technical specifications for online collection systems pursuant to Regulation (EU) no 211/2011 of the European Parliament and of the Council on the citizens' initiative, published in the Official Journal of the European Union, L 301, on 18 November 2011;

[19] de Witte, B., Trechsel, A.H., (directors), Damjanović, D., Hellquist, E., Hien, J., Ponzano, P., Legislating after Lisbon New Opportunities for the European Parliament, European Union Democracy Observatory (EUDO), Robert Schuman Centre for Advanced Studies, European University Institute Florence, www.eudo.eu, (2010);

[20] For the purpose of clarity, those minimum numbers should be set out for each Member State in an annex to this Regulation. The minimum number of signatories required in each Member State should correspond to the number of Members of the European Parliament elected in each Member State, multiplied by 750.

[21] According to the Directive no.1999/93/EC of the European Parliament and of the Council on a Community framework for electronic signatures, of 13 December 1999.

[22] Commission Implementing Regulation (EU) no 1179/2011 laying down technical specifications for online collection systems pursuant to Regulation (EU) no 211/2011 of the European Parliament and of the Council on the citizens' initiative.

EXTENDED SEIZURE AND CONFISCATION WITHOUT CONVICTION – TRENDS IN EUROPEAN CRIMINAL LAW

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ABSTRACT

The article deals with the recent legislative amendments and the perspectives existing in the field of the special confiscation within the Romanian criminal Law. The author remark the tendency of the European legislator and, consequently, the Romanian's also, to extend the sphere of assets which may be confiscated, the appearance of the "extended confiscation" and the "non-conviction based confiscation" concepts and notice these are not in accordance with the Romanian Constitution.

Keywords: safety, seizure, seizure extended ,goods confessable, the new penal code, seizure arranged by prosecutor.

INTRODUCTION

Special seizure is one of the safety measures described in Article 112 of the penal code. They constitute, together with penalties and measures educational, the sanctions of criminal law applicable to persons who violate our country legal rules what incriminated criminal deeds. The sanctions of criminal law shall form a central institution of the branches of law, they are means by which to perform defense fundamental values of the company by pulling to liability of the persons they have harmed by discouraging of offenses. The safety measures are aimed at particular in criminal sanctions assembly and are concerned with first prevent crime by removing certain statuses objective, external or linked to the person obedient, which would encourage criminal repeating behavior. They have appeared, that criminal penalties specific, distinct, relatively recent modern states in the legislation - approximately at the beginning of the twentieth century XX[1]. Each safety measure is both a means of preventing - has the role to prevent termination of new facts provided for in the law on criminal proceedings as well as a means of remedial measures, removing of imminent danger. Being a penalty, also has a non-signatory - repressive restrictive with a content of rights. In the case of Romania we identify, for the first time, the safety measures covered distinctly in penal code of 1936. Article 71 of that code describing as safety measures : admitting to an asylum of offenders mad ; admission asylum of offenders tricky mental or physical ; holding criminals in a special institute ; admitting unofficially employed abroad and the dinner in a colony jail, and more[3]. In the current criminal code the safety measures are: forcing the medical treatment ; admitting medical ; a prohibition on dealing with a feature or to exercise a profession, a profession or another occupation ; prohibition was to be in certain neighborhoods ; expulsion of aliens ; confiscation special ; the prohibition to return to family home for a specified period. In accordance with Article 111 of the code with the safety measures are aimed at removing of imminent danger and the prevention of acts that provided for in the law on criminal.

They shall be taken of those who have committed deeds of the law under criminal law. May be taken even if copyright does not apply to a punishment, except ban was to be in certain cities. New criminal code describes, in the root that article 108, four safety measures : obliging to medical treatment ; admitting medical ; prohibition on employment a function or of the pursuit of a profession and confiscation special. It can all take it to a person who has committed an offense under the penal law replacements. They may be taken, and in a situation in which copyright does not apply to a punishment. In the subject line of safety measures confiscation occupies a special position distinct. To classical definition refers to the forced and free property of the state of certain goods which belong to person who has committed a criminal offense provided for by the law, whose ownership by copyright, by their nature or because of the link to abetted murder, likely was committed to new facts as provided by law under criminal law.

According to Article 118 of the penal code in force, shall be subject to confiscation :

- ✓ Goods produced by discouraging offense provided for in the law on criminal proceedings;
- ✓ Goods which have been used in any way, from the termination of offenses, if they are the offender or if, belonging to another person, it has known to their intended use. The measure may be ordered in the event criminal offenses perpetrated by actual via the press.
- ✓ Goods produced, modified, or adapted in order to was committed a criminal offense, if they have been used to commit it, and if they are the criminals. When the goods belonging to another person confiscation is available if production, modification or adaptation has been performed by the owner or the owner of criminal science ;
- ✓ Goods that were given to determine committing a facts or to reward on copyright;
- ✓ Goods acquired by discouraging offense provided for in the law on criminal proceedings, if they are not returned injured person and in so far as they do not serve as a means to claim it.
- ✓ Goods whose ownership is prohibited by law .

In the traditional manner main purpose of the systems of justice criminal was depriving them of freedom of criminals and enumeration of the above meet rigorous definition fever confiscation[4] . In recent decades it has been recognized more and more of that tracking and confiscation of goods infringing by the criminals, particularly of criminal groups, represents an important means to affect and to discourage criminal activity. In this context, at present we are witnessing to a rethinking of confiscation have a tendency to give, without any reduction in its content arrest, a character repressive and to broaden your scope of goods that can be entered in owned by the state with this Title. IT WAS imposed more and more, both in doctrine and in legislation, the idea that need confiscation not only of the object used to abetted his deed or obtained through charitable deed and also of its equivalent value, that the object is no longer found. It's a great topical the idea according to which criminal investigation must have, at the beginning, and the objective not available infringement and identify the products with a view to their confiscation. By law no 420 / 2006 Romania ratified Council of Europe Convention on laundering, discovery, seizure and confiscation of infringement and terrorist financing, done at Warsaw on 16 May 2005. As a member of the European

Union, our country is obliged to implement Decision - framework of the seizure 2005/212 on products, tools and goods related to the infringement ; Decision - framework 2001/500/JHA on money laundering, the identification, tracing, seizure and confiscation tools and product infringement ; Decision 2006/783 - framework on the application mutual recognition of orders to seize and Decision of the Council of the European Union 845/2007 concerning cooperation between the bureau of the recovery of the goods. This last decision requires Member States to establish or designate an Office national recovery of goods which are related to abetted crimes. On 20 January 2011 has been published, in the gazette, part I, No. 51, the judgment government no. 32/2011 of the appointment Office for crime prevention and the cooperation with the recovery of claims offices in the Member States of the European Union within the Ministry of Justice, as the national office for the recovery of claims in the field tracking and identification products from discouraging of offenses or other property related to criminal offenses[5]. In the same context, by Law No 278/2006 was introduced in the criminal law et al. 2 Of the article 118, which describes new situations and new goods which can be seized: confiscation of the criminal equivalent of the goods as well as a third party as innocent used criminal offense from the termination ; confiscation of money or goods in place of those which are no longer found ; confiscation of goods or money obtained from the operation or use of property subject to confiscation, other than those described in the letters b and c . Special provisions regarding confiscation of goods are to be found on many special laws which incriminate facts in the various fields of crime prevention : The Law No 39/2002 on organized crime ; Law No 678/2001 on traffic of persons ; Law No 143/2000 on the drug traffic ; Law No 78/2000 for the pursuit of acts of corruption; the Law No 656/2002 on establishing National Office to Prevent and to combat money laundering. Romanian new criminal Code, which was published in the Official Gazette No 510 of 24 July 2009, describes the content of the measure the safety special confiscation in article 112 expanding your scope of goods and values which may be seized. So, are subject to confiscation special :

- ✓ Goods produced by discouraging offense provided for in the law on criminal proceedings;
- ✓ Goods which have been used in any way, or intended to be used in committing a facts provided for in the law on criminal proceedings, if they are of copyright, if, belonging to another person, it has known for their use.
- ✓ Goods used, immediately after committing murder, in order to ensure that dropping copyright or keeping developmental quality times the product thus obtained, if they are of copyright or if, belonging to another person, it has known for their use.
- ✓ Goods that were given to determine committing a facts provided for in the law on criminal proceedings or to be dispensed by the author.
- ✓ Goods acquired by discouraging offense provided for in the law on criminal proceedings, if they are not returned injured person and in so far as they do not serve as a means to claim it.
- ✓ Goods whose ownership is prohibited by law under criminal law.

In paragraph 2 of that Article provides that in the event that the value of the goods confessable in accordance with Article 112, et al. 1B, and c is manifestly disproportionate to the nature and severity of offense is confiscation in part, as well as with equivalent, taking into account the consequence produced or that could be produced and the contribution from the object to it. If the goods have been produced, modified, or adapted in order to was committed offense provided for in the law on criminal proceedings, provide them to seize in its entirety. According to cite 3, in the cases provided for in al. 1, The provisions referred to in b and c, if the goods may not be confiscated, whereas it does not belong to offender, the person to whom they belong to is not known for their use, it will seize the equivalent in money, with application of the provisions of paragraph 2. In paragraph 5 shall act obligation confiscation, in the place of property described in al. 1B-e, if there are to be found, of some money or other goods, up to the value. Finally[6], according to et al. 6, It shall forfeit property and obtained money from the exploitation of goods subject to confiscation, and goods produced by them, with the exception of goods referred to in paragraph 1b, and c. With respect to the new regulations, described above, you should let us look at giving broader scope of goods and values confessable but and generalization of applying this safety measures in the situations of facts provided for in the law on criminal. In no case of seizure, unlike the previous law, except as described in 3 al. article 112, the law does not require committing a criminal offense but of a facts provided for in the law on criminal proceedings for the application of this safety measures. At present is in debate in the Chamber of Deputies, camera decision-making a bill initiated and supported by the Government of Romania - adopted earlier by the Senate - which is aimed at modification of the penal code currently in force, with the introduction of a new case of seizure: 'extended seizure"[2]. Thus, in Article 112, after the letter g is will introduce letter h, the following : "confiscation extended" and that this article again, 1182, describes situations in which it is applied (person is convicted of one of the offenses listed, the punishment was provided for by law is more than 5 years and his act committed is likely to procure good material) and cumulative conditions necessary to be met for the purpose of taking measure : a) the value of the goods acquired by a person convicted in a period of 5 years before, and, if applicable, after time when it was committed an offense, to be issued for making the act of bringing cases to court, exceeds manifestly revenue of this in a legally ; (b) the court is convinced that the goods come from criminal activities the nature of the infringements for discouraging to which it may take as far as . By the same bill is tracking and modifying the provisions of the penal code nitrate in force, by entering those same changes, i.e. 'confiscation extended" (with provisions identical). Financial Action Task Force (FATF) or Grouped d' Action Financier (Task Force) is an intergovernmental organization founded in 1989 during the summit in Paris the G-7. FATF has currently 36 members and its purpose is to develop policies to combat money laundering and to combat terrorist financing. FATF recommendation states to adopt certain policies or measures of criminal justice to protect the system overall financial the phenomena money laundering and terrorist financing. They have been issued 40 recommendations which have become standards in the combating of money laundering. Some of the recommendations have been complaints of the European Parliament and the Council and transformed into directive. In confiscation FTAF issued Recommendation no. 3, Recommendation No 38 and a document on best international practice to help jurisdictions to implement the two recommendations. Is it launched the concept " non-conviction based confiscation " (confiscation arranged outside of a criminal convictions) : in accordance with recommendation 3 of FATF countries may adopt measures for the confiscation of property, of the instruments or income a person with no that this to suffer a convicted criminal. In the same spirit, the 12.03.2012 , European Commission adopted a proposal for a Directive of the European Parliament and of the Council of Europe concerning the establishment of minimum standards for the freezing of property with a view to a possible subsequent confiscation and seizure of property in criminal matters. In the proposal are defined goods and products confessable is defined notion of "seizure" (sanctions or ordered by the court of judgment as a result of an organized process of offenses resulting in definitive deposed area object in question) and are listed four variations of seizure: seizure based on a judgment of the court; seizure expanded; seizure not based on a judgment of the court; seizure applied by third parties. In the first situation requires the member to take measures for total or partial confiscation of the instruments and products offense after a convicted definitive. The second is the case to the confiscation that there will be when the court is not able to provide for his condemnation of the person on the grounds of the death or sickness all the time, when the person fails or there is a risk to intervene prescription criminal liability. The third case relates to the confiscation of the goods or goods to which the person convicted or accused they sent to third parties with free of charge or at a price below their value. Directive requires states to take measures for the conservation and unavailable confiscated of the goods to be taken by the authority of the tribunal, with the possible substantive by appeals. Are imposed and measures for the management of the goods unavailable through the establishment of national offices that have such powers. Should we show that the mere description of confiscation without condemnation reveals an inability placing them in the legislation English without a prior amendment to Article 44 of its constitution. At present, in our country, the measure confiscation special can be ordered, in the phase of judgment, the court of judgment and in phase criminal prosecutions, in accordance with the provisions of Article 245, et al. 1, Paragraph b, Code criminal procedure, the prosecutor who has cessation or under criminal prosecution. New Code of criminal procedure retain the same regulations - in the judgment of a seizure has the authority and for the criminal look at, with solutions of disposal or waiver criminal court proceedings, in accordance with the provisions of Article 315, et al. 2, Paragraph b, the chief prosecutor. Requires, in our reasonable opinion, a question possibility given to infringe the law Criminal prosecutor to take, by way of an order a safety measure. As I stated above, the seizure special is a safety measure, and therefore a specific category of the penalties of criminal law. In the case of Article 10 of Universal Declaration of Human Rights (adopted by the UN General Assembly at 10.12.1948) " Every person has the right, in full equality, to be heard in a fair and public by a court independent and impartial, who will decide either of his rights and duties, either on an acceptance of any defendants in criminal matters facing against it (the underlining our - I. M. Z.). Same provisions found in the root article 6 of the European Convention of Human Rights: 'Everyone has the right to judgment on an equitable basis, in a public hearing within a reasonable time the cause of it, by an independent and impartial tribunal established by law, which will decide either to infringement of his rights and obligations of a civilian, either on an acceptance of any defendants in criminal matters directed against ". In accordance with Article 20 of Constitution Romania constitutions on the rights and freedoms of citizens are to be interpreted and applied in accordance with Universal Declaration of Human Rights, with the covenants and other treaties in which Romania is a party. If there are differences between covenants and treaties on fundamental human rights in which Romania is part, and internal laws, have priority over international regulations, except that their Constitutions or internal laws contain more favorable provisions. Article 44 the Constitution shall guarantee the right of ownership. In paragraph 8 shall be provides for the prohibition confiscation wealth acquired in a legally and legality of the acquisition shall be presumed. Returning to the provisions of Article 245, et al. 1, (b) (criminal procedure Code and the provisions of Article 315, et al. 2, (b) in the new Code of criminal procedure we also see that they be granted prosecutor possibility to dispose special confiscation, by order, then it has ceased, removal or, respectively, the ranking or relinquishment of criminal prosecution. In other words, in the legislation infringe English Criminal prosecutor, who does not carry provided an "independent and impartial courts and no it does not act within the framework of a public trial and contradictory, may apply a safety measure, and therefore an penalty of criminal law. We are seeing, in the case of Article 162 of the Code of criminal procedure, by the year 2003, the prosecutor might take, on a provisional basis, during criminal prosecution two safety measures : obliging medical treatment and admission to medical care. Measures were valid until their confirmation or rejection by the court, in the phase of judgment. By Law No 281/2003 (published in the Official Gazette of 1 July 2003) that Article has been amended in the sense that prosecutor, if it finds in the phase criminal prosecutions that defendant is not in any of the situations referred to in Article 113 or 114 of the penal code recognizes the authority for the purpose of taking, on a provisional basis, of the measure of safety to being forced to medical treatment or a medical admission. In the new Code of criminal procedure burden to take, on a provisional basis, of the security measures for the being forced to medical treatment and medical admission returns, according to article 245, restrict the rights and freedoms (during criminal prosecution), restrict preliminary to the camera (in the course of the procedure of the chamber preliminary) and forum (in the course of judgment). In this context shall be legitimate question: why prosecutor is unable to take on a provisional basis these safety measures but it can take, definitively as far as the safety special confiscation? This skill does not represent legal breach of the principle of nulla poena sine judicio ? It is to imagine to the world current as a person to undergo a criminal penalty without being ordered by Judge? That any person who has suffered an injury of the interests of its legitimate complaint may be made by a prosecutor superior institution and to the authority of the tribunal, subject to the conditions of Article 275- 278, code of criminal procedure against solution confiscation arranged by a prosecutor does not exclude any, uphold us, failure to do this Romanian penal legislation in this area, to Community law. Rules of the law Review material, and doing all of the rules governing special raw material confiscation us legislation reveals dynamics in relation to the progress social relations regulated, they also expect it hopefully Romanian or European efforts to keep up with contemporary crime influenced by the phenomenon globalization but and the need to comply with strict adherence to fundamental rights and freedoms of the citizen.

REFRENCES :

[1] C-tin Mitrache, ş.a. - ,, Drept penal român. Partea generală" , Editura Universul Juridic, Bucureşti, 2007.

[2] ,,Constituţia României", Editura Best publishing, Bucureşti, 2006.

[3] ,,Noul Cod penal al României" , Editura Best publishing, Bucureşti, 2009.

[4] M. Delmas – Marty - ,, Procedures penales d" Europe", PUF, Paris,1995.

[5] Alina Cristina Bogdan, ş.a -,,Norme de drept penal comunitar", Editura G. & G. Consulting, Bucureşti, 2007 .

[6] Radu Chiriţă - ,, Dreptul la un proces echitabil", Editura Universul Juridic, Bucureşti, 2008.

FEDERALISM IN CONTEMPORANEITY. FEATURES AND PERSPECTIVES.

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ABSTRACT

The Paper addresses proper structure of the states in contemporary era, characterized by the phenomenon of globalization. Features are described phenomenon of globalization and main characteristics of federal state. The author concludes that federalism is an ideal state structure phenomenon in the context of globalization.

Keywords: globalization, federal state ,decentralization ,unitary state, the European Union, subsidiarity, autonomy.

INTRODUCTION

In contemporary the socio-economic life is influenced substantially by the phenomenon of globalization. The globalization, related to the market economy and liberalism and opposite side the nationalism and protectionism, is a modern term used to describe changes in contemporary companies and into the world economy, characterized by increasing international trade, investment and cultural exchanges caused by crushing barriers and increasing interdependence national economies. The process of globalization, carried out intensively over the past 30 years it was expressed in the form of increase, on the background liberalization movement of goods, of the international trade of services, of capital markets, foreign direct investment. The consequences of the process have been : the appearance multinational corporations, global financial markets, the transnational non-governmental organizations, and for the organizations and transnational criminal networks international terrorist. An important aspect of globalization lies in technological progress which, in particular in the fields of transport and telecommunications, national state mediator. The globalization produces effects environments and therefore on economic, political and cultural. It is clear that the process of globalization determines civilization and cultural homogenization of individuals and allows a quick movement of persons and ideas from one geographical area to another. It determines diminish the role played by national governments and the force (reduce the role of factors such as national frontiers, territoriality, nation and its sovereignty) and increased the role transnational forces (the international organizations, of transnational companies) in the process of management of the world. The transnational business entities are faced with a lack of uniform rules at the international level. The World Bank report on the year 2000 hushed, on the world economy, two parallel processes which take place concurrently: on the one hand, globalization, i.e. transnationalization (up to over nationalization) trade, finance and the state of the art. and, on the other hand, decentralization, i.e. transmission by national governments to local communities to more and more administrative duties as may, social and educational budget. Gradually, the member national will occur in the army, diplomacy and the adoption of legislation.

