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There are many definitions of the sustainable development, but most frequently the Brundtland definition is used. The sustainable development is one that satisfies the needs of the current generation without endangering the future generation's ability to satisfy its needs (14). The sustainable development concept comprises that the current generation uses the resource in such a manner that the quality and quantity of these resources is minimally altered so that the future generations could use it. In the recent years, the scientific public pays a lot of attention to the sustainable development of the water resources (5), (7). A special attention is paid to the water usage in agriculture (9), (12). The new ethics of the sustainable development requires the new approach to water resources management.

SUSTAINABLE RURAL DEVELOPMENT

The sustainable rural development more and more depends on the efficient usage of water resources (11). Most often, at least in one part of the year, the rain is not sufficient for plant growth and rain plant production significantly depends on the yearly precipitation variation. The increase and stability of the agricultural production is possible in the irrigation conditions. The most part (around 70%) of the global water resources is used for food production. Although there is enough water on the global level, many areas face the water shortage phenomenon.

The water shortage can be defined as a lack of adequate quantity of water of the appropriate

quality, at the right place, at the right time. The situation is rendered additionally difficult by the reduction of the water and soil resources quality that, in the great part, has been caused by the human activities. As the water resources shortage increases, so also does the usage of the water of inappropriate quality. The intensive usage and bad management of such irrigation water causes: damage to the soil quality and salinization. The special attention in sustainable rural development should be paid to the irrigation water quality.

The great challenge for the agriculture will be the obligation to increase food production, especially in the areas with limited soil and water resources. The possibility of farming land expansion is limited so that the increase of production must be affected by the increase of the crop yield. Both rain and irrigated agriculture have the ability to produce more food per unit of soil and per unit of water. In order to satisfy the future needs for food and growing competition for water between the various users, the more efficient usage of water in the irrigated agriculture becomes very important. The basic measure for the increase of the water usage efficiency is the reduction of the irrigation water losses. The global data show that the plants use only 45% of the water used in irrigation. The calculation of plant needs for water from the climatic data is the key element for providing higher water usage efficiency.

Agriculture is the important sector of the Serbian economy. Plant production has been significantly reduced during the recent years because of the draught. Construction of the large number of irrigation systems is planned and it is the right moment for the sustainable irrigation analysis.

INDICATORS OF SUSTAINABLE RURAL DEVELOPMENT

The Agenda 21 invites the development of the sustainable indicators. A large number of indicator sets has been established for various applications. No particular indicator set can satisfy the needs of all potential users. It is necessary to develop a special indicator set for the needs of the sustainable rural development observation, and it can be developed through the following activities:

- Adoption of the analytic framework
- Adoption of the indicator selection criteria and,
- Indicator selection.

There are several methods for organising the sustainable development indicators (Category list, Goal-Indicator matrix, Driving force-State-Response (DSR) framework, Pressure-State-Response framework, Endowment framework). The most used is the DSR framework. It is described in the UN Commission on Sustainable Development (UNCSD) reports.

The indicator has to fulfil the following criteria:

- to point at the problem important for the sustainable irrigation
- to be understandable
- to be quantified
- to be founded on the available data
- to be theoretically well-founded
- to provide basis for the international comparison

In the UNCSD indicator set, there are a large number of potential indicators of sustainable rural development. The indicators can be adopted from other sources (Organization for Economical and Cooperational Development (OECD) (6), EnviromentaL Indicators for Sustainable Agriculture (ELISA). The following indicator can be considered as possible candidates: Urban population growth rate, Gross Domestic Product (GDP) per capita, Environment protection costs in GDP percents, Water Usage Degree, Underground Water Reserves, Changes in Land Usage, Monthly rain index, Pesticide usage, Fertilizer usage, Farmed soil irrigation percentage, Salinization. The mentioned indicators belong to the group of social, economical and ecological indicators.

The development of the additional ecological indicators is necessary in order to fully comprehend the sustainable rural development. In chapter 2, the problems important for the sustainable agricultural production are briefly signified. On the basis of the criteria for the indicator selection, this paper would point out the irrigation water quality.

IRRIGATION WATER QUALITY

Irrigation water quality indicator is used to show if the available water resources have the required quality for application in agriculture. Irrigation is characterised by the complex water-plant-soil relationship, and in that ecosystem the man as the end user of the irrigated fields occupies a very important place. That explains the difficulties in producing one universal classification of irrigation water quality.

The adopted classification should possess understandable, qualified and internationally comparable indicator. Thus, local classifications (Neigebauer, Miljkovic) cannot be used for this indicator. United Nation Food and Agricultural Organization (FAO) and US Salinity Laboratory (USSL) classifications are used for the evaluation of the irrigation water quality throughout the world (5). FAO classification (2) gives the complex picture of the usability of the irrigation water from the point of its influence on the soil and the plants. However, the scope of the analyses is not often suited to the needs of that classification, which makes it difficult to apply.

USSL classification (12) the evaluation of the water quality forms on the value of its electric conductivity (EC) as the indicator of its salt concentration, and on its value of SAR (Sodium Adsorption Ratio) as the indicator of its relative sodium activity. On the basis of the reached values of EC and SAR the water quality is formed by a chart, which enables the classification of water in 16 categories. However, in order to make it easier to formulate the indicator it is necessary to reformulate and simplify the output categories. J. M. Servant classified the irrigation water into seven quality groups: good (C1S1), medium to good (C1S2, C2S1), medium (C1S3, C2S2, C3S1), medium to bad (C1S4, C2S3, C3S2, C4S1), bad (C2S4, C3S3, C4S2), very bad (C3S4, C4S3) and useless water (C4S4) (1). Anyway, this classification has a large number of groups, as well, which makes it hard to use. In (10) there is a less complicated and easier to use division into four quality groups: very good (C1S1), good (C1S2, C2S1, C2S2), not satisfactory (all with C3 or S3) and bad (all with C4 or S4). This division is more suitable for the quantifying of the indicator. Nevertheless, the more reliable classification should be still sought for.

EXAMPLE

The evaluation of the irrigation water quality indicator in the Juzna Morava river basin, upstream from the Toplica river estuary is given in this chapter. The research has been conducted

in the 1990-1992 period. The mineralization indicators (electrical conductivity, calcium, magnesium, sodium, potassium, sulfate) are displayed as the extreme values in the Table 1. In the same table, the evaluation of the water quality according to the USSL classification and according to the division from (3) is given.

Table 1. - Extreme values of