The development in this historic moment is impossible for any company, for any state without taking into account the general trends, processes specific globalization. Social organization should be adjusted at any time dynamics of life economic and social order not to become a blocking factor has progressive developments.

The analysis of global developments economic, social and technological reveals a good dynamic in the states occupy territorial area stretched, in the states have important human resources and natural as well as in the states and have suitable structure and political regime her aspirations citizens and national particularities. The history shows that we model federal state has offered and provides and currently appropriate form civilization development, social-economic and democratic for many peoples. The United States of America, Germany and Switzerland represent models of economic prosperity and alive social democratic policy and to respect the rights and fundamental freedoms of the citizen. At present, other federal states -Brazil, India, Canada, Australia, Russia- provides dynamic models of positive development.

The State creating federative, composed or union is defined most often by comparison with the state uniform and with reference to its design. Thus, most authors define it as as a state made up of two or more Member States (federated States) of unification which shows a new state, distinct from those which it is established and which is the subject of law. George Alexianu labeled federal state it as the "an association of more than one member, who shall retain in inner apparent sovereignty, and on the outside they have no sovereignty, constituting of sovereignty each member, a new sovereignty common" .

The word "federalism" comes from Latin meaning "foedus" which means "consensus", “contract". In a broad sense, by federalism means, in an etymological, a company based on each right enshrined.

William H. Riker federalism labeled as "a policy organization in which the activities are divided between the central governments and regional and the government in such a way that each type of government has final decision in certain areas".

The definition is consistent with conventional vision: federalism is described as division or territorial space of power; the units components are defined from a geographical point of view.

Daniel J. Elazar defines federalism with the emphasis on the "non-consolidation" of power. According to this author federalism takes 'fundamental distribution of power between multiple centers. None of these centers does not have a more or less significant, unlike a organizational pyramid in which the levels are distinguished, from the point of view constitutional, that more or less large" .

S. Rials defines the state federal as "a state containing in itself more mass caterers with appearance state" emphasizing broad powers of the Communities' federated States and the fact that they do not have sovereignty of States themselves.

Transition to federalism itself (modern) has been carried out in two ways: either by pairing mode for certain member unitary, an association that has passed through confederation form (for example USA and Switzerland), or by decoupling a member what are transforming structures radically by giving mass caterers that make up the character state and his powers of super position (for instance USSR in 1924; Czechoslovakia in 1969). This is what happens in the states have a population composed of different nationalities or in the member wishing to grant of regions or provinces a range wider than that resulting from the decentralization measures (for example Belgium). Federalism tends to be used in two types of countries -in countries and in relatively large multinational companies.

Countries with large and territorial area with a population large which have adopted federal system are USA, Russia, Canada, Australia, India, Mexico, and Brazil.

Countries - multinational companies - are Switzerland, Belgium, Canada, and India. Within the multinational companies, the federalism has the special feature to grant autonomy ethnic minorities.

Charles D. Tarlton distinguish between federations symmetrical (in which territorial units components are "that thumbnails of important aspects of the entire federal system"[3] , i.e. units are homogeneous structural components, social and cultural) and the asymmetric units in which there are components that are different between them, but there are some that are different and the country as a whole. Symmetrical federations may be regarded as USA and Germany and asymmetrical Russia and Switzerland.

Some authors have noticed that in agreement with developments in social life and order economic, responding to the increase in the communication and collaboration in the development and enforcement federal laws between the state and the entities federated States, federalism has evolved from classic "two-tier" to a form of the 'collaborative federalism" .

Collaboration between the state federal forms and federated States have developed continuously: the simplest form is a direct negotiation between governments autonomous (federal state government and the governments of the states federated States or between the latter) for the identification of common purposes and of the sources of funding for these purposes (for instance: to fight effects of recession, mixing economic development level of the various regions, the development of public services, etc.). Such collaboration has determined in Europe birth of a "federalism modular" . There is no and take the form of a "spontaneous cooperation" when federal government take the initiative conduct of national programs (in raw material of education, transport, agriculture, health, etc.) by providing subsidies and stimulating by the Federal governments of the states federated States to achieve an additional financing and to adopt a specific public policy with the federal . Spontaneous Cooperation, arising in practice German federation, has evolved in this federation by walking up to the creation of institutions on the coordination of common policies: committees of the planning, made up of Federal Minister of Agriculture, Federal Minister for Finance and one minister from each land.

Same trend toward "collaborative federalism"[2] is confirmed in Canada to conferencing fared no better federal - provincial (conferencing provinces that addresses constitutional negotiations, agreements, and; conferences of ministers of spring; conferences to the execution levels itself). In Canada annually take place 500 of such conferences and they are assisted by a permanent administrative service which represents "a unborn by the government federal-provincial" . According to Maurice Croisat "this structure plays a key role in the federalism Canadian capital, as this is a instance of the negotiations where they expressed their interests and solve conflicts between federation and provinces" .

In conclusion should we see that the trend of contemporary federalism consists of the reduction in legislative and budgetary autonomy the governments of the member federated States. It has constrained exclusive legislation of the states federated States (particularly in Germany and Switzerland) for the benefit of range legislation federal competition in which the right has priority in the case of a conflict. Budgetary autonomy at the level it is noted also a reduction in its federal powers due federal linked to the financing and the conditions of use of it (Federal rules in this area represents rules of conduct for the governments federated States) and due to federal control of the subsidies paid.

Although as stated is visible, in no federation federal authorities may not take decisions that unique components, they need to have the authorities federated States. It is found that, on the background of increasing federal authority a edge enhancement inter dependencies federation-states federated States and the coordination of government activities.

The federalism is the current dominated the idea integration policies from the rules, objectives and programs established in common. This integration allows for possibilities of differentiation in the content of the programs and their execution.

The dynamic of federalism is dominated by the idea of balance between integration and differentiation. Seeking a balance between the two trends is fundamental at present, both in the federal states and internationally, in relations between sovereign states.

The federalism and sovereignty. Applying the concept of sovereignty federal state has generated controversy over legal: in case of a state sovereignty belongs to the unit, and, in the case of states belonging to confederation of states which form; to who belongs to federal state sovereignty in the case?

The sovereignty is the adjective of power by the state to be a complete power (single) on national territory and to be independent in external relations.

According to Olivier Beaud sovereignty each member must have the base "the sovereignty constitutional", in other words "public" (sovereignty) is conditional on the existence of a sovereign autonomy. He believes that, in a federal state sovereignty, as the source of any power, belongs to autonomy federal power (in a federal state power federal autonomy can more exactly to do and had freed in stages, materials federated States' constitutions, changing federal constitution in such a way as to restrict constitutional autonomy of the member states.

The federal law leadership on the laws of the member as well as federated States and the impossibility, for a federal member, to oppose entry into force of a federal constitutional rule fully demonstrated that federated States are not sovereign states.

Carl J. Friedrich distinguished federal sovereignty of States from the mode to "division of powers" between federation and federal states. It finds that "the distribution of powers", but and federalism, not "Wiring diagrams" or "models" but also processes in full production; federalism is not a reality static and constant, but on the contrary, essentially, under the sanction its potential disappearances, a dynamic process, it is always new" .

We appreciate that sovereignty, the federal states, the "Locate" at the federation, however, the analysis notes that federal power structure in all federal states democratic produces the power to the people, i.e. and the federated States. Starting from the concept of sovereignty, for the purposes of its classic, some authors consider that the form of federal state is not a perennial crop, but is always that of a unitary state in the process of training or dissolution .

Features federal state : There are a variety of federal models but a distinction can be made of common traits and essential in the federal states.

According to Ivo D. Duchacek, Daniel J. Elazar, Carl J. Friedrich and K. C. Wheare federalism has primary and secondary meanings. Primary definition consists of the division of power between the governments guaranteed central and regional governments. Secondary characteristics are as follows: bicameralism strong, solidly built rigid and a constitutional energetically.

Need for rigid constitution derives from the need to guarantee federal division of power, guarantee carried out by way of a Constitution which must not be modified nor at the central level and at regional level. To ensure that division of power is carried out by operation of a constitutional control energetic and by the existence of a camera in federal parliament in which regions to have a strong representation.

The federal State - that promotes and protects a system of decentralized government, however, is characterized by unit.

Federal State is a "super power"[4] in relation to federated States, the order its legal is superior to those in the federal states. Its legal order (the federal republic) covers whole of the territory of federated States and the entire population (every citizen has a dual citizenship).

Federalism promotes decentralization but its shapes are very varied so that there may be states very decentralized and federation uniform life true policy is located at federal level.

In a comparative analysis on the criterion that decentralization approach more member Arend Lijphart concluded: there are two times more than one member uniform than federal and most federal systems are decentralized. It finds that that six federal states (Australia, Canada, Germany, Switzerland, the USA and Belgium) are decentralized systems and the government while a federal state - Venezuela - it is a centralized state ("terminology to federalist should not mark a system very centralized governance and public administration"); that Austria and India is located between these two types of federalism in the sense that it is not so decentralized that, for instance, Australia, but not so centralized that Venezuela . Whichever situation of India whose constitution, and governmental practices are just “quasi federal" . The frequent use of the so-called "presidential leadership" in a partisan purposes divert from federalism: central government's constitution gives the right to dismiss the governments of the States and to replace them in their ruling directly to the center to resolve emergencies. Presidential Commission has prepared the leadership has been used to change the governments controlled by other parties and to summon new elections in federated States with the hope of gain.

Between federalism and as Regionalism there are essential differences: the state federal are characterized by the fact that state attributes are divided between two levels, and federated States participate, in one form or another, to the exercise of powers federal states while regions are not mass caterers state, do not have their own constitution and does not participate in the exercise of powers statehood federal scale.

The federal states may be familiar with various forms of administrative regionalization: "Switzerland may be exemplified as a federation that knows a regionalization international character when you need to resolve certain economic problems" .

Some authors, bringing that at the present time the terms 'federalism" and "as Regionalism" are highly topical in Europe, have been found after a brief comparative analysis of Germany, Austria, Belgium, Switzerland, Italy, Portugal and Spain that, both first states (which are federations), as well as and the last three (which they are the member regional unit) promote, in essence, a division of powers between the state and national "periphery". They consider that both federalism and the regional unit respond current trends for the granting of the extensive autonomy of regions (the "periphery") in conditions for the participation of 'center' in the administration and coordination of resources.

From the essence federal system is the participation whole and its parts in the drafting and amending its constitution. From this fundamental feature of federalism Carl Joachim Friedrich distinguish "federalism of integration" in which the participation in the drafting and amending its Constitution "may constitute a foundation the safest for the autonomy of the constituents" and "federalism of differentiation" in which "participation in the drafting and amending its constitution can be the means of achieving diversity"[4]. In the United States proposals for the revision of its constitution produces by the Congress, and in Switzerland it is allowed and people's own initiative.

Distribution of functions between the member federal legislative and federation which represents a feature each federation. In some federal states, such as Switzerland or India, a constitutional text lists descriptive fields legislative powers of the federation.

As far as federal law enforcement federal in some systems (for instance in the USA) this is done by federal authorities. In other federal systems (for instance: Germany and Switzerland) federal law is made and applied by local authorities, under federal control. Carl J. Friedrich considered that such a delegation of power strengthens federalism" .

In the usual way, and in federal states, some of the areas of your life by the state such as foreign affairs, the treasury, the problems with monetary, postal services and defense are all attributes of power. Regulatory competence issue of education, culture, police and regional administration belongs to in the usual way, units federated States. Economic and Fiscal (taxes, duties, social assistance, technology) are regulated in a variable, and in some states at federal level, and in others to the federated States.

Another essential feature of federalism consists in that it provides a balance between two opposing natural principles: principle of autonomy and the principle member federated States association in a state assembly which overlaps.

Achieving a balance between the two principles be integration of certain member states federated States to which it is respected personality and originality. It is from the essence of federalism achieving "consensus" in city. According to Carl J. Friedrich federalism "allow in a manner more widely of minorities dissident to transmit political messages to other citizens and by politicians; ... it multiplies opportunities citizens to participate in the life policy and therefore, his opposition politics; ... increase your chances of peaceful regulatory conflicts in society" .

Federalism is teaming up with constitutional democracy: in a federal state citizen belongs to concurrently to two communities; democracy does not conflict with federalism, whereas both "need composite as a community to submit more than one level of existence in the field of common values, interests and beliefs" . According to Chantal Millon's -Delsol "federalism is maintained the closest to the basic needs of individuals, do not grant it than the interval of which he is capable at the time, and at that point, but that's a grant on the whole. It contains an idea of progress for the freedom, what's possible because freedom is not her experience here at a concept given once for all"[1] . The author stresses that federalism "aliened need for sovereignty with respect for autonomy, it would be the only one who can assume, validly, diversity, with greater explosive, contemporary companies[1]. From the essence federal system is the participation whole and its parts in the drafting and amending its constitution. From this fundamental feature federalism Carl Joachim Friedrich distinguish "federalism of integration" in which the participation in the drafting and amending its Constitution "may constitute a foundation the safest for the autonomy of the constituents" and "federalism of differentiation" in which "participation in the drafting and amending its constitution can be the means of achieving diversity.[1] In the United States proposals for the revision of its constitution produces by the Congress, and in Switzerland it is allowed and people's own initiative. Distribution of functions between the member federal legislative and federation which represents a feature feature each federation. In some federal states, such as Switzerland or India, constitutional texts lists descriptive fields legislative powers of the federation. 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Another essential feature of federalism consists in that it provides a balance between two opposing natural principles: principle of autonomy and the principle member federated States association in a state assembly which overlaps. Achieving a balance between the two principles be integration of certain member states federated States to which it is respected personality and originality. It is from the essence federalism achieving "consensus" in city. According to Carl J. Friedrich federalism "allow in a manner more widely of minorities dissident to transmit political messages to other citizens and by politicians; ... it multiplies opportunities citizens to participate in the life policy and therefore, his opposition politics; ... increase your chances of peaceful regulatory conflicts in society.[1] Federalism is teaming up with constitutional democracy: in a federal state citizen belongs to concurrently to two communities; democracy does not conflict with federalism, whereas both "need composite as a community to submit more than one level of existence in the field of common values, interests and beliefs" . According to Chantal's new York cheesecake supreme Millon's "Delsol "federalism is maintained the closest to the basic needs of individuals, do not grant it than the interval of which he is capable at the time, and at that point, but that's a grant on the whole. It contains an idea of progress for the freedom, what's possible because freedom is not her experience here at a concept given once and for all. [1] The author stresses that federalism "aliened need for sovereignty with respect for autonomy, it would be the only one who can assume, validly, diversity, with greater explosive, contemporary companies.[1] Enumeration characteristic features of federalism provides us with great clarity the image state structure appropriate current stage of development of human society marked by the effects globalization process. European Union. The legal nature of the European Union, and of the prospects, of the directions has its development is the subject of significant debate. Current organization of the Union, the maintenance of a Europe crumbled, divided into the States national provides a development of the future, keep European states between the member advanced economic and technological advancement? There are European states member model of development, or they have surrendered once the shifting hegemony world and this role of the United States, Russia, China, Japan ? Its existence and development of the Community shall be justified, in our reasonable opinion, just from the need to adapt the organization model state in the development social and economic. In respect of the legal nature of the European Union have expressed themselves several opinions : Leontin-Jean Constantinesco has characterized the Union as an international organization integrated with evolutionary character. Jean-Paul Jacqué EU has characterized as an "specific assembly based on a sharing of powers between sovereign itself and its Member States, the powers being exercised in common community within the framework of the system institutional community. That is the way in which we can speak of integration. It appears that the Treaty can no longer be analyzed through international law, but also approached a habitués. By analyzing institutions of the European Union Arend Lijphart considers that the European Parliament represents bottom camera, the Council of the European Union represents top camera of the parliament while European Commission serves as executive and can be compared to a cabinet. Making reference to the Court the author concludes that "compared to other international organizations, EU supranational is very centralized and united, but compared with the member national - even decentralized for Switzerland - EU is obviously more, nonfederal than federal and also very decentralized. Probable development of the European Union toward a federation itself has been stimulated by Germany and France. In May 2000 Joschka Fischer, German minister of foreign affairs - held a speech about the future of Europe at the University Humbold in Berlin affirming that "closer relations of cooperation will lead to a European Constitution and, possibly, to a European federal state with a government and a parliament. The European monetary union with effect from 1 January 2002 is a corollary of The approximation between economies of countries community. The European Economic Community was represented by encouraging economic growth, the establishment and improvement of the situation social situation of the population. This purpose has been fulfilled. More than the Community, in addition to economic growth of the area and a distribution of income and wealth so that the fuse has been ensured social, all of the members of society might lead a life of dignity.[3] Entry into force on 1 December 2009 of the Treaty of Lisbon which fined the 2 treaties which governing the European Union- the Treaty which established EU and EU Treaty- means intention of the member states that the Union to evolve gradually toward a union of type creating federative. The main new elements described in the treaty demonstrates this intention and relate to: acquisition by the EU legal of the personality; establishment of the functions "chairman of the Union" and "minister of foreign affairs of the Union" or reduction of the number of commissioners with 1/3 ; facilitating decision making in 40 new areas (among them, and police and judicial cooperation) in the direction of eliminating veto right national, if the decisions shall be adopted by a qualified majority ; change the voting system for the purposes of qualified majority is done by the vote of 55% of the states, i.e. , 15 states ; extending right of decision areas of the European Parliament to important areas like agriculture, fishing, the affairs of the police and justice. Unfavorable through the effects of financial crisis on public finances of some member, on 16.12.2010 has been carried out by consensus heads member states, an amendment of the Treaty of Lisbon by which the member of the euro area are authorized to create a mechanism of the stability which will be activated if it will prove to be essential to ensure stable euro. In a union federal monetary policy effects are compensated for by the budget transfers to a state federate to another (from a land or canton to another) that which is not currently characterized European Union- a union of sovereign states. If they are plan drawn their views on the need for evolution to the establishment of Europe where many are opinions that it considers that the model federal is suitable for the future of Europe. Because federalism it seems, in this historical moment, that the only form of social organization which may guarantee that the identity in national and regional conditions specific interdependencies globalization. Principles of subsidiarity, autonomy and participation- which characterize the state federal- offers the possibility cohabitation harmonious of globalization (with its effects uniform zing) and preserving cultural identity, national or ethnic.[1]

REFERENCES

[1] Chantal Millon- Delsol- ,,Statul subsidiar”, Editura Efes, Cluj Napoca,1997.
[2] Arendt Lipjhart - ,,Modele ale democraţiei”, Editura Polirom, Iaşi,2000.
[3] Oscar Lafontaine, ş.a - ,,Nu vă fie frică de globalizare”, Editura Inter Graf , Reşiţa, 1998.
[4] J. H. H. Weiler - ,,Constituţia Europei”, Editura Polirom, 2009.

[1] Dusan Sidjianski - ,,Viitorul federalist al Europei,,, Editura Polirom, 2010, pag 13

IMPACT OF THE INTERNATIONAL ENVIRONMENTAL CONVENTIONS ON THE ROMANIAN MINING LAW

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ABSTRACT

The process of world trade and business globalisation requires the restructuring of the manner in which national governments are regulating their mineral resources protection and valorisation issues. In 1997, there were more than 175,000 miners in Romania. Eight years later, their number has dropped to 57,000, and the trend is continuing. Within this restructuring context, the paper has as goal firstly, to briefly present the main international conventions concerning environmental protection important to mining industry and, on the other hand, to highlight those prescriptions that exerts a major impact on Romanian mining legislation. Based on a thorough critical analysis of international conventions and protocols on environmental protection, ratified by the Romanian Parliament, we have identified three categories of errors that are frequently occurring in connection with the perception of international conventions. We have detailed the impact induced by every major convention/protocol on the protection and recovery regime of mineral resources. The ultimate goal which subsumes the study results taken is to create the procedural framework for promoting sustainable development of mining industry.

Keywords: mining law, environmental protection, international convention, restructuring

INTRODUCTION

How the states are governing the protection and exploitation of mineral resources is changing [1]. Until recently, regulation of the above areas was a problem whose solution represented the exclusive right of the country in which the mineral resources were quartered. The increased awareness regarding the fact that nations are interdependent and environmental problems rarely respect borders, led to the recognition of the fact that global solutions are required to global problems. This trend has manifested simultaneously with economic and world trade globalization. Consequently, there is an ever growing number of international conventions on environmental protection which do impose obligations on the member states who adhere to them.

International conventions themselves are also constantly changing. Those first developed, such as the Convention concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972) or the Convention on Wetlands of International Importance*,* especially as Waterfowl Habitat (Ramsar, 1971), have had a very limited scientific character, being focused on protecting sensitive areas from development effects. The more recently agreed tools, such as United Nations Framework Convention on Climate Change, are addressing much more complex issues both from scientific and political point of view. Currently, to separate the political issues from the scientific ones is virtually impossible, so that the adoption of any agreement involves political negotiations which finally put their mark on its content.

Three categories of errors do occur frequently in connection with the perception of international conventions [4]. The first one is to consider them as "vague", "inapplicable" or "irrelevant". A second one involves to blaming United Nations (UN) for what seems at first sight, an undesirable interference in national priorities and trade issues. Thirdly, it is a mistake to believe that international conventions are having a static character.

Regarding the first type of error, it can be observed that international conventions on environmental protection do express the aspirations of the peoples of the world to solve global environmental problems. Consequently, they contain a moral component with a major share, the ignorance of which can be dangerous. Moreover, they tend to become mandatory through the intermediate of national laws.

Regarding the second type of error, it should be emphasized that the United Nations as an organization, rarely initiates the development of agreements in response to the emergence of certain international evolution trends. There are many affected/interested factors and parties involved in defining environmental programs, including businesses, NGOs, governments and intergovernmental organizations. The sovereign right to ratify or not a convention belongs to each state. An imperative requirement for any country is the "de facto" participation in the negotiations preceding the completion of conventions and protocols related, because it is much easier to change an international legal instrument before signing it, than later.

Regarding the third type of error it should be noted that all the conventions do evolve with time, each one having a dynamic character. Each agreement has its own mechanism of change, usually resulted in a meeting of the parties that have acceded to it, with a periodicity comprised in the range of 1-3 years. These meetings aim to analyze how the consideration of amendments and protocols that customizes the way the Conventions should be implemented and the manner of development policy, including how to interpret them. Of course, the modification of an agreement is not a simple endeavour, but it can gradually become.

MAIN INTERNATIONAL CONVENTIONS ON ENVIRONMENT RELATED TO MINING INDUSTRY

Recognizing the ever increasing importance to be paid to the issue of environmental protection, the Romanian Parliament ratified, especially after 1990, a number of international conventions that address this area. It should be noted that, in accordance with Art. 11, paragraph 2 of the Constitution "*treaties ratified by Parliament, by law, are part of the national law*". In case of contrariety between a treaty and a law, it prevails the treaty. International environmental treaties that Romania has adopted or adhered to, are part of the internal national law and are sources of law to environmental law, regardless of their character (bilateral or multilateral) or the area covered [2].

Based on the general observations made above and the critical analysis of international conventions and protocols on environmental protection ratified by the Romanian Parliament the table 1 presents the following data:

- the list of the main international conventions and protocols regarding the environmental protection, relevant to the mining industry, indicating the legislative act through which they were ratified by the Romanian Parliament
- the identification of the impact of each convention/protocol on protection and recovery regime of mineral resources.

Table 1 Main international conventions and protocols regarding the environmental protection, relevant to the mining industry

Nr. crt.	Convention/protocol	Impact on protection and recovery regime of mineral resources
1.	Convention on Wetlands of International Importance, especially as Waterfowl Habitat (signed in Ramsar, on 02.02.1971 and entered into force on 21.12.1975); Romania adhered to the Convention by Law no. 5/1991 [7] and has a Ramsar area, namely the Danube Delta	Affects the licensing process of exploration and exploitation for the perimeters located nearby wetlands
2.	Convention concerning the Protection of the World Cultural and Natural Heritage (signed in Paris, on 23.11.1972, and entered into force on 17.12.1975); Romania adhered by the Decree no. 187/1990 [6] and has entered the World Heritage List 4 objectives: Biertan church, monasteries in northern Moldavia, Horezu monastery and the Danube Delta	Affects the licensing process of exploration and exploitation if there is a potential impact on natural or cultural heritage; Prohibits exploration or mining working in areas covered by or likely to be included on "World Heritage List"
3.	Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985); Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal, 1987); Amendment to the Montreal Protocol (London, 1990) - Romania joined by the Law no. 84/1993 [10]; Amendment to the Montreal Protocol (Copenhagen, 1992) - Romania has accepted the amendment by GO. 24/2000, approved by Law no. 9/2001; Amendment to the Montreal Protocol (Montreal, 1997) - Romania has accepted the amendment by Law no. 150/2001	Requires combustion and fire prevention and control, imposes conditions on the application of air refrigeration systems and techniques
4.	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel, 1989); Romania joined by the Law no. 6/1991 [8]	Generate a potential impact on the marketing of certain metals
5.	Convention on the Conservation of European Wildlife and Natural Habitats (signed in Berne, on 19.09.1979 and entered into force on 01.06.1982); Romania joined by the Law no. 13/1993 [9]	Affects the licensing of exploration and exploitation, if there is a potential negative impact on natural habitats.
6.	Convention on Biological Diversity (signed in Rio de Janeiro, on 05.06.1992, and entered into force on 29.12.1993); Romania has ratified the Convention through Law no. 58/1994 [11]	Affects the licensing of exploration and exploitation, if there is a potential negative impact on biological diversity
7.	Kyoto Protocol (document adopted at the Second Meeting of the Parties of United Nations Framework Convention on Climate Change, Kyoto, 1997); Romania joined by the Law no. 3/2001 [12]	Influences the selection of energy sources, price and use; requires the control of greenhouse gases emissions, which may particularly affect coal mining operations

Below are listed and detailed the provisions of the most important international conventions on environmental protection relevant to mining, presentation stressing the impact of these provisions on the regime of protection and recovery of mineral resources in Romania.

The Convention concerning the Protection of the World Cultural and Natural Heritage

The Convention concerning the Protection of the World Cultural and Natural Heritage was adopted under the aegis of UNESCO in 1972 and entered into force in 1975. Romania has acceded to this Convention by Decree no. 187/1990. In drawing up this Convention it was started from the idea that the cultural and natural heritage are of equal value, and for some of their goods which are of exceptional interest and are representative of all humanity to establish a global legal regime of special protection.

Obligations of States Parties are relating to: insurance, identification, protection, conservation, valuing and transmission to future generations the property of universal value and the adoption of a general policy regarding natural and cultural heritage, creating recovery services and its protection, research development, conservation measures. All signatory states undertake not to deliberately take any action likely to prejudice directly or indirectly assets located in other States Parties. Each good or item remains subject to national law regulation and individual states to identify and delineate the various goods within its territory and to propose them to be declared as world heritage. Acceptance decision lies with the intergovernmental World Heritage Committee. It sets, develops, updates and disseminates the "World Heritage List" and "Endangered World Heritage List".

Currently, the Convention applies differently in different regions of the world. While in developed countries this Convention plays an important role in protecting natural values, not the same happens in developing countries where the Convention expresses to lesser extent and lower force. The literature mentions cases in which multinational mining companies have started the exploitation of mineral resources in developing countries, resources located quite in the territory of natural reservations under the "World Heritage List" [4].

This issue is topical in Romania too, as the penetration of foreign private mining companies on the mineral resources market in our country can give rise to conflicts and inadequate situations generated by these companies' intentions to affect, through the proposed mining workings, architectural sites and archaeological value recognized both nationally and internationally. In this sense, we can cite the situation existing in Roşia Montana where the Roşia Montană Gold Corporation SA (a company with predominant Canadian capital) had started the preliminary works to exploit the gold and silver deposit located partly in the actual location of the village.

Currently, there are at least 12 sites placed on the "World Heritage List" considered by UNESCO as endangered by mining operations. Because, on the one hand, the signatory states - parties tend to add many sites that can be incorporated into the provisions of this Convention, on the other hand, the concept of natural or cultural heritage becomes more rigorous, it is inevitable emergence of disputes between mining companies and those who intend to use the Convention against mining.

In conclusion, it can be said that the Convention will be increasingly involved in "confrontation" development - environment.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted in 1989, and Romania acceded to the Convention by Law no. 6/1991. By Law no. 265/2002 Romania agreed the amendment to the Basel Convention adopted through Decision III/1 at the 3rd Meeting of the Parties Conference (Geneva, 18 to 22 September 1995), respectively that amendment and Annexes VIII and IX to the Basel Convention adopted by Decision IV/9 at the 4th Meeting of the Conference of the Parties (Kuching, Malaysia, 23-27 February 1998).

The Basel Convention detains an important role in the future developments of the mining industry. The focus of the problem is the definition of "hazardous waste". The first definitions were so broad that it could be interpreted as including metal waste from machining metals. The development and application of metal recycling techniques has been hampered in some time by what was considered to represent a weapon to combat the real problems associated with hazardous waste storage. Consequently, the Basel Convention was amended so that most metals can be further recycled safely.

The impact of this Convention to the mining industry is felt more by the marketing departments, rather than the exploitation and environmental departments because it can affect, first, the market prices of metals. Industry has adapted with difficulty to the possible consequences of the Convention and even how mining has developed not only emphasizes the need for industry and those engaged by industry to keep attention awake on policy development and international regulations, but also highlights the imperative to take also decisions to consider the appearance of accepting responsibility for the final products of mining operations.

Convention on Biological Diversity

Convention on Biological Diversity is an integral part of the Framework Convention adopted by the Conference in Rio de Janeiro, in 1992. It entered into force in 1993 and was ratified by Romania by Law no. 58/1994. States Parties to the Convention undertakes to carry out a wide range of activities: biodiversity conservation, sustainable use of its components and fair and equitable sharing of benefits arising from the use of resources, including by appropriate access to resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and technology and adequate funding.

The preservation obligations assumed by States Parties are concerning: the adoption of direct measures for in situ conservation, ex situ and integrated conservation, sustainable use of biological diversity elements. Also provided are requirements regarding: the duty to cooperate for the conservation and sustainable use of biological diversity, identification and monitoring the status of its components, to integrate considerations relating to the conservation and sustainable use of biological resources into national policies and laws, the way of conducting the study impact.

Analyzing the Convention provisions it results the finding that the Convention does not impose a strict approach to the problems regarding biological diversity. Depends only on the signatory state governments to strengthen them and, especially, to implement the commitments they have assumed. It is expected that the proposed mechanisms for the Convention to evolve so that it becomes effectively applicable.

To date, the mining sector has not systematically addressed the issue of biological diversity. Within certain mining companies there have been timid attempts to address this problem, but the overall tendency was rather to consider this issue as relatively unimportant.

Mine companies who take their obligations as a consequence of the Convention on Biological Diversity, can play an important role both in the protection and conservation of biological diversity and to improve degraded habitats. The issue regarding the areas where mining activities will never be allowed requires a systematic approach by governments and industry. Another key problem lies in the quantification of impacts and, therefore, in the way of reporting - information that should be as comprehensible as possible. From this perspective, it should be noted that the International Council on Metals and the Environment (ICME), a representative association for the mining industry, held frequent meetings at expert level, on the issue of biological diversity.

Kyoto Protocol

Kyoto Protocol was adopted in 1997, during the second meeting of Parties to United Nations Framework Convention on Climate Change (Rio de Janeiro, 1992). Romania has acceded to this Convention by Law no. 3/2001. By adopting this protocol it was decided a relatively slow decrease in emissions of greenhouse gases. The commitment of states, envisage a reduction on average by 5.2 % by 2008-2012 compared with 1990 levels. By signing the Kyoto Protocol Romania pledged to reduce by 8 % reduction in greenhouse gas emissions.

The reduction within the developed states refers to 3 - 6 gasses, respectively, primarily carbon dioxide (CO_2), methane (CH_4), nitric oxide (N_2O) and three substitutes of chloride-fluorine-carbons (CFC). Kyoto Protocol refers to a "clean development mechanism" and is an international instrument to achieve the objective of reducing the greenhouse gas to the "system of negotiable premises ". Subsequent meetings in Buenos Aires (1998) and Bonn (1999) have advanced little in the process of defining rules triggered by the Kyoto Protocol. U.S. complained a participation of developing countries (mainly China and India) in reducing CO_2 emissions, as well as exclusive recourse to market mechanisms.

Kyoto Protocol has significant implications for mining. Several States have adopted measures to reduce electricity consumption by reducing carbon dioxide emissions and minimizing dependence on fossil fuels. Because mining and steel industries are energy intensive, they may possibly face increased costs, but to improve performance.

Although the Protocol does not place the centre of gravity on the developing countries, participation of some (China and India) is voluntary it will exert pressure on them (political and economic) to change their energy generating sources and systems. Mining of coal meets additional difficulties on the renewable energy market. Of all the fossil fuels coal is the least popular, mainly due to large quantities of carbon dioxide generated by burning fuel per unit mass. Consequently, natural gas is increasingly preferred in power plants built in recent years in Europe and beyond. We should not forget that the operation of underground coal mines leads to release in the atmosphere of large quantities of methane, a phenomenon that has attracted the attention of bodies responsible for environmental protection in countries with developed mining industry, which required almost mandatory methane capture and recovery.

Mining industry of several states have already adopted certain ways to react to what is known as "global warming". Thus, mining companies in Australia with the Australian Government established and try to apply the provisions of the document entitled "Greenhouse Challenge" [3], by which the mining operators are encouraged to adopt voluntary measures to reduce emissions greenhouse. Another example is The Office of Energy Efficiency concerns of Natural Resources Canada which has developed the document entitled "Energy Efficiency Planning and Management Guide" [5].

Kyoto Protocol has special significance for developing countries. Along with other industries, mining industry in these countries have to reduce specific energy consumption through better management of resources, improving the technology used and the awareness of employees, regardless of hierarchical level on which are placed in the protection environment for future generations. Organizations and bodies will be empowered, not only to encourage but also to assist in apply the judgment of legislative instruments in the field.

CONCLUSIONS

Application of conventions and protocols described in the paper becomes an imperative for mining in Romania, because these international documents are, at present, part of the national framework. From this perspective, the paper sought to identify and analyze the impact induced by each Convention / Protocol on the regime of protection and recovery of mineral resources. Protecting the natural and cultural heritage, biological diversity, avoiding risky disposition of hazardous waste and reducing greenhouse gas emissions, is creating the procedural framework for promoting sustainable development of the mining industry.

REFERENCES

[1] Băbuţ, G.B. Mining legislation (in Romanian), Focus Publishing House, Petroşani, Romania, 2009.

[2] Băbuţ, G.B. & Băbuţ, M.C. Environmental protection legislation (in Romanian), Universitas Publishing House, Petroşani, Romania, 2012.

[3] * * *, Minerals Industry Greenhouse Challenge Workbook, Minerals Council of Australia, 1997.

[4] * * *, Berlin II Roundtable on Mining and Environment. UNDESA/UNEP, Berlin, 22-26 November 1999.

[5] * * *, Energy Efficiency Planning and Management Guide, The Office of Energy Efficiency of Natural Resources Canada, Ottawa, 2002 (available at: http://oee.nrcan.gc.ca).

[6] * * *, Decree no. 187/1990 for acceptance of the Convention concerning the Protection of the World Cultural and Natural Heritage by General Conference of the United Nations Educational, Scientific and Cultural Organization on 16 November 1972, Official Journal of Romania, part I, no. 46/31.03.1990.

[7] * * *, Law no. 5/1991 for Romania's accession to the Convention on Wetlands of International Importance, especially as Waterfowl Habitat, Official Journal of Romania, part I, no. 18/26.01.1991.

[8] * * *, Law no. 6/1991 for Romania's accession to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (with subsequent amendments), Official Journal of Romania, part I, no. 18/26.01.1991.

[9] * * *, Law no. 13/1993 for Romania's accession to the Convention on the Conservation of European Wildlife and Natural Habitats, adopted at Berne on September 19, 1979, Official Journal of Romania, part I, no. 62/25.03.1993.

[10] * * *, Law no. 84/1993 for Romania's accession to the Convention for the Protection of the Ozone Layer, adopted in Vienna on March 22, 1985, and Protocol on Substances that Deplete the Ozone Layer, adopted in Montreal on September 16, 1987, and to accept the Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted at the second meeting of the Parties in London, from 27 to 29 June 1990 (with subsequent amendments), Official Journal of Romania, part I, no. 292/15.12.1993.

[11] * * *, Law no. 58/1994 for ratification of the Convention on Biological Diversity, signed in Rio de Janeiro on 5 June 1992, Official Journal of Romania, part I, no. 199/02.08.1994.

[12] * * *, Law no. 3/2001 for ratification of Kyoto Protocol to the United Nations Framework Convention on Climate Change, adopted on December 11, 1997, Official Journal of Romania, part I, no. 81/16.02.2001.

IMPLEMENTATION OF THE LAW TO IMPROVE SOLID WASTE RECYCLING PROGRAMS IN BENGHAZI CITY: LIBYA

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ABSTRACT
This study analyzes the law enforcement plays an important role and an actor in the implementation of solid waste, if the law applied firmly and without the general public will participate in the program of recycling waste end increasing recycling rates in Libya, Benghazi. So the program of waste recycling needs in the early stages to implement the law. Furthermore, the data were collecting by questionnaire and interview to obtain data and information required. The purpose of this study is to examine an application of the law or help improve solid waste recycling programs located in different areas of Libya. The results show that respondents largely agreed that a law on the recycling of solid waste has to be enforced. 77.2% of the respondents expressed enforcing a law on recycling, 22.8% not agreed with that. However, enforcing laws related to the recycling of solid waste was agreed by the MHE & EGA. Therefore, imposing a law would be one of the key strategies to increase recycling activities in the future. Where such application and implementation will deeply have a significant impact and will additionally assist in the activities of the solid waste recycling at the present time and in the near future.

Keywords: Implementation; law; solid waste; recycling programs; Benghazi.

1. INTRODUCTION

Solid waste pollution, water pollution, and sanitation problems are among the foremost environmental concerns in most cities in Libya. These problems directly affect the quality of human life and the appearance of the environment, and have serious implications on overall development. Solid waste pollution is particularly problematic. The repeated accumulation of waste at roadsides and at the entrances of cities and villages is shameful. In addition, wastes, including plastic and industrial, are burned in open air, worsening the environmental situation. Nonetheless, solid waste can be considered a national treasure that can generate significant revenues if managed properly. Recycling and material recovery are two possible ways of creating economic value from solid waste.

In Benghazi, recycling activities are nonexistent despite the presence of recycling programs sponsored by the Ministry of Health and Environment (MHE) in collaboration with the city's Environment General Authority (EGA). Recycling programs have failed to inspire the public, to win their willingness to take recycling seriously, and to make recycling part of their daily routine. In 1982, the government of Libya enacted a law prohibiting indiscriminate solid waste disposal in the capital city of Libya (Tripoli).

Libya is actively seeking waste management companies to provide a comprehensive plan for the collection and disposal of waste in the major urban centers of Benghazi. Of particular interest to investors interested in the oil and gas sector is Law No. 7 of 1982, which established a Technical Center for the Protection of the Environment. The Technical Center was replaced in 1999 by the Environmental General Authority, which strictly prohibits the disposal of oil and the washing of tankers within Libya's territorial waters (EGA, 2008). In 2003 was to change the law No. 7 of 1982 by Law No. 15, but there was no significant difference only a simple change and add amendments (EGA, 2010).

Although the law on the protection and improvement of the environment No. 15 of 2003, and the law of hygiene No. 13 of 1984 stipulates the need to dispose of waste according to scientific bases and the available places complexes progress in most cities, but he noted the lack of these compounds in most of them and thus the reason for this obstruction of the process of collecting and preserving waste into residential neighborhoods, and this led to the accumulation of waste on both sides of the roads and in empty arenas(El-Mabrouk, 2007).

The main objective was to ascertain whether law implementation will be helping participation in the recycling of solid waste and increases the rate of participation in the recycling of solid waste in Libya.

2. LITERATURE REVIEW

In this section, I review the literature that studies application to the law to improve solid waste recycling programs. Lu et al. (2006). Who stated that the principle of rewards and punishment was to encourage the public to participate in the implementation of municipal solid waste separating and recycling activities, on the other hand, Tam and Tam (2006) found that mandatory regulation and legislations implemented by the government are needed to control waste recycling management and environment attitudes toward the construction industry.

Abdelnaser (2008) found that households in the east coast and northern part of Malaysia are more supportive, agreeing with the imposition of the law to enhance recycling activities. Legal enforcement puts a heavy burden on improving solid waste recycling on the local level. Local governments must therefore consider this valuable approach in designing solid waste recycling plans and programs. For instance, Abdelnaser et al. (2009) noted that, with legal enforcement, households in Alor Setar agree to recycle. Ekere et al. (2009) advocated that waste separation at the household level needs to become part of a new waste management policy or by-law to enhance reuse. However, Sidique et al. (2010) found that the enactment of recycling ordinances making residential recycling mandatory increases the rate of recycling. In contrast, (Read, 1999; Clarke and Maantay, 2006; Abdelnaser, 2008) found that some people are unwilling to practice recycling within the bounds of the law in their area or country. Another study by Clarke and Maantay (2006) and Read (1999) noted that legislations and regulations are the primary ways through which governments seek to control and influence waste management and recycling practices.

3. THE CASE STUDY

Benghazi is located in the north-eastern Libya at coordinates (32° 07' N 20° 04' E / 32°.117 N 20°.067 E) with an area of 43,535 km, Benghazi is the second largest city in Libya. It lies on the Mediterranean Sea in northeastern Libya, approximately 621 miles (1000 km) east of Tripoli (Figure 1). Benghazi is the industrial, and transportation center for a region producing grains, fruits, and livestock. Its port, although overshadowed by that of Tripoli, handles a considerable amount of foreign trade. Food processing, as well as sponge and tuna fishing are the city's chief industries. Benghazi has an international airport, and a highway links directly the city with Tripoli (National Planning Council, 2009).

Figure 1. The study area indicated on the Map of Libya by a red square
Source: Mappery (http://mappery.com/Benghazi-City-Map) (2010)

4. METHODOLOGY

The study was carried out by distributing a questionnaire and interview with officials of the Environment to Benghazi, Libya. A questionnaire was distributing among the population in the city of Benghazi and sent to residents four zones with different background. Furthermore, prepared the interview about the importance of implementing the law for people's participation in solid waste recycling programs. The interview was conducted with government officials in Libya and Director of the Environmental General Authority of Benghazi, and a representative of the Ministry of Health and Environment in Libyan government. The Environmental General Authority in Benghazi has divided the city into four main zones to simplify the garbage collection process (EGA, 2008) Each Zone has some areas, as shown in the following Figure (2):

Zone one : Bengazi Al Madinah, Sidi Hassin, Sidi Abayd, Al Sabri, Al-Lathamah, Shuhada Al Salmaney, Raas Abayds.
Zone two: Hay Al-Mukhtar, Al Uruba, Shuhadaa Al Salawai, Al Kwayfiya, Abu Atni, Al-Thawra Al-Shabiyah.
Zone three: Al-Keesh, Al Berka, Al-Hadaa'ik, Benghazi Al-Jadida, Al Hawari, Al Fuwayhat.
Zone four: Garyounis, Abu Fakhra, Al-Quwarsha.

Figure 2. Viewing the four main zones in the city of Benghazi on the map
Source: EGA (2008)

5. RESULTS

Through this study on the role and importance of law enforcement in helping people to participate in the recycling program of solid waste in Benghazi City, respondents largely agreed that a law on the recycling of solid waste has to be enforced. As shown in Figure (2), 77.2% of the respondents expressed enforcing a law on recycling.

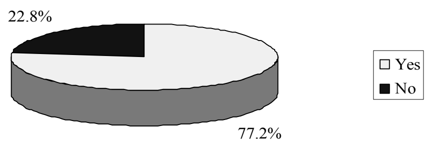

Figure 3. Law enforcement on recycling in Benghazi City

Two interviews were conducted with officials directly involved in the management and recycling of solid waste: a representative from the Ministry of Health and Environment (MHE) of Libya and one representative from Environment General Authority (EGA) in Benghazi City. MHE said yes, we strongly agree, because imposing a law will help increase recycling activities in future. EGA claimed that I agree with this because if there is enforcement, the public will obey the law. Many overseas experiences have implemented such programs, and many improvements and settlements have been happened and they have better results in their implemented programs. Enforcing laws related to the recycling of solid waste was agreed by the MHE & EGA. Therefore, imposing a law would be one of the key strategies to increase recycling activities in the future.

6. DISCUSSION

Respondents in the city agree with the strict enforcement of the law on solid waste recycling, citing the discouraging situation of solid waste management and the increasing incidence of reckless solid waste disposal. Two interviewees share the same opinion that imposing the law is an effective strategy to widen recycling activities in future. Several studies supported this finding.

For instance, a recent research by Abdelnaser et al. (2009) noted that, with legal enforcement, households in Alor Setar agree to recycle. Other researchers (Read, 1999; Clarke and Maantay, 2006; Abdelnaser, 2008) found that some people are unwilling to practice recycling within the bounds of the law in their area or country. Abdelnaser (2008) found that households in the east coast and northern part of Malaysia are more supportive, agreeing with the imposition of the law to enhance recycling activities. Legal enforcement puts a heavy burden on improving solid waste recycling on the local level. Local governments must therefore consider this valuable approach in designing solid waste recycling plans and programs. Sidique et al. (2010) found that the enactment of recycling ordinances making residential recycling mandatory increases the rate of recycling.

Ekere et al. (2009) advocated that waste separation at the household level needs to become part of a new waste management policy or by-law to enhance reuse. Another study by Clarke and Maantay (2006) and Read (1999) noted that legislations and regulations are the primary ways through which governments seek to control and influence waste management and recycling practices. This finding is supported by the finding of Tam and Tam (2006) who found that mandatory regulation and legislations implemented by the government are needed to control waste recycling management and environment attitudes in the construction industry. This is also consistent with the findings of Lu et al. (2006) who declared that the principle of rewards and punishment was to encourage the public to participate in the implementation of MSW sorting and recycling activities.

6. CONCLUSIONS

From the results that have been reached; it was found that most of the respondents see that the application and implementation of the law are necessary and will help in making the recycling programs a success one, where the majority of respondents agreed on the idea of implementing the law for public participation in solid waste recycling. This finding has also been observed by the results that were gathered from the 2 carried interviews whereas the views of the Ministry of Health and Environment in Libya, and the Environmental General Authority in Benghazi were strongly agreed on the idea of applying the law as a strategy to protect and improve the environment. Additionally, enforcing laws related to the recycling of solid waste was agreed by the MHE & EGA. Imposing a law would be one of the key strategies to increase recycling activities in the future. Such as application and implementation will deeply have a significant impact and will additionally assist in the activities of the solid waste recycling at the present time and soon. Application of the law and its implementation will help a lot to the success of recycling programs and solid waste management.

REFERENCES

[1] Abdelnaser O. Attitude of Malaysians on recycling of solid wastes in Malaysia, Case studies in the major towns of the east coast and north Malaysia, PhD Thesis, Universiti Sains Malaysia, Malaysia, 2008.

[2] Abdelnaser O, Mahmood A., Aziz H. A., Guy M. Robinson. Investigating households' attitude toward recycling of solid waste in Malaysia: A case study. International Journal of Environmental Management and Technology, vol. 3/issue 2, pp 275-288, 2009.

[3] Clarke M. J., Maantay J.A. Optimizing recycling in all of New York City's neighborhoods: Using GIS to develop the REAP index for improved recycling education, awareness, and participation. Journal of Recourses, Conservation and Recycling, vol. 46/issue 2, pp 128-148, 2006.

[4] Ekere W., Mugisha, J., Drake, Lars. Factors influencing waste separation and utilization among households in the Lake Victoria crescent, Uganda. Journal of Waste Management, vol. 29/issue 12, pp 3047-3051, 2009.

[5] El-Mabrouk, F. A. Solid waste and hazardous and special and appropriate technologies for wastewater treatment in Libya. Center for Research and Consulting. University of Garyounis, Libya, 2007.

[6] Environmental General Authority (EGA). Information obtained through interview by researcher Mr. Abdelsalam with director Environmental General Authority in Benghazi, Libya, 2010.

[7] Environmental General Authority (EGA). Information on solid waste management issues in Benghazi city, Libya, Retrieved September 6, **2008**, from http://www.environment.org.ly/index_en.htm, 2008.

[8] Lu Li-The., Hsiao T., Shang N., Yu Y., & Ma H. MSW management for waste minimization in Taiwan: The last two decades. Journal of Waste Management, vol. 26/issue 6, pp 661-667, 2006.

[9] Mappery. Benghazi City Map. 2010. http://mappery.com/Benghazi-City-Map

[10] Ministry of Health & Environment. Information obtained through interview by researcher Mr. Abdelsalam with representative the Ministry of Health and Environment in Libya, 2010.

[11] National Planning Council. Study the possibility of investment of solid waste in order to achieve environmental and economic returns, both in partnership with companies national or non-national in Benghazi city. Libya, 2009.

[12] Read A. D. "A Weekly doorstep recycling collection, I had no Idea We Could" Overcoming the Local Barriers to Participation, Journal of Resources, Conservation and Recycling, vol. 26/issue 3-4, pp 217-249, 1999.

[13] Sidique S. F., Joshi S. V., Frank lupi F. Factors influencing the rate of recycling: An analysis of Minnesota counties. Journal of Resources, Conservation and Recycling, vol. 54/issue 4, pp 242-249, 2010.

[14] Tam V. W. Y., Tam C. M. Evaluations of existing waste recycling methods: A Hong Kong study. Journal of Building and Environment, vol. 41/issue 12, pp 1649-1660, 2006.

INFRINGEMENT OF WATER POLLUTING AS DESCRIBED BY THE ROMANIAN CRIMINAL CODE

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ABSTRACT

In the present study I am analysing the infringement of water polluting together with other infringements of the public health as described in the Romanian Criminal Law in art 311. The Romanian Criminal Law stipulates that infringement of water sources and networks by any means, if harmful for people, animals or plants, is punished with prison from 6 months to 4 years or fine. The water sources that the law refers to are: springs, fountains, lakes and bowls. The water networks refer to pipes, filters, canals, cradles etc. The analysis of the infringement of water polluting is done according to the well-known doctrine structure and comprises: the infringement object and subject, the content of the infringement: the objective side of the material element, the immediate consequence and cause relation; the subjective side of the infringement as well as their means of realisation and the sanctions applicable.

Keywords: infringement, sanction, Romanian Criminal Code, health

INTRODUCTION

Romania disposes of a rich network of running waters displayed as rivers, where nature itself is determined by Europe's most important river – the Danube - which collects in its basin almost all these rivers. There are also dead waters such as fresh waters, and salt waters, barrier lakes built by man for different purposes. Under the soil, there is a lot of water called subterranean water (phreatic and deep waters) [1].

Romania's rivers spring from the Carpathians and lead to the outer Carpathian circle from the centre to the margins in a radial course. The lakes extend over a small surface, only 1, 1% of the country's territory. The Black Sea has a surface of 462,535 km^2 (together with the Azov Sea). It is a continental sea that extends between Europe and Asia Minor [2].

The water sources that the legal text refers to are: springs, fountains and bowls. The water network refers to the pipes, filters, canals, cradles, etc.

The infringement of water polluting is part of the crimes against public health, as described in cap II; title IX, art 311, of the Romanian Criminal Code, the special part.

LEGAL CONTENT

Infringement is considered as a behavioural act forbidden by the incriminatory, norms usually done by a person, thus breaching the obligation of not complying with a person's social values. The Romanian Criminal Code stipulates in art 17 that infringement is a socially dangerous deed, committed on purpose or not as described by the criminal law.

Art 311 of the Romanian Criminal Law as modified by Law no 169 as of 10 April 2002 regarding the modification and completion of the Criminal Law and other special laws [3] stipulates that water polluting by any means of the water sources and networks, if harmful for peoples', animals' and plants' health, is punished with imprisonment from 6 months to 4 years or fine.

PRE-EXISTENT CONDITIONS

The object of infringement

The special judicial object of infringement is the social relations that refer to public health, whose existence and development is conditioned by charging the water sources and networks in order to avoid them to become harmful to people, animals and plants' lives [4]. The material object of the crime is made of water sources and networks.

Subjects of the infringement

The people who are involved in the judicial report of the criminal conflict are subjects to crime.

In other words, the crime subjects are the people involved in a crime, either by committing it or by suffering the consequences of the deed [5]. In the specialised literature, the active and passive subjects of the crime are differentiated.

The active subject of a crime is a natural person who committed the crime directly and spontaneously – as author or took part in the crime as instigator or accomplice. The passive subject is a natural or legal person entitled to preserve the social value, who is hurt or endangered by the crime.

The active subject can be any person. The legislator does not regard any special investment of the subject for his crime to be considered as infringement, so that the spontaneous *active subject* is not qualified as such.

This crime is possible arraignment under all its forms: co-authorship, instigation and complicity.

When a person directly and spontaneously commits a crime whose decision he/she solely makes and is not supported by any other person, he/she is the *author* of the crime. The *co-author* is a form of participation to a crime where two or several people are involved as described by the criminal law. Instigation is a form of criminal participation which consists of determining a person called instigator, to breach the law as described by the criminal law. The instigator makes the decision to commit the crime, which he transmits to another person, the instigated person, who will commit the crime. Regarding complicity, it is a form of criminal participation that consists in a person's deed purposely committed or a person's contribution to a crime as described by the criminal law. Also, complicity refers to the case when a person promises to keep the goods resulted from the crime or to support the criminal, even if after the crime, the promise is not fulfilled [6].

The passive subject can be any person who suffers from the present or future consequences of a crime as a result of infringement, thus endangering his/her health.

CONTENT OF THE LAW

The objective aspect

The material element of the objective side is the behaviour forbidden by the incriminatory norms. The material element of the crime as described in art 311 of the Romanian Criminal Code refers to an action of crud, alteration, change of water components, water sources and networks, regardless of the means. It refers to the existence of certain water sources and networks of public use for people and animals.

The immediate consequence is the danger that the water becomes harmful for people, animals and plants, possibly leading to sickness in people, animals and destruction of plants.

If after water consumption there is a result, the deed, by report to this result, will be a crime against life, health.

Casualty implication. Between the infestation of the water source or network and, in case of use of infested water as mentioned above, there must be underdone a cause and effect report.

The subjective aspect

The guilt in the case of infringement of water polluting is intention. Intention is described by the legislation art 19 p 1 of the Criminal Code, and also by the doctrine as: direct and indirect intention. The former is characterized by prevision of the crime result and desire of accomplishment by committing the crime. The former, the indirect intention, is characterized by prevision of the result, which is not a scope in itself, and the criminal accepts it.

FORMS. MODALITIES. SANCTIONS

Forms. The preparation and the attempt, although possible in case of water pollution, are not punished by the law. The infringement takes place in the moment of water pollution and immediate results.

Modalities. The crime is classified in a sole article of the law as the typical crime. The crime can be described in several means of development.

Sanctions. The sanctions of the infringement of water pollution is punished with prison from 6 months to 4 years or fine.

CONCLUSIONS

In the New Romanian Criminal Code – Law no 286/2009 regarding the Criminal Code [7] the infringement of water pollution is described in art 360 within other crimes related to public health and comprises: In case of crud by any means of the water networks where water become harmful for people, animals and plants' lives, is punished with imprisonment from 6 months to 3 years or fine. The attempt is punished.

Thus, we notice that the punishment is prison from 6 months to 3 years or fine and from 6 months to 4 years and fine as described by the Criminal Code in force. Also, according to the New Criminal Code, the attempt is punished while the present code it is not punished although described.

REFERENCES

[1] World geography. Romania's hydrography: streams, rivers, lakes, http://www.geografialumii.ro/hidrografia-romaniei;

[2] Idem;

[3] Published in the Official Journal no 261 as of April 18, 2002;

[4] Nistoreanu, G., Boroi, A., Molnar, I., Dobrinoiu, V., Pascu, I. & Lazăr, V., 1996. Criminal Law – Special Part, Continent XXI Printing House, Bucharest, Romania;

[5] See Mitrache, Ctin. & Mitrache, C., 2009. Romanian Criminal Law. General part. VII-th Edition, Universul Juridic Printing House, Bucharest, Romania, p. 120; Bulai, C., 1992. Criminal Law. General Part, Bucharest, "ŞANSA" S.R.L. Printing House, Bucharest, Romania, p. 81;

[6] For more details, see Mitrache, Ctin. & Mitrache, C., cit., pp. 317-327;

[7] Published in the Official Journal no 510 as of July 24, 2009.

NATIONAL ACTION PLAN ON CLIMATE CHANGE: MEASURES IN THE FIELD OF EDUCATION AND SCIENCE

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ABSTRACT

In compliance to the international commitments of Bulgaria related with the UN Framework Convention on climate change (UNFCCC) and the Kyoto Protocol (KP) as well as the requirements of the European legislation in this area, the Ministry of Environment and Water (MEW) organized the preparation of the III National Action Plan on Climate Change (2013-2020), which was presented for the first public discussion in March this year. The plan has been developed within the frames of the project "Holistic Approach to Reducing Greenhouse Gas Emissions in Bulgaria", supported within the frames of the Norwegian Programme for Cooperation with Bulgaria.

Along with the measures in the main economic sectors, a package of measures in the field of education and science has been also developed in this plan. These measures are consistent with the needs of the respective sectors on the one hand, and with the National Strategy of Scientific Research until 2020 and the Programme for Development of Education, Science and Youth Policies in Bulgaria on the other hand.

The measures in the field of education are structured into two groups:

(1) Development and implementation of state requirements for the topics related to climate change in the primary, secondary and university education.

(2) Enhancement of the knowledge and qualification of teachers and lecturers on issues related to climate change and in particular – to reducing the greenhouse gas emissions.

The basic measures in the sphere of science are directed towards practical-applied scientific research. Eight groups of investigations are structured that correspond to the reported sectors for annual inventories of greenhouse gases submitted to the UN Framework Convention on Climate Change (as is the structure of the present action plan as well): energy; industry; households and services; transport; agriculture; land use and forestry; waste; social aspects of the low-carbon society. In this way the main part of the package of measures corresponds to the necessity and important requirement for conducting scientific investigations, specifically oriented towards the needs of practice. A group of measures is also identified referring to fundamental scientific research as an initial ground base for further development of applied scientific investigations and their practical realization.

Keywords: education measures, scientific measures, reduction of greenhouse gases

INTRODUCTION

Climate changes and their consequences, irrespectively of their dependence on anthropogenic activity or on natural astronomical or geophysical reasons, represent a fact that requires extensive and comprehensive study, as well as taking of relevant mitigation and adaptation measures. In this context, as well as in connection with the international commitments of Bulgaria under the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (KP) and as required by the current European legislation in this field, MEW has launched the preparation of the III National Action Plan for Climate Change (2013-2020). The first two National Plans refer respectively to the period 2000–2004 and 2005–2008 and their operation time has already elapsed, so that the establishment of an updated document for actions in the sphere of climate change is required, and this is also another reasonable motivation for the development of a new plan [2], [3].

The Third National Action Plan on Climate Change (NAPCC) that was submitted to first public discussion in March this year, shall be developed within the frames of the project “Holistic approach to reducing the emissions of greenhouse gases in Bulgaria” under the Norwegian Programme for Cooperation with Bulgaria.

The basic strategic objective of the present Third Action Plan is to outline the range of the activities in the area of climate change for the period 2013-2020 by analyzing and taking into account both the international context and the new realities of global policy in this sphere, as well as the EU commitments, reflected also in the adoption of the legislation in late 2008 at the highest political level (the European Council and the European Parliament). The envisaged measures for each of the sectors are consistent with two major aspects of policy on climate after 2007 – decreasing the greenhouse gases in Bulgaria and implementing the existing European legislation in the area of climate change.

The reduction of greenhouse gas emissions is the principal accent of this plan and therefore its concept is based on preserving and rational and responsible use of resources as a key prerequisite not only for improving and protecting the environment but also to achieving sustainable economic growth and increasing the competitiveness of Bulgarian economy. The introduction of low-carbon, energy efficient and waste-free technologies, as well as the utilization and recycling of greater amounts of waste, will contribute not only to the overall reduction of greenhouse gases but also to improvement of productivity and resource efficiency. Possibilities will be ensured for finding new sources of growth and work places by cost saving, market realization of innovations and better management of resources throughout their lifecycle.

The measures for each sector are developed in conformity with one major criterion – the contribution to reducing the greenhouse gas emissions in Bulgaria. The overall effect of implementation of these measures will guarantee the achievement of the legally binding targets for the country related to the "Climate and Energy" package, as well as the goals for energy efficiency. The measures are summarized for each of the sectors: energy, households and services, industry, waste, agriculture, land use and forestry, transport and education&science.

MEASURES IN THE FIELD OF EDUCATION AND SCIENCE

The measures in the sphere of science and education are consistent with the needs of the respective sectors on the one hand, and with the National Strategy of Scientific Research until 2020 and the Programme for Development of Education, Science and Youth Policies in Bulgaria. Several leading national scientific priorities in the mentioned two documents are focused on areas that are closely related to the opportunities for reducing greenhouse gas emissions: energy sources and energy saving technologies; management and control on harmful and hazardous household and industrial waste; new raw materials [4], [5].

The major **objective** of the measures is to focus scientific research, development and educational activity on the problem of reducing greenhouse gas emissions, investigating and studying the natural and anthropogenic factors to ensure their sustainable management in direct cooperation with practice under conditions of improved expert, administrative-organizational, technologically-informational and financial environment [1].

The measures are distinguished along two priority axes [1]:

I. Promotion of the subject of climate change and reduction of greenhouse gas emissions in the educational process

1. Creation and implementation of state requirements for climate related subjects in the primary, secondary and university education

In compliance with Bulgarian legislation, the introduction of a compulsory element of certain aspects of knowledge in the sphere of elementary and school, as well as university education can be realized by establishment of state requirements / educational standards for each specific subject or discipline of the curricula.

Since the topic of climate change and the anthropogenic factors determining it is interdisciplinary, the requirements have to be developed for the different subjects of each educational degree.

The development of the requirements includes the following activities:

- analysis of European and world experience and existing curricula with their relevant appliances, and identifying the appropriate places and elements for introducing the corresponding climatic aspects – analytical work of teams of experts;
- experimental introduction of elements in the existing curricula;
- development of proposals for requirements based on the analysis and experiments using the wide experience of European and other countries;
- a series of discussions and consultation process;
- formation and proposal for introducing the formulated requirements.

Due to the interdisciplinary character of the subject of climate change (respectively greenhouse effect reduction), it is relevant to develop and introduce new thematic lesson units, or elements of existing lesson units, for almost all subjects of school education, accordingly – disciplines for academic education. Furthermore, school education on the subject may be enriched by extracurricular activities.

The thematic lecture modules (or their individual units and elements) for university education have to be introduced in the bachelor, master, qualification and doctoral programmes related to sectoral aspects of greenhouse pollution and methods for its reduction. Wherever possible – this has to be done for the secondary specialized education. The more specific relevant topics are as follows:

- renewable energy sources (RES); exploration, production and energy utilization of unconventional energy resources; modern systems for management of electric power networks; energy management; energy economy; energy saving, low-carbon and innovation technologies in the field of power generation; small-scale energy production; post-low-carbon technologies, including in the sphere of conventional energy generation, nuclear energy, fuel cells and installations for capturing, utilizing, transporting and storing carbon dioxide;
- specialized assemblage of generators and heaters using biomass, photovoltaic and solar thermal systems, geothermal installations and heat pumps, etc.;
- energy saving, low-carbon and innovation technologies in the field of waste management;
- energy saving, low-carbon and innovation technologies in the field of industry – cement, chemical, metallurgical, wood processing, etc.;
- energy-efficient design, construction and spatial planning;
- low-emission transport, including electric transport vehicles;
- economy of climate change;
- low-carbon and carbon-absorption technologies in land use, agriculture and forestry;
- high-resolution meteo- and emission monitoring and databases;
- climate-effective legislation; energy / climate diplomacy; social and personality determinants of low-carbon society, etc.

The extra-auditorium activity has to be enhanced by:

- Course and diploma works in the system of university education dealing with the issue of reducing greenhouse gas emissions;
- Doctoral competitions / education on the mechanisms of anthropogenic impact on climate and the possibilities for reducing this impact;
- Holding of annual National Forum (meeting, workshop, conference) on the topic, etc.

2. Enhancing the knowledge and qualification of lecturers on climate related issues and in particular – on reducing greenhouse gas emissions

The following activities may contribute to ensuring good competence of teachers and improving their qualification:

- High competition requirements for qualification in the subject of candidates appointed to teaching positions;

- Qualification training courses on the topic for teachers in primary and secondary schools;
- Specializations and meetings for exchange of experience (including international ones) for lecturers on higher educational degrees – bachelor, master and doctoral;
- Regular attestation control on the professional training of teachers and lecturers;
- Informational support on the issues of climate change and possibilities for its mitigation;
- Feedback systems from the trained persons concerning the quality of lecturing on the treated topic.

II. Concentration of scientific-research activity on the subject of reducing greenhouse gas emissions and its sectoral aspects, and on attaining low-carbon economy

1. Practical-applied scientific research

Scientific investigations focused on the Energy sector:

- RES: resources – assessment of the potential of geothermal, bioenergy, sea wave energy resources in Bulgaria;
- RES: technologies, facilities for utilizing the above resources;
- Geological potential in Bulgaria for storage of CO2-emissions;
- Low-carbon parameters of energy production and supply.

Scientific investigations focused on the Industry sector:

• Modeling the effect of diverse anthropogenic and natural factors on greenhouse gas emissions and pollution&purification of the atmospheric basin;

• New technologies, materials, devices, approaches, raw materials: low-emission, high-energy, energy-efficient, emission-absorption&storage;

- RES in industry;
- Utilizing waste heat in industrial sector;
- Efficiency in heat economy and reducing the losses in condensation economy;
- Efficiency of electric consumption;
- Reducing compressed air losses;
- Monitoring system for energy flows in industrial systems;
- Co-generation installations with guaranteed constant thermal-energy consumption;
- Using wastes as fuel in cement industry;
- Energy efficiency of industrial activities.

• Optimal spatial solutions for production areas in accordance with the topoclimatic prerequisites for pollution / self-purification of the atmospheric basin

Scientific investigations focused on the Households and Services sector:

• Efficient transformation of primary energy carriers;

- Reducing the final energy consumption;
- National standards for energy efficiency of buildings (zero-net energy consumption);
- RES in households and services;
- Index of regional climatic safety – optimization and high-resolution territorial application;
- Software and online instruments for calculating the differential carbon footprint.

Scientific investigations focused on the Transport sector:

- Low-carbon transport / intelligent transport systems / intermodal transportation:
  - RES in transport / biofuel and other technologies;
  - Models for simulation of traffic and transport emissions;
  - Software for movement optimization (Mobility Plans). Online tools for planning and optimization of individual mobility;
- Inter- and multi-modal transport;
- Environmentally friendly construction of transport infrastructure;
- Improvement of conventional transport infrastructure.

Scientific investigations focused on the Agriculture sector:

- Reducing the soil-agricultural emissions – improved practices for: fertilization; soil cultivation; enhancing carbon-absorption properties of soil; protection of soil against erosion; management of vegetation waste and biomass; crop selection;
- Model for simulating the emission&absorption characteristics of soils;
- Water- and energy-saving irrigation technologies;
- Reducing methane emissions from biological fermentation in livestock breeding / improving the quality of nutritious mixes for animals & improving the genetic characteristics and reproductive possibilities;
- Low-carbon practices for manure processing;
- Bioenergy resources.

Scientific investigations focused on the Land Use and Forestry sector:

- Inventory of land use in Bulgaria and possibilities for new reforestation;
- Improvement of the legal framework for regulating land use changes;
- Regional planning and regional development for reducing greenhouse gas emissions;
- Forests as a RES source;
- Recovery of wetlands;
- Protection and maintenance of mature forests / preserving the carbon reserves in forests. Preserving forest genetic resources. Assessment of the CO2-absorption potential of forests in Bulgaria;
- Intensive forest cultures for biomass production.

Scientific investigations focused on the Waste sector:

- Energy potential of biogas from landfills;
- Reducing the emissions from landfills.

Scientific investigations, directed to social-economic aspects of the subject for low-carbon society:

- Climate-effective: legislation, internal policy, international law and diplomacy of the country in the international negotiation process;
- Society and reduction of greenhouse gas emissions: social determinants of low-carbon society;
- Man and reduction of greenhouse gas emissions: personal attitudes for transition to low-carbon lifestyle;
- Reduction of greenhouse gas emissions and economic innovations in the context of "green economy".

2. Fundamental scientific research related to reducing greenhouse gas emissions

The main trends of fundamental research are:

- New methods for in-depth utilization of renewable sources of raw materials;
- Modeling of nonlinear dynamic systems and micro- &meso-scale processes in the atmosphere;
- Improvement of the integrated methodology for inventory of harmful-substance emissions in the atmosphere;
- Large-scale modeling of local factors determining the climatic renewable energy sources and improvement of the methodology for their assessment at a local level; Modeling the changes of local climate in Bulgaria under different scenarios of global climate change;
- Ecosystem investigations and reducing greenhouse gas emissions;
- Global navigation systems for meteorological and climatic purposes;
- Differentiation of the contributions of natural and anthropogenic factors to climate change;
- Sectoral monitoring and statistical databases of emission&meteorological parameters.

3. Improving the knowledge and qualification of research staff on climate change problems

Some of the activities for achievement and maintenance of good research expertise are:

- High competition requirements for training the candidates on the subject to take research positions;
- Specializations and meetings for exchange of experience (including international) on the subject;
- Systems for feedback and assessment from practical viewpoint of the research quality of the treated topic;

- Access to the databases of national and local government monitoring networks for meteorological and emission parameters of atmospheric environment; establishment of a national center for information and data;
- Updating the climatic annuals and reference books;
- National coordination, harmonization and control on the activities in the field of science for reducing greenhouse gas emissions;
- Accreditation requirements for target research institutions for including the subject in their scientific programmes and their relevant certification (this refers to cases when the climate change issue corresponds adequately to the profile of the respective scientific-research unit);
- National support for specialized research centers in the system of science, treating the subject of reducing greenhouse gas emissions and achieving a low-carbon society (example – a technological park in the industrial sector).

REFERENCES

[1] Mateeva Z.S. Analysis of the measures in the field of education and science, Proceedings of analytical texts at the Third National Action Plan on Climate Change, Bulgaria (in press) (in Bulgarian).

[2] First National Action Plan on Climate Change, Bulgaria, 2000 (in Bulgarian).

[3] Second National Action Plan on Climate Change, Bulgaria, 2005 (in Bulgarian).

[4] Programme for Development of Education, Science and Youth Policies in Bulgaria (2009 – 2013), Bulgaria, 2009 (in Bulgarian).

[5] National Strategy of Scientific Research until 2020, Bulgaria, 2011 (in Bulgarian).

OPERATIVE PROGRAMMES REGARDING REGIONAL DEVELOPMENT AND HUMAN RESOURCES

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ABSTRACT

This study analyzes the operative programmes regarding development of labor market and human resources, it also shows the evolution of relations between the people and regional development.

This paper focuses on some programmes, like the Operational Programme Human Resources Development 2007 – 2013, or the National Program of Rural Development. These programmes are going to show what the father of economic science said: "Work was the first price or the first coin to be bought things. Not the gold and silver, but the work was first acquired wealth of the world, its value for those who possess and wish to exchange for other new products is exactly equal to the amount of work available or that it is able to buy other products."

Also, market and market processes will end at the end of the world, that's why I think it is important to know how to grow this economy and relations between human resources.

Keywords: *human resources, regional development, programmes, labor market*

In order to improve workforce employment, there have been developed a series of operative programmes for regional occupation and for improving interhuman relationships.

Therefore, in 2000 it was developed the first National Action Plan for Workforce Employment by the Ministry of Labor and Social Solidarity[1]. Then it followed the National Plan for Romania's Development between 2000 and 2006. Moreover, there had been developed special programmes destined to economical stimulation in underdeveloped regions, such as:

- Special Programmes destined for stimulating the economy in under-privileged areas (programmes sustained from the state budget's funds). Among these, we could mention:
  - -The "Business Development" Special Programme
  - -The "Investments Encouragement" Special Programme

[1] Daniela Luminita Constantin, Cornelia Parlog, "*Human Resources in Romania. Territorial Mobility*", the Academy of Economic Studies Publishing House, 2002, p. 134

-The “Rural Activities Encouragement” Special Programme

➢ The programme regarding the encouragement of the Small and Medium Enterprises sector and their impact on the local development. Among these, we could mention:

-The programme referring to economic-financial facilities provided to Small and Medium Enterprises;

- The programme entitled “The Fund for Local Economic Development Initiatives”;
- The programme for small and medium loans, developed by the Romanian-American Investment Fund and the Romanian Bank;
- The programme for micro-loans, the Romanian American Investment Fund;
- The programme for Small and Medium Enterprises encouragement in the marketing and export promoting domains;
- The Industrial Reconfiguration and Professional Reconversion Programme

-The programme for microloans for rural investors;

- The Rural Development Programme

➢ The PHARE Programme;

➢ The SAPARD Programme;

➢ The ISPA Programme.

The PHARE Programme was conceived in 2000 and it had been used in different states during the pre-adhesion to the EU preparations. Also, the PHARE Programme refers to the “Economical and Social Cohesion” component.

The SAPARD Programme wants to improve the market access and the competitiveness of agricultural products and fishing stock; it also desires the development of rural economy, that of human resources and, moreover, the improvement of agricultural infrastructure.

The ISPA Programme aims at aligning the infrastructure standards of the states that want to adhere to the European Union to those that are already members of the EU. In order to fulfill this aim, it offers a substantial financial contribution in order to improve the environmental and transportation structures. The projects financed through the ISPA programme have the following objectives:

- Wastewater treatment and purification;
- Urban waste management;
- European transport networks integration;
- Infrastructure rehabilitation, modernization and development;

- Harmonization of national legislation to the communitarian regulations[2].

The most recent and up-to-date programme developed for such kinds of situations is the Sectoral Operational Programme Human Resources Development (SOP HRD) which I am going to detail thenceforth. This is an important tool in supporting the economic development and the structural changes. SOP HRD establishes the primary axes and the major domains of intervention in the case of Romania in the field of human resources in order to implement the European Union's financial assistance through the European Social Fund inside the Convergence Objective.

The Sectoral Operational Programme Human Resources Development has been developed under the coordination of the Ministry of Labor, Family and Equal Chances. During the consultations, there had been involved various institutions, such as: The Ministry of Economy and Finance, The National Agency for Workforce Employment, The Ministry of Education, Research, Youth and Sports, The Ministry of Interior and Administrative Reform, The Ministry of Agriculture and Rural Development, The National Institute of Statistics, The National Research Institute for Labor and Social Protection, as well as other agencies and ministries. Moreover, there had been many consultations with social partners, organizations of the civil society, public administration and other relevant actors.

The main objective of the Sectoral Operational Programme Human Resources Development is the development of the human capital and that of competitiveness, by means of correlating domains such as education, lifelong learning and workforce market in order to provide high opportunities of participating to a modern, flexible and inclusive workforce market for over 1.650.000 persons.

The Sectoral Operational Programme Human Resources Development also has a series of specific objectives, such as:

- Promoting the quality of the educational system and that of the initial and continuous professional development, including the domains of higher education and research
- Promoting the entrepreneurial culture and improving work's quality and productivity
- Facilitating the insertion of the youth and the unemployed in the labor market
- Developing a modern, flexible and inclusive labor market
- Promoting the (re)insertion in the labor market of the inactive population, even in rural regions[3]
- Improving the public services for employment

[2] Daniela Luminita Constantin, Cornelia Parlog, "*Human Resources in Romania. Territorial Mobility*", the Academy of Economic Studies Publishing House, 2002, p. 143

[3] The rural area is formed by rural regions defined according to 350/2001 Law regarding territorial and urbanism development and 351/2001 Law regarding the approval of the National Territory Development Plan – Section IV

- Facilitating the access of vulnerable groups to education and labor market.

The content of the 1-6 main axes approaches individual and systemic problems, at a national or regional level.

These main axes are:

- **Priority Axis 1**: Education and professional development in order to sustain economic growth and to develop a society which is based on knowledge
- **Priority Axis 2**: Correlating lifelong learning and workforce market
- **Priority Axis 3**: Increasing the adaptability of workers and enterprises
- **Priority Axis 4**: Modernizing the Public Employment Service
- **Priority Axis 5**: Promoting active employment measures
- **Priority Axis 6**: Promoting social inclusion
- **Priority Axis 7**: Technical Assistance

Priority Axis 1 takes into account the need of education and professional development according to the current needs of the workforce market. This axis would observe the increase of coherency between educational systems, initial and continuous professional development and various learning contexts.

Priority Axis 2 wants to assure, at a state level, the equality of all persons regarding the access to the learning process and it also wants to form those skills and abilities which are necessary for a durable integration to the workforce market. Because the unemployment rate is growing and because education is not perceived as a continuous process, the result is the exclusion from the workforce market.

Also, Priority Axis 4 states for a national approach, trying to diversify the services offered by the Public Employment Service, in order to improve them from a qualitative point of view and to make them more visible and accessible by bringing them closer to the beneficiary. The Public Employment Service's informing activities would be able to prove the ability of this Service to provide workforce market analysis, data interpretation, being able to anticipate the trends and to see in advance the new evolutions of the workforce and the companies' dynamics.

Priority Axes 3, 5 and 6 refer to individuals and regards to the increase of the employment degree and the adaptability capacity; they promote the entrepreneurial spirit, that of social inclusion and they also stand for equal chances in the case of human resources. These priority axes promote a regional approach, taking into account the existence of some disparities between regions in what regards the employment rate, the unemployment rate and various peculiarities (such as long term unemployment, structural unemployment, even in rural areas), the participation to continuous professional development, entrepreneurial culture and poverty rate.

Priority Axis 7 supports the implementation of the general management and the assessment of The Sectoral Operational Programme Human Resources Development. It also supports the promotion and communication in what regards the same operational programme.

In accordance to the strategy highlighted by the National Strategic Reference Framework, the increase of the economic competitiveness requests a more efficient use of human resources. As a response to the structural problems of workforce market regarding the low rate of employment and the lack of qualified workforce in some regions and specific activity sectors, it is required a high attention towards promoting and developing human resources related to the workforce market, in general. In this direction, in conformity to the European Employment Strategy and the conclusions written in the Common Document of Employment Evaluation, the priority would be given to providing active employment policies addressing to the unemployed youth, the long term unemployed population, old workers, low qualified personnel, vulnerable groups and inactive population.

Therefore, the development of human resources would be based on growing the investments in education and professional development, on inserting and keeping as much persons as possible in the workforce market, on growing the work offer, improving the adaptability of workers and enterprises, promoting social inclusion and vulnerable groups.

Specific actions would be promoted in order to develop new professions and professional standards in education. They would also promote entrepreneurial culture, consolidate partnerships with local partners; moreover, these actions would highlight the importance of lifelong learning and the active employment measures, in order to fight hidden unemployment and modernize the Public Employment Service and social inclusion in education and workforce market.

It is obvious that an increased attention would be provided in the case of rural areas because a large number of the population resides in these regions. The hidden unemployment phenomenon and underemployment are a major concern and they require specific measures in order to identify and maximize all the opportunities for the integration of the long term unemployed in the labor market. Consequently, there would appear new employment niches in non-agricultural domains in rural regions which would be available to large categories of the inactive population.

The human resources development strategy is in conformity to the European community strategic orientation regarding the 2007-2013 Cohesion and it represents an essential component in reaching the Community's main objective regarding economic growth and better workplaces.

The financial plan of the Sectoral Operational Programme Human Resources Development has been developed in conformity to the financial plan of the National Strategic Reference Framework of Romania 2007-2013. As we know, the Sectoral Operational Programme Human Resources Development is financed by the European Social Fund. The allocation of the European Social Fund for the Sectoral Operational Programme Human Resources Development consists of 3.476 million Euros, representing 85% of the programme's total value. The national contribution has been evaluated to approximately 613 million Euros. The priority axes established for human resources development in Romania are supported by the proposed financial allocations, which proves the importance of each of the three major intervention domains belonging to the European Social Fund in Romania by means of the Sectoral Operational Programme Human Resources Development:

1. Promoting lifelong learning and the adaptability of workforce and enterprises, with an average of 38.37% of the financial allocation.
2. Promoting active employment measures for the inactive population, especially for those who survive thanks to subsistence agriculture, the unemployed youth and the long term unemployed, as well as integrating them in the labor market. It is also taken into account the social inclusion of vulnerable groups, with an average of 34.21% of the financial allocation.
3. Education and professional development in order to support the economical and social development, based on knowledge, having as primary objective the modernization of the educational system and the initial and continuous professional development, including higher education and research, with an average of 23.55% of the financial allocation.

   According to the General Regulations[4] - Art. 59(1), in order to implement the Sectoral

Operational Programme Human Resources Development, the following authorities had been designated as being responsible:

- The Management Authority for the Sectoral Operational Programme Human Resources Development – the Ministry of Labor, Family and Equal Chances
- Intermediary organisms for the Sectoral Operational Programme Human Resources Development: The National Agency for Workforce Employment, The Ministry of Education, Research, Youth and Sports, the National Center for Professional Education, two intermediary organisms that would be designated by means of public auction, according to national legislation and communitarian regulations.

The responsibilities and functions of the Management Authority had been established according to the Structural Funds Regulations, especially the EC Council Regulation no. 1083/2006 and Commission Regulation (EC) no. 1828/2006.

Therefore, according to article 67 of the Council Regulation (EC) no. 1083/2006, the Management Authority for the Sectoral Operational Programme Human Resources Development must provide the European Commission an Annual Implementation Report, from 2008 until the 30th of June, at an annual rate. Before passing it to the Commission, the report would be examined and approved by the Monitoring Committee of the Sectoral Operational Programme Human Resources Development.

The monitoring process is a continuous one, as it must show the progress in what regards the efficiency and correctitude of the financed operations; it also compares the progress to the previously established goals. At the same time, the system would facilitate data and information collecting in order to analyze the progress of operations and the necessity of corrective measures.

The evaluation of Operational Programmes cannot be separated from the general organization of management and that of Operational Programmes' implementation

[4] Council Regulations (EC) no. 1083/2006 regarding general assignments for the European Regional Development Fund, the European Social Fund and the Cohesion Fund which abrogates the EC Regulations no. 1260/1999

system, being perceived as a tool use in order to establish the relevance, efficiency and efficacy of the provided financial assistance and the results' impact and sustainability.

The obligation of developing systematic evaluation activities of the Operational Programme and the general rules for these activities are provided by the Council Regulation (EC) no. 1083/2006 from July 11th 2006 regarding the general regulations of the European Regional Development Fund, the European Social Fund and the Cohesion Fund (Art. 37, 47-49).

Another operational programme is the Progress Programme and it belongs to the European Union. It regards the workforce employment and social solidarity. It has been created in order to financially support the application of the EU's objectives regarding workforce employment, social businesses and equal chances, according to the regulations provided by the Social Agenda. Moreover, this programme contributes to fulfilling the Lisbon strategy regarding economic growth and workforce employment.

The Progress Programme started in 2007 and it would continue until 2013, functioning together with the European Social Fund. This programme replaces four previous programmes, which ended in 2006 (they have been mentioned above) and were focused on actions against discrimination, promoting equal chances and fighting against social exclusion. The European Union chose to create a single programme in order to provide an efficient use of European funds and to maximize the impact of the actions.

The Progress Programme tries to guarantee the fact that the European Union's social policy can face the major political changes and focuses on actions which need a high effort at the level of the EU. It can also offer support to member states in order to create workplaces, to guarantee equal chances and to evenly apply the EU's legislation.

The Progress Programme possesses a total budget of 743.25 million Euros, for this seven years period (2007-2013). The European Union would use this budget in order to act as a catalyst for change and modernization in five domains:

- Workforce employment
- Social protection and inclusion
- Labor conditions
- Non-discrimination
- Equal chances for men and women

The Progress Programme is accessible to 27 member states, to candidate states and AELS/SEE member states.

In conclusion, the future evolution of human resources in Romania and the European Union, as well that of their mobility will always represent a part of the development of such programmes, because the evolution of workforce is influenced by numerous social, economical, educational or demographical factors.

REFERENCES

[1] Daniela Luminita Constantin, Cornelia Parlog, "*Human Resources in Romania. Territorial Mobility*", the Academy of Economic Studies Publishing House, 2002

[2] Gina Cristina Dimian, "*Regional Competitiveness from the Perspective of Human Resources*", the Academy of Economic Studies Publishing House, Bucharest, 2008

[3] 350/2001 Law regarding territorial and urbanism development

[4] 351/2001 Law regarding the approval of the National Territory Development Plan – Section IV

[5] The Sectoral Operational Programme Human Resources Development – 2007-2013

[6] www.mmuncii.ro

[7] Council Regulations (EC) no. 1083/2006 regarding general assignments for the European Regional Development Fund, the European Social Fund and the Cohesion Fund which abrogates the EC Regulations no. 1260/1999

POLICIES AND STRATEGIES TO IMPROVE THE ENVIRONMENTAL PERFORMANCE OF RESIDENTIAL BUILDINGS MADE OF PREFABRICATED PANELS IN ROMANIA

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ABSTRACT

The support programs for retrofitting residential buildings made of prefabricated panels have a short history in Romania. The present research paper outlines the past and present challenges, opportunities and strategies of policy instruments for retrofitting buildings to reduce primary energy use and GHG emissions in the country in relation with the European legislation. The research outlines the types of policy instruments used to improve the environmental performance of the buildings stock and the current potential in Romania, based on the specificity of the local context. A comparative analysis of a bottom-up versus top-down approaches was performed based on data from Timisoara, an interesting case of parallel development of the government programs and private initiatives of the tenant association. The main objectives of the research were to identify the main barriers for development of these practices in Romania and to find the existing alternative solutions in order to propose the most appropriate policies and strategies adapted to the local context.

Keywords: policies, sustainable development, residential buildings, environmental performance

INTRODUCTION

Retrofitting older buildings is one of the most important issues for the European commitment towards the targets of CO2 and GHG emissions reduction and energy efficiency. As long as the residential buildings represent 75% of the building stock in Europe, the policies addressed to the retrofitting of this part of the stock are crucial. In the present context, 25 to 45 percent of the Romanian population lives in collective residential buildings made of prefabricated panels, built between 1953 and 1989 – a higher degree of urbanization leads to an increasing percentage, so for the big cities the retrofitting of this stock represents a major challenge.

Today only few European countries are managing successfully different types of political instruments in relationship with all the aspects of sustainable retrofitting of residential buildings: ecological, economic, social and technical. In this context is important to identify and define the proper policy instruments adapted to the local context in order to assure the most effective medium and long-term strategies that address the issue.

The first part of the research is focused on the various types of policy instruments for retrofitting and the ones that are currently used in Romania and also the barriers in implementing efficient measures for energy efficiency. The second part presents the specificities of the Romanian residential built stock among other European countries in order to understand the local conditions. The third part presents some interesting cases of private market initiatives in Timisoara, compares the outcomes of these initiatives with the ones produced by the government programs and analyses the results in the perspective of different scenarios of renovation [1]. The final part contains the conclusions about the efficiency of different types of political instruments and measures that can be taken in order to assure the commitment for the 20-20-20 EU policy (the reduction of greenhouse gas level and energy consumption with 20% and the increase of renewable energy mix with 20% by 2020) and to find alternative and innovative solutions for the cost-optimal energy performance of buildings adapted to the local market in order to reach the declared long-term target of reducing greenhouse gas emissions level by 80-95% by 2050.

TYPES OF POLICY INSTRUMENTS TO IMPROVE THE ENVIRONMENTAL PERFORMANCE OF THE BULLDING STOCK AND THEIR PRESENT USE IN ROMANIA

There are five main types of policy instruments for a sustainable built environment and improving energy-efficiency [2] and principles for a successful residential retrofit [3].

The first type of instruments - regulatory instruments are: the performance-based standards and the technology-based standards, both mandatory. In Europe, these are CEN/TC 350 series of standards related to sustainable buildings - a work in progress, and in particular ISO and CEN/TC standards related to energy-efficiency. The instrument with most important potential impact on energy efficiency in existing residential buildings both in the short and medium term is the Energy Performance of Buildings Directive – EPBD and the standards related to it [4]. From this perspective, Romania's national policy and the calculation methodology of the energy performance of the buildings are well adapted to the EU legislation.

The second type of policy instruments is represented by the economic instruments: those mainly based on the polluter-pays principle (emissions and products charges and taxes, tradable permits, deposit-refund systems, non-compliance fees, performance bonds, liability payments) and environmental subsidies that are usually in contradiction with the polluter-pays principle. There are some good innovative examples among the European countries regarding the support programs for retrofitting, especially the various loans programmes offered by the German KfW bank and the Green Investment Scheme in Czech Republic (based on trading the emission credits under the Kyoto Protocol). Romania has one of weakest financial support scheme among European countries; the past and present national programs will be presented in a later chapter.

The third type of instruments - the information tools are: public information campaigns that aim to raise public awareness, technological information diffusion programs that aim to change the behaviour of the firms and environmental labelling schemes. This is crucial in order to develop voluntary programmes, but is one the weakest points in Romania and in many European countries. As long as these tools do not work properly, an increase in the voluntary programmes cannot be expected. In the present situation the market function only as a response on the pressure of the increasing energy price and consequently interventions are minimal and often made without adequate technical knowledge.

The fourth type - the voluntary policy tools are: unilateral commitments or declarations, negotiated agreements between a public organization and a business group, selective regulations or public voluntary programs (programs in which the government provide the framework for the policy, but leave participation up to the market). Using these types of political instruments is a normal practice in a state with a stable legislation and a long-term commitment from the state in this direction. This leads to innovative public-private partnerships. This is not a current practice in Romania, because the government has a project-based oriented approach, with no clear long-term commitment from the state that could send appropriate signals to the market. In all the existing national programmes is a lack of predictability, as they are terminated or changed in a short period.

The fifth type of policy instruments are the research and development tools. Only in the recent years some international partnerships have been established, involving especially the higher education institutions and the Regional Development Agency. Again, the support for the research and development in the private sector or establishment of partnerships in this area is at a low level.

SPECIFICITIES OF THE BUILT STOCK IN ROMANIA AMONG OTHER EUROPEAN COUNTRIES – UNDERSTANDING THE LOCAL MARKET CONDITIONS AND BARRIERS

The study carried out in 2011 by the Building Performance Institute Europe – Europe's buildings under the microscope reveals some specificities of the Romania's building stock comparing with the other European countries [1]. There are some other sociological studies [5] and also the results of population census [6], which complete this information with accurate data or information about the perception of population regarding their dwellings.

Comparing Romania with other European countries, it can be said that our country provides some of the poorest living conditions for its citizens. The homes are small and, in many cases, over-crowded. Despite this fact, the satisfaction with the personal dwellings is quite high.

It is obvious that residential floor standards vary a lot, Eastern European countries having a standard much lower in term of floor space per capita then the other countries: the single family house has only 26 m^2/capita (while the Northern and Western countries have 41 and in the Southern regions the standard is 50) and the apartment floor space has 20 m^2/capita (comparing to 36, respectively 31) – this means around 60%. The sociological studies performed in our country reveal that dwelling satisfaction increases steadily with each additional square meter, up to a point. A logical conclusion is that inhabitants will desire more space in the future, a trend that is already visible looking at residential constructions in Romania after 1990.

Another important point is that Romania has 95% owner-occupied residential buildings, by far the highest percentage among all the European countries (it is followed by Spain and Hungary with more than 80%, the rest of the states having less that 80%). It is important also that Romania is in the third place in Europe with dwellings in property by private owners. This is a sign of a well-developed sense of ownership and a fact that housing is perceived as a good long-term investment.

According to Eurostat statistics, in 2009 European households were responsible for around 70% of the total final energy use in buildings and the space heating is the most energy intense end-use in EU houses and accounts for around 70% of the final energy use. The heating energy consumption in the buildings made of prefabricated panels is estimated between 180 and 240 kWh/m^2. As the energy price is constantly increasing and the population income is decreasing, many households will be in fuel poverty (according to UK funding schemes this happens when it has to spend more than 10% of its income on household fuel use).

As a conclusion of this big picture that can help to establish innovative market schemes, one can say that private property is regarded as an important issue and, as it will be presented later, the owners are willing to pay for improving the living conditions.

The main barriers are first of all the financial one, as the medium income is low. This corresponds to the main perceived barrier in all European countries. The second main barrier regards the institutions and administration: the lack of financing grants, the misalignment between national programme design and market needs (the five year reimbursement period is unrealistic, as long as states with higher income per capita have a 15 years loan period), the lack of long-term commitment from governments. The third main barrier is informational and it refers not only to the lack of data about the building stock, but also to the lack of public information about technical details, so when it is performed voluntarily, the thermal rehabilitation barely reaches the minimum actual standards.

SUPPORT PROGRAMS FOR RETROFITTING RESIDENTIAL BUILDINGS IN ROMANIA

In Romania, a thermal rehabilitation programme for multi-level residential buildings has been launched in 2002, but it really started to work in 2007, as a part of the first National Energy Efficiency Action Plan [7]. The aim was to decrease heating energy consumption in renovated buildings from 180-240 kWh/m^2 to below 100 kWh/m^2. The financing was divided between the national budget, the local budget and the owner, one third each. In 2008, 89 blocks of flats were rehabilitated and in 2009 ten times more (with Government Ordinance OUG 18/2009), with a different percentage: 50% state budget, 30% local budget and 20% owner association. In 2010 the program continued, but in a deep period of crisis the state changed the financial conditions (Government Ordinance OUG 69/2010), by eliminating the State grant and introducing the 100% State guarantee for dedicated loans up to 5 years. As expected, due to the short period of pay-back, the program almost stopped.

From 333 financial schemes that have been screened under the BPIE survey in Europe only 2 of them were used in Romania [1] and belong to the same programme that changed from financial grants to loans subsidies.

CASE STUDY - RETROFITTING RESIDENTIAL BUILDINGS MADE OF PREFABRICATED PANELS IN TIMISOARA – BOTTOM-UP VERSUS TOP-DOWN APPROACHES

Timisoara, one of the biggest cities in the western part of Romania is an interesting case-study of an innovative bottom-up approach of various stakeholders, either the tenants association or small and medium construction enterprises. Residential buildings made of prefabricated panels represent about 40% of all housing units, and they are mostly ground floor and four storeys (figure 1).

This case-study is a proof that market dynamics do not follow straight paths and there are a multitude of reasons why consumers make specific decisions.

The most important reasons that retrofitting residential buildings made of prefabricated panels is an appealing alternative in case of Timisoara are various. Some of the most important are the thermal discomfort (due to the low thermal quality of the materials and the bad joints between the panels) and also the poor quality of indoor space. There are also strong social and cultural motivations: after the communist period people wanted to change the appearance of gray residential neighbourhoods in order to feel at home in their own houses, to have an identity that defines their place. And last, but not least, was the economic motivation: as the energy price was in continuous growth and the annual costs for space heating exceeded in many cases 5%, even 10% of household income, so it became a major concern (opposed to many European countries where the energy bills do not exceed 3-4% of the income).

Figure 1. Typical neighbourhood in Timisoara with the type 1340 project

Interesting to note is that all sustainability pillars are present here: the ecological one, the economic and the socio-cultural pillar. Hence, the strategies and political measures should address all these pillars in order to be effective, as long as energy efficiency programmes are only one step towards a sustainable development of the built environment. In this case, as the official programme stopped and there were many tenants association that wanted to go further, two different approaches have been found.

One was the resident's initiative: façade retrofitting (walls and windows) on their own expense, sometimes taking a regular credit. This was possible due to the fact that Timisoara has a higher income per capita than the average population and this type of renovation is not expensive in the Eastern European countries. Also the previous examples of refurbishment have shown a significant cost reduction for space heating. The major strength of these renovations is that they proved that such initiatives are possible, even if such an apartment building have 20 different owners. The major weakness is that the lack of proper knowledge and poor financing made possible only a shallow renovation, or in some cases what we may call a maintenance work, absolutely necessary at the moment.

The second initiative is an example of market innovation in time of financial crisis. As Timisoara is a vivid university town, there are still many students and young people searching for small apartments, to buy or to rent. Another reason is that for the Romanians is important to own a home and in this period the loans provided by banks are more restrictive, so the attention focuses in this particular case on small apartments, with one or two rooms. The market demand exceeds the existing stock. Some small and medium construction companies convinced the residents to make an exchange: to give the common parts of the terraces of the blocks in exchange of façade renovation (including doors and windows), the repair and/or replacement of the degraded common parts of water, sewer and gas facilities. As the majority of the owners do not have enough money (as in the case of the first initiative), it was considered the best solution, as long as the companies built an attic with apartments for sale, making a good profit. Another plus in this trade was in fact the attic itself because one of the most degraded parts of these buildings is the terraced roof.

The second initiative is the best so-called "win – win" example on short and medium term, but it is a "win – lose" situation on a long run, because it closed many of the future possibilities. The best solution in this early period for policies related to energy efficiency, as shown below, is a cost-optimal refurbishment that allows the possibility of a second extensive renovation, maybe with the possibility of extension, both vertically and horizontally (as mentioned above, after a period of financial crisis will increase the need for bigger apartments, due to the poor indoor space conditions of these prefabricated panel buildings). The first solution is the most cost-effective for this period and local conditions and it is flexible, so it is the winner on a long run. Furthermore, the experience proves that these types of tenants association took a proactive attitude towards the public space.

In both cases, from the technical point of view, the lack of knowledge and dissemination of good practices led to unsatisfactory retrofit. That is why the barriers related to awareness, advice and technical expertise are perhaps most important on the long run than those related to finance.

THE TWO-PHASE REFURBISHMENT SCENARIO – BEST CHOICE FOR RESIDENTIAL BUILDINGS IN ROMANIA

The BPIE study [1] analyses six different scenarios under which the renovation of the European building stock, derived from combinations of the renovation rate and renovation depth. Scenario 0 is the baseline, business as usual shows that at the prevailing renovation rate of just 1% per year (as it is now), only 40% of the stock is renovated by 2050. As expected, the results in saved energy are minor compared to today (only about 30% savings), which highlights the need to implement medium and long term strategies that are not affected by the government changes. Scenarios 1a (slow and shallow) and 1b (fast and shallow) are an illustration of the consequences of focusing mainly on shallow renovation measures which may be perceived as the cheaper and more pragmatic solution. Scenario 2 (medium) combines the intermediate renovation path with the medium rate of growth. By 2050, the impact will be higher, with energy savings of approximately 50%. Scenario 3 (deep) combines the deep renovation path with the medium rate of growth. The weak point of this scenario is the relatively high initial cost (compared to all scenarios represents a doubling of the investment costs in the first period and prevents the learning effect). Scenario 4 (two-stage renovation) starts from the assumption that buildings will be renovated twice between 2010 and 2050. As a result of the learning curve, cost reductions will be massive in the second stage, the overall investment is much lower than in the deep scenario and finally the energy savings are the highest from all scenarios – 71% and the CO2 emissions will decrease by 73% to 91%.ng

Analysing the trends of the top-down and the bottom-up approaches in Romania, it becomes clear that the present situation leads naturally to scenario 4 (two-stage renovation) due to the fact that the present examples of retrofitting (from both trends) suffer from a lack of technical knowledge and lack of proper financing. This can be called "the optimistic scenario", the other one being scenario 1 – business as usual. But the fact that the stakeholders found innovative solutions in a period of financial crisis proves that the construction market moves towards energy efficiency.

The fact that the present situation leads to this result is very beneficial in a long run, but there are two main ideas in order to implement this change: it needs a long-term commitment from the state and the governments (even with less expensive financial programmes) and proper information and transfer of best practices and innovation.

BOTTOM-UP VERSUS TOP-DOWN APPROACHES IN ORDER TO FIND ALTERNATIVE SOLUTIONS AND POLICY INSTRUMENTS

In Timisoara, these cases of bottom-up approaches are increasing in number, which proves the reproduction potential of these ideas. There are many neighbourhoods where almost 30-40% of the buildings are already refurbished with private initiatives and in the past three years only in the western part of the country these examples exceed by far the number of those who have benefited from government grants.

One of the most important strengths of the bottom-up approach is the pro-active attitude of the community members and the potential strengthening of the private initiatives, so the main gain refers to the social pillar of sustainable development. One of the most important weaknesses refers to the lack of technological information and transfer of the best practices, so it addresses the cultural pillar.

Regarding the top-down approach, two of the most important strength are the possibility of control, monitoring and implementation of the best knowledge in order to improve the environmental performance and the possibility for Romania to trade the emissions credit and invest the money in this direction, so the pillar taken into account is the ecological one. The main weakness address both the economic and the ecological pillar, as long as the major concern in all European countries, not only in Romania, is that the use of financial instruments today is only achieving the business-as-usual case, with very few financial instruments providing enough funds for deep renovations.

CONCLUSIONS

The priorities at national levels in order to achieve the long-term target assumed by all European countries, including Romania have to address the major barriers and untapped opportunities. Some of the most important are related to predictability of government programmes, meaning a long-term commitment of the state for energy efficiency, not a project based approach. Another important issue is related to a holistic view of building renovation and designing long-term programmes based on market understanding and examples of best practice from other countries. And finally, the crucial issue is related to the pro-active involvement of the private sector and other relevant stakeholders, develop an efficient system of knowledge transfer and raise consumer's awareness about the need to invest in energy efficiency.

REFERENCES

[1] Economidou M. & all. Europe's buildings under the microscope – A country-by-country review of the energy performance of buildings, EU, pp 26-53 and 98-122, 2011

[2] Kibert C.J. Policy instruments for sustainable built environment, Journal of Land Use and Environmental Law, USA, vol. 17/issue 2, pp 379-394, 2002

[3] Neme C., Gottstein M. & Hamilton B. Residential efficiency retrofits: a roadmap for the future, EU, 2011

[4] The European Parliament and the Council of the European Union. Directive 2010/31/EU of the European Parliament and the Council on the energy performance of the buildings (recast), Official Journal of the European Union, 2010

[5] Sandu D., Comsa M., Rughinis C., Toth A., Voicu M. & Voicu B. Viata sociala in Romania urbana, Romania, pp.55-76, 2006

[6] INSEE – Institutul National de Statistica. Recensamantul populatiei si al locuintelor – 18 martie 2002, vol.3, table 6, Romania, 2003

[7] ARCE. The First National Action Plan in the field of Energy Efficiency (NAPEE) 2007-2010, Romania, 2007

THE LEGISLATIVE FRAMEWORK FOR CONSTRUCTION WASTE MANAGEMENT IN SLOVAKIA

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ABSTRACT

An integral part of any construction activity is the production of the construction waste. It is necessary to deal with the construction waste already in the project preparation phase, which ultimately brings not only financial savings but also time saving. Slovakia, as a member of the European Union is trying to reduce the percentage of construction waste and thus contribute to protecting the environment and the ecosystem. The adoption of the "Law no.223/2001 – Law on Waste",which set out requirements for all producers of waste, including waste classification (also in the building industry). In addition to this Act, they are adopted and constantly are adopting regulations taking into account the actual needs for environmental protection. This contribution gives an overview of current legislation in Slovakia, his specifications, following the European Union legislation and examples of waste management on building site.

Keywords: construction waste, legislative framework, planning phase, phase of construction, management

INTRODUCTION

Construction waste is an integral part of every construction. Due to growing pressure for environmental protection in all spheres of industry, construction included, it is necessary to accept and adopt measures for the environment protection and ensure environmental quality for future generations. The Slovak Republic has also prepared Waste Management Programme, which covers the management of all wastes in accordance with the definition of waste.

Under the term construction waste, in terms of the Law no.223/2001 – Law on Waste, section 40c§1: *"Construction and demolition wastes are wastes that are coming from construction work, security work, maintenance work, adjustment (reconstruction) or from removal of structures (demolition) building."*

The production of construction waste and demolition waste is markedly changed in the present. The looking at a construction waste, disposal and ways of its treatment is changed, after the acceptance of new legislative of European Union (EU). The construction waste begins a source of renewable materials. We can consider a recycling of construction waste as a new industrial branch. The recycling considers a waste as a source, which creates a new value. The final output of recycling process is a product - recycled material, which consequently used in civil engineering field [1].

OVERVIEW OF CURRENT LEGISLATION FOR THE ENVIRONMENT AND CONSTRUCTION WASTE IN SLOVAKIA

In terms of waste generated on building site and by the construction processes, the most important laws regarding waste management are [2]:

- Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment
- Council Directive 97/11/EC amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment
- Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment
- Law no. 17/1992 on Environment
- Law no. 587/2004 on the Environmental Fund
- Law no. 24/2006 on the Assessment of environmental impact
- Law no. 469/2002 on environmental labeling of products
- Law no. 245/2003 on the Integrated Pollution Prevention and Control of Environmental Pollution
- Law no. 223/2001 Law on Waste
- Law no. 17/2004 on Fees for Waste Disposal
- Law no. 359/2007 on the prevention and remedying of environmental damage
- Notice of the Ministry of Environment no.283/2001 for implementing certain provisions of the Waste
- Notice of the Ministry of Environment no.284/2001 of establishing Waste Catalogue

CATEGORIZATION OF THE CONSTRUCTION WASTE

In terms of waste management, major importance is the categorization of waste in construction. The construction activities can distinguish four major groups of construction waste:

- waste arising from the construction activity,
- waste arising from the preparatory and auxiliary transport activities,
- waste arising from the operation of construction equipment,
- waste arising from the demolition of buildings or from their parts.

With the adoption of a announcement no.284/2001, the Waste Catalogue became identical with the List of Waste established by EU legislation. Since year 2003 we divide waste primarily to two large groups:

- Hazardous waste (H) and
- Other wastes (O)

Construction wastes are included in the 17th waste group. The Table 1 provides an overview of the categories of construction waste. From the 38 subgroups of construction and demolition waste (including excavated soil and contaminated sites), are 21 subgroups defined as other waste (O) and 17 subgroups such as hazardous waste (H). The ratio of waste types shows, that the issue of waste management is an important part of environmental protection and sustainable building. Figure 1 describes the quantity of construction and demolition waste in Slovakia for year 2005 in thousands of tones.

Table 1: Categories of construction and demolition waste per Waste catalogue [3]

Code	Name
17	**CONSTRUCTION AND DEMOLITON WASTE (including excavated soil from contaminated sites)**
17 01	Concrete, bricks, tiles and ceramics
17 02	Wood, glass and plastic
17 03	Bituminous mixtures, coal tar and tarred products
17 04	Metals (including their alloys)
17 05	Soil (including excavated soil from contaminated sites), stones and dredging spoil
17 06	Insulating materials and construction materials containing asbestos
17 08	Construction material based on plaster
17 09	Other wastes from construction and demolition

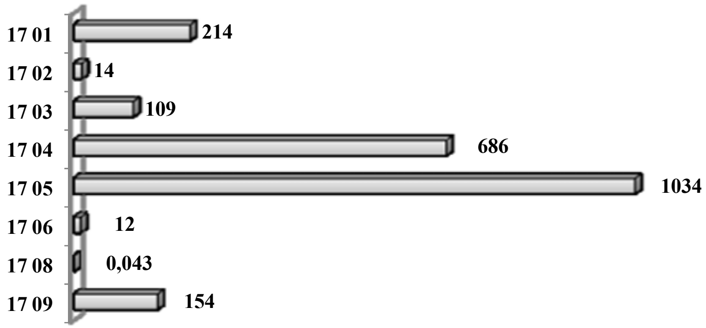

Figure 1: Quantity of construction and demolition waste in Slovakia for year 2005 in thousands of tones in each waste category [4]

The central state administration authority in waste management is the Ministry of Environment. Other state administration bodies in waste management in Slovakia are:

- Slovak Environmental Inspectorate
- Regional offices of the environment
- District Offices of the environment

From the year 2004 until the economic crisis in year 2009 Slovak construction industry has shown an increase of building production (Figure 2). That also means an increase of construction and demolition waste. In year 2008 the European Parliament adopted the Directive of EP and Council Directive 2008/98/EC of waste. Subsequently was defined the five-stage waste hierarchy [5]:

1. Waste prevention
2. Treatment of wastes for reuse
3. Recycling waste
4. Other uses of waste
5. Removal of waste.

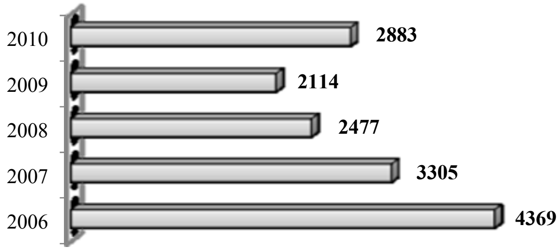

Figure 2: Creation of construction waste and demolition waste in Slovakia in thousands of tones [6]

CONSTRUCTION WASTE MANAGEMENT

It is necessary to deal with the construction waste at the planning stage and also in the stage of project preparation. This will ensure that the contractor will know what types of waste in construction will occur and thus enable him to plan:

- **WHERE** will the waste be stored,
- **HOW** it will be dispose,
- **WHO** will ensure the collection, respectively recycling (collecting courts, specialized companies for disposal of construction waste) and
- **HOW MUTCH** it will cost.

For those planning is often neglected, respectively it does not attach high importance. But this is wrong, because ultimately it brings not only time and finances savings, but also contribute to the environment. Following illustration (Figure 3) shows the options for disposal of construction waste on site, either directly (in situ) or off-site in specialized facilities and landfill (off situ).

Figure 3: Waste management

In the adopted Waste Management Program for the years 2011-2015, there are clear targets for construction and demolition waste: *"At the end of 2015 improve the preparing for reuse, recycling and recovery of construction waste (except waste 17 05 04 soil and stones category O) at least of 35% weigh of waste"*. The overall responsibility for controlling and monitoring the fulfillment of the objective, is taking by the Ministry of Environment, responsible for implementing are the District Offices Environment and Slovak Environmental Inspectorate.

CONSTRUCTION WASTE MANAGEMENT IN PLANNING PHASE

Preparation and planning are a prerequisite, the first and crucial step, determining the future success (effectiveness) carried out the building. According to the theory of planning, the planning process is determining the course of conscious activity that provides the link between the status quo (before the project) and the desired end state, which is achieved by the implementation [7].

Methodology of waste prevention and recycling talks about [8]:

- tools for promote waste prevention
- tools to support the recycling
- measures in the waste recycling
- accompanying measures to promote waste prevention and recycling

The ideal case would be to prevent waste. However, in practice it is not possible and therefore it is necessary to address the issue of waste management already in the phase of construction. According to Slovak Building Law (no.50/1976), where are determined the conditions how and where the developer is obliged to dispose with construction waste material. It has to be a part of project documentation, particularly in her technical report. Figure 4 describes the ideas of waste management in this phase – what kind of waste we can have and what we can do with it.

Figure 4: Waste management in planning phase

If in the planning phase are right determined the types and amounts of construction waste, during the construction itself cannot be the moment of disturbance due to construction of unforeseen construction waste. Planning phase determines exactly how a given type of waste will be further treated, or what the financial demands associated with it will be supplier for the producer of waste.

WASTE MANAGEMENT IN PHASE OF CONSTRUCTION

Construction processes are dynamic processes that affect not only the whole process of construction but also they have an impact on construction costs, construction time and resources. At this phase is no time or space for ideas how to dispose of generated waste, his storing and so. All of this should be solved in the above-mentioned phase of planning. During the construction time would be only to fulfill the above conditions. The constructor (and investor also) is not interested to the unnecessary extension of construction waste material, while the priorities interested to him are the final costs and completion of the earlier works on site. Figure 5 describes the treatment of waste generated in the construction phase.

Figure 5: Waste management in construction phase

In the phase of construction, there are usually options:

- construction waste is recycled directly on site and also is used in the construction process,
- construction waste is stored at a separate site collection and exported continuously during the construction time or exported before the completion of construction.

According to the Law on Waste, the waste producer (contractor) must have:

- Registration letter of waste
- Identification list of hazardous waste

Responsibility for the waste producer or holder is keep evidence of the types and quantities of handled waste in “Registration letter of waste “. This paper deals with their recovery and disposal. There is the responsibility to report the data from the evidence to the competent authority of government waste (§19 sec.1g), h) Law on Waste).

The evidences of waste are kept by type of waste. Waste generation or disposal should be continuously written. Data from the registration letters are written in "Notification of waste and handling" and forwarded to the appropriate district office environment.

Hazardous waste, respectively packages of hazardous waste and place of storage in building site must be provided by "Identification list of hazardous waste". This list includes name and number of waste, his characteristics, the recommended method of disposal or recovery as well as measures for accidents or fires. Removal and disposal of construction waste the contractor solves contractual with specialized company.

In the process of approval of construction, contractor is required to submit disposing confirmation of construction waste, issued by the competent specialized company (collecting yard, landfill, or company engaged in waste management).

Compliance with the law is carried out by inspectors of waste management Slovak environmental inspection. The fine for non-compliance of law depends on type of waste and violation of rules and regulations. Fines ranged from 664 EUR to 166 000 EUR. Revenue from fines is incomes to the Environmental Fund.

CONCLUSION

This paper brings the legislation related to the disposal of construction waste in Slovakia. The most important phases for the question over construction waste are the phase of planning and construction process itself. The legislative base is broad; applicable laws, rules and regulations mentioned in this paper cover the issue sufficiently. They meet the demands and requirements of the European Union. It is important to realize that the environment must be protected also in terms of manufacturing, construction exception. Building industry produces too large a percentage of construction and demolition waste. Statistics show that adoption, enforcement and checking compliance of legislation in this area leads to reduction of that percentage and thus significantly increases the protection of the environment and the life of the population.

REFERENCES

[1] Distribution systems of construction and demolition waste recycling and ways of area covering through recycling plants : Ivan Hyben, Marcela Spišáková. 2009. In: Selected Scientific Papers : Journal of Civil Engineering. - ISSN 1336-9024. - Roč. 4, č. 2 (2009), s. 77-88

[2] Ministry of environment of the Slovak Republic: The overview of actual environmental legislation < http://www.minzp.sk/dokumenty/legislativa/prehlad-aktualnej-environmentalnej-legislativy/>

[3] Archiportal.sk: Waste Catalogue. < http://www.archiportal.sk/katalg-odpadov-a-ich-kategorizcia/>

[4] Press release: Construction waste in Slovakia. < http://www.minzp.sk/informacie/tlacovy-servis/tlacove-spravy/tlacova-sprava-stavebny-odpad-slovensku.html>

[5] Optimalizácia pokrytia územia strediskami recyklácie stavebných odpadov : Interest area covering by construction and demolition waste recycling plants, Ivan Hyben, Marcela Spišáková. 2010. In: WASTE FORUM. - ISSN 1804-0195. - Vol. 3, no. 1 (2010), p. 18-25

[6] Enviroportal.sk: Environmental information. <http://cms.enviroportal.sk/odpady/verejne-informacie.php>

[7] Stavbyvedúci - manažér stavebného procesu : Mária Kozlovská, Ivan Hyben. Bratislava : Eurostav, 2005. 260 s : Druhé vydanie: Bratislava : Eurostav, 2006. 259 s. ISBN 80-969024-6-6.

[8] Environmentálne aspekty a ich vplyv na využívanie odpadov: Environmental aspects and their impact on the use of waste, Ledererová Miriam. 2010. In: Sborník konference Recycling 2010. ISBN: 978-80-214-4061- 6.

THE METHODS OF STUDYING THE TERRITORIAL IDENTITY FACTORS

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ABSTRACT

The escalation of global competition in the second half of the twentieth century gave a rise to a new direction of competition between cities – a struggle for people, investments in tourism and business, or in other words, a struggle for the spheres of influence. Such characteristics as natural and climatic features, culture, social infrastructure, a political system, and others have become the marketing elements that create the image of the city (area). As the object of research we have chosen the urban district of Saransk in Mordovia. The choice of the object to be studied is conditioned by the following factors: the stability of political life, economic achievements, sports achievements and by the fact Saransk is one of the most comfortable cities in Russia.

The analysis of the factors of territorial identity revealed that the urban district of Saransk has all conditions necessary for successful developing and creating a positive image of the city. The creation of the image of Saransk is under influence of both positive and negative factors. The most important positive factors are a good geographical location and economic climate, diversified industry, the unique architecture of the city, victories of the Mordovian athletes in Russian and international competitions, etc. The negative factors are a negative balance of natural and mechanical growth, criticality of power network, the necessity for modernizing and technical developing the main sectors of economy.

One of the priority goals is higher attractiveness of the urban district of Saransk. The accomplishment of this goal supposes carrying out the program of territorial marketing.

Keywords: territorial identity, territorial marketing, image of the city, image marketing, infrastructure marketing, informational marketing, competitiveness of the city.

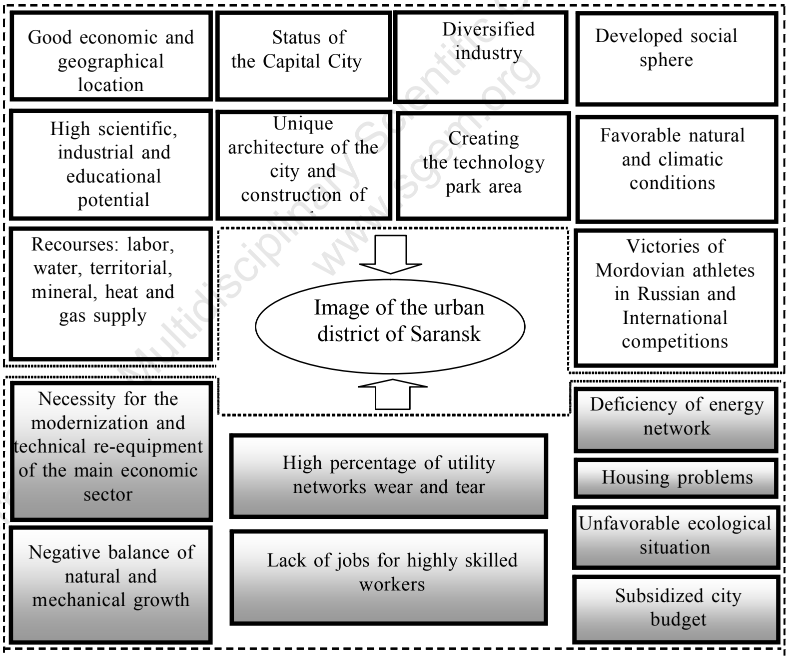
The accomplishment of these priority goals of developing the image of the urban district of Saransk will enable to stabilize the economy and social sphere, increase competitiveness and the quality of life, and create the conditions for reaching a new level of the development. The escalation of global competition in the second half of the twentieth century gave a rise to a new direction of competition between cities – a struggle for people, investments in tourism and business, or in other words, a struggle for the spheres of influence. Such characteristics as natural and climatic features, culture, social infrastructure, a political system, and others have become the marketing elements that create the image of the city (area) that is attractive to new residents, tourists, investors, business, etc. The interest in creating a city image is conditioned by forming national strategies for developing cities and regions and by looking for ways to improve their competitiveness[1,2,5].

As the object of research we have chosen the urban district of Saransk, the authorities of which work actively on creating the image of the city. The choice of the object to be studied is conditioned by the following factors: the stability of political life, economic achievements, and great sporting achievements and by the fact Saransk is one of the most comfortable cities in Russia.

The urban district of Saransk demonstrates an example of the successful creating the capital city from a small provincial town. Saransk performs the functions of the capital through providing favorable cultural and economic conditions for the residents, businesses, and visitors of Saransk, introducing the citizens to Russian and world culture, and supporting gifted young people.

Today, Saransk is a large, administrative, economic, scientific, cultural, and sports center of the Republic Mordovia and a center of business activity in the Volga Federal District. The figure describes the features and resources of the city of Saransk as favorable and unfavorable factors influencing on the image of the city. (Fig.1)

Favorable factors affecting the image of Saransk



Unfavorable factors affecting the image of Saransk

Figure 1 – Favorable and unfavorable factors of the image of Saransk urban district

We have determined the factors that provide developing the economic complex of the city and have a beneficial effect on its image. Constructing new facilities, creating the technological park area, the victories of Mordovian athletes in Russian and international competitions are the most important factors for creating the image of the city. These factors attract investors from Russia, CIS and non-CIS states.

The most unfavorable factors are criticality of power network, utility networks and infrastructure wear and tear, demographic problems, the necessity for the modernization and technical re-equipment of the main economic sector - industry. The authorities of the city make all efforts to take proactive measures to settle these problems and improve the image of the city of Saransk.

The leading place in the city's economy continues being taken by industrial production and its main sector – engineering that has high scientific and industrial, and human capacity. There are possibilities to change the sectoral structure of industrial production through diversification.

In order to ensure the interests of local people, social orientated sectors of industry working to meet the survival needs of the population for food, clothing and housing as well as natural resource industries, using local raw materials should be further developed. The fact that the state is oriented to domestic commodity producers results in increasing agricultural output and developing processing factories.

To estimate the image of the urban district of Saransk we used the SWOT analysis that includes the identification of strengths and weaknesses of the city's image, as well as opportunities of its development and threats from environment. To show the results of the analysis we have built the matrix of strengths and weaknesses of the city's image, and future opportunities and threats as compared to cities-competitors (Fig. 2).

STREANGTHS	**WEAKNESSES**
Status of the Capital City Stability of political situation in the city and a high level of public trust in the mayor of the city and the members of Saransk City Council Good geographical location High intellectual and human capacity Developed educational system Good opportunities for city-building Diversified economic structure Increasing productivity of housing construction Constructing technology park Sports center of the Volga region	Weak financial base and a heavily subsidized city budget Absence or lack of effective promotion of the local products Utility networks and infrastructure wear and tear Natural decline in the population of the city and ageing population High cost of housing and under-housing Some environmentally unfriendly areas
OPPORTUNITIES	**THREATS**
Improving the competitiveness of manufacturers and investment potential of the city Using energy-saving technologies in the enterprises of the city Growing demand for skilled workers Improving terms of home loan Growing educational and professional level of labor and increasing share of graduates among workers Russia's largest sports center City of world-class sporting events	Utility networks wear and tear and old infrastructure Deficiency and high cost of energy Almost full absence of local fuel industry Wear and tear of basic production assets in all economic sectors High percentage of old and hazardous dwelling Critical demographic situation, population ageing and decline in the birth rate High percentage of residents with low money income Unauthorized dumpsites

Figure 2 – SWOT-Matrix for the image of the urban district of Saransk

This matrix demonstrates that the urban district of Saransk has both positive and negative sides of the city's image. The strengths of the city's image are the status of a capital, a good geographical location, high intellectual and human capacity, good opportunities for city-building, constructing a technology park, and a high level of the sports development.

The weaknesses of the city's image are a weak financial base, a very high degree of utility networks wear and tear, natural decline in the population and a negative migration balance [3].

The opportunities of Saransk are improving the competitiveness of manufacturers and investment potential of the city, using energy-saving technologies in the enterprises of the city, and developing Saransk as a sports centre of Russia.

Potential threats to the image of the urban district of Saransk are utility networks wear and tear and old infrastructure of the city, deficiency of energy, a high percentage of old and hazardous dwelling, and a critical demographic situation. The authorities of the urban district of Saransk and the Government of the Republic Mordovia should make necessary arrangements for developing the strengths of the city, opening up its opportunities, balancing weaknesses, and averting possible threats.

It is advisable to analyze the internal environment of Saransk with the SNW-analysis including the examination of the city's image with the criteria "strong- neutral-weak" (Table 1). The data for the analysis have been got from the surveys of the consumers of the geoproduct and from the informational materials on the urban district of Saransk.

Table 1 – SNW-analysis of the urban district of Saransk

No.	The sides of Saransk	Qualitative evaluation of the sides of Saransk		
		Strong (S)	Neutral (N)	Weak(W)
1	Natural and climatic features		X	
2	Social and economic conditions		X	
3	Industrial infrastructure	X		
4	Social infrastructure		X	
5	Investment potential			X
6	Innovative potential		X	
7	Reputation of the city's authority	X		
8	Financial and economic indicators		X	
9	Rich and verified cultural life	X		
10	Historic and cultural sights		X	
11	Positive media coverage	X		

A qualitative evaluation of the components of the city's image allows us to conclude that sufficiently strong components are the city's production infrastructure, the reputation of the city authorities, the city's rich and varied cultural life and generally positive media coverage of the city. However, the city of Saransk is not sufficiently attractive to investors. It is possible that the construction of a technology park will improve the situation.

To analyze the image advantages of the urban district of Saransk we have used the SPACE- analysis. This analysis helps to determine the city's most advantageous strategic position and the ways of its strategic development. The SPACE-analysis is used to estimate the attractiveness of the city, economic stability, and financial capacity (Table 2). Every SPACE factor is rated with the use of rating scale from 1 to 6 (based on expert estimation and surveys data) and then average value for each of the four groups of factors was calculated.

Table 2 – The SPACE -Matrix of the urban district of Saransk

Factors of environmental stability (ES)	**Score**	**Factors of industrial strength (IS)**	**Score**
Technological change	3	Potential for growth	4
Rate of inflation	4	Potential for profits	3
Variability of demand	4	Financial stability	4
Cities-competitors pressure	3	Level of technology	3
Price elasticity of demand	2	Recourse efficiency	3
Obstacles for to entry into the city's market	3	Capital intensity	3
		Ease of entry into the city's market	3
		Productivity, the involvement of production capacities	3
Average score (total score)	***3,2 (19)***	*Average score (total score)*	***3,3 (26)***
Factors of competitive advantage (CA)		**Factors of financial strength (FS)**	
Quality of geoproduct	4	Return on investment	3
Life cycle of geoproduct	3	Financial dependence	4
Customer loyalty	4	Liquidity	4
Factor of capacity utilization in cities-competitors	4	Required / available capital	3
Level of technology	3	Cash flow	4
Vertical integration	4		
Average score (total score)	***3,7 (22)***	*Average score (total score)*	***3,6(18)***

The SPACE- Matrix demonstrates the factors of competitive advantage have the highest score that indicates the urban district of Saransk is rather competitive as evidenced by the high quality of geoprodukt and loyalty of customers. The lowest score was got by the factors of environment stability that tells about some pressure of competing cities, obstacles to entry into the city's market, and insufficient technological changes.

The data of the SPACE analysis of the competitive environment in the urban district of Saransk is presented by the polygonal graph. There are four possible strategic statuses of a city: aggressive, competitive, conservative, and defensive. The strategic status of Saransk is conservative (Figure 2).

The results of the SPACE matrix analysis the factors of environmental stability (ES) have an average score of 3.2, the factors of industrial capacity (IS) - 3,3, the factors of competitive advantage (CA) - 3,7, and the factors of financial capacity (FS) - 3 6, so we can consider the state of the city to be conservative. This state is typical for a rather attractive image

However, a conservative state of the city's image suggests that factors the factors of industrial capacity, economic environment stability have not been developed enough. Therefore, Saransk has a competitive advantage in a relatively unstable environment. Financial strength is a critical factor. Taking into account the fact that Saransk a subsidized city, it is very important to avert the threat of defunding. The main mechanisms are searching financial resources and developing distribution networks.

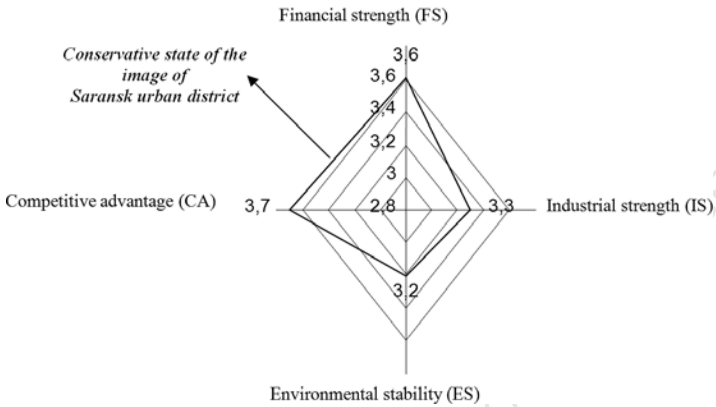


Figure 2 – Graph of the SPASE Matrix

The calculation of an image rate helps to determine the position of Saransk urban in the Volga region.

Using the method of expert estimation and the data of surveys we have rated the image characteristics of the following cities: Saransk, Samara, Nizhny Novgorod, Ulyanovsk (Table 3).

Table 3 – Calculation of image values for the cities of the Volga region (range from 1 to 5)

Image characteristics	Weight	Saransk	Samara	Nizhny Novgorod	Ulyanovsk
Natural and climatic conditions	0,05	4	4	4	4
Socio-economic conditions	0,15	3,5	4,5	4,5	3
Level of industrial and social infrustructure	0,1	4	4	4,5	3,5
Quality of life	0,15	3,5	4	4,5	3
Investment attractiveness	0,1	3	4,5	4,5	3
Reputation of the authorities	0,05	4,5	4	4	3
Economic and social security	0,1	4	4	4	3,5
Financial and economic indicators	0,15	3,5	4	4,5	4,5
Cultural Life	0,1	4	4	4,5	3
Historical and cultural	0,05	3,5	4	4,5	4,5
Total wight	1	37,5	41	43,5	33,5

Calculation of the image values for the cities

1. Ki Saransk = (0,05*4) + (0,15*3,5) + (0,1*4) + (0,15*3,5) + (0,1*3) + +(0,05*4,5) + (0,1*4) + (0,15*3,5) + (0,1*4) + (0,05*3,5) = 3,7

2. Ki Samara= (0,05*4) + (0,15*4,5) + (0,1*4) + (0,15*4) + (0,1*4,5) + +(0,05*4) + (0,1*4) + (0,15*4) + (0,1*4) + (0,05*3,5) = 4,1

3. Ki Nizhny Novgorod = (0,05*4) + (0,15*4,5) + (0,1*4,5) + (0,15*4,5) + (0,1*4,5) + +(0,05*4) + (0,1*4) + (0,15*4,5) + (0,1*4,5) + (0,05*4,5) = 4,4

4. Ki Ulyanovsk = (0,05*4) + (0,15*3) + (0,1*3,5) + (0,15*3) + (0,1*3) + +(0,05*3) + (0,1*3,5) + (0,15*3) + (0,1*3) + (0,05*4,5) = 3,6

Using these values we have built the polygon graph of the image characteristics of the cities (Figure 3).

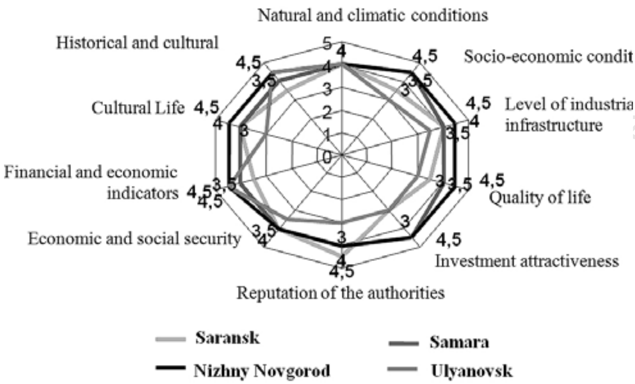


Figure 3 – Polygon graph of image characteristics of the cities of Saransk, Samara, Nizhny Novgorod, Ulyanovsk

From this figure we can see that Saransk takes the 3rd place in comparison with Samara, Nizhny Novgorod, and Ulyanovsk.

The analysis of the territorial identity factors allows us to conclude that Saransk urban district has all characteristics and resources necessary for its successful functioning and, consequently, creating a positive city image. The creation of the image of Saransk is under influence of both positive and negative factors. The most important positive factors are a good geographical location and economic climate, diversified industry, the unique architecture of the city, victories of the Mordovian athletes in Russian and international competitions, etc. The negative factors are a negative balance of natural and mechanical growth, criticality of power network, the necessity for modernizing and technical developing the main sectors of economy.

The study of the territorial identity factors by the methods of SWOT-, STEEP-, and PEST-analyses enables to identify promising directions for developing the image the urban district of Saransk. They are following:

- developing the economic and industrial capacity of the city and attracting investments;
- developing small businesses;
- improving the quality of public social services;
- eliminating distortions of the labor market;
- carrying out demographic and migration policies;
- applying energy-saving technologies to every industrial process;
- creating better terms of home loan, etc.

The choice of these priority goals was confirmed in the course of the research with the use of the methods of the SNW-analysis and the SPACE-Matrix.

The accomplishment of these goals involves increasing the competitiveness of the city and the quality of life and, therefore, creating a positive image of the city of Saransk.

The attractiveness of the territory is one of the components of the city's image (area's image). Therefore, a top-priority goal is improving the attractiveness of Saransk and the accomplishment of this goal includes realizing the program of territorial marketing. Judging from the results of surveys the, the city marketing tools are [2,4,5]:

– Image marketing - the creating of the city brand. This means creating, developing, and promoting a positive image of the city with the use of the following marketing tools: slogans, visual symbols, various actions (image of a place – the Saint Warrior Fedor Ushakov's Cathedral, Ice Palace, Moordovian N.P.Ogarev State University, Soviet square, Pushkin Park of Culture and Leisure);

– Infrastructure Marketing - the harmonization of the infrastructure with the development needs (developing the education system, planning the city area, developing city-building, recreational industry, power supply reliability, and utility networks);

– Display marketing - a set of actions aimed at providing positive information about the city in order to create a positive perception about the city, the products manufactured in it, conditions of business (direct advertising, the system of PR and GR activities, creating the system of the Internet sites about the city and its investment attractiveness).

In summary, creating a positive image of the city is a complex process requiring a special attention and great efforts. The city should constantly work very hard to leave a favorable impression on the population. Only then, as practice shows, you can expect a long-term success. The accomplishment of these priority goals of developing the image of the urban district of Saransk will enable to stabilize the economy and social sphere, increase competitiveness and the quality of life, and create the conditions for reaching a new level of the development.

REFERENCES

[1] Важенина, И.С. Имидж и репутация территории как основа продвижения в конкурентной среде // Маркетинг в России и за рубежом. – 2009. №5. - С.82-83.

[2] Майкова С., Гвоздецкая И., Сармаева. Город-сад. Имидж города: исследование термина в картах и схемах. // Маркетолог. 2010. № 11. С. 13.

[3] Окунев Д.В. Новое качество социально-трудовых отношений: проблемы формирования. Материалы Третьего Всероссийского социологического конгресса «Социология и общество». Москва. ИС РАН 2008. С. 26-37.

[4] Панкрухин, А.П. Маркетинг территорий. 2-е изд. - СПб.: Питер, 2006. - 416 с.

[5] Солдатова Е.В. Имидж территории: сущность и инструменты формирования. Известия Академии управления: теория, стратегии, инновации. 2011. № 3. С. 12-16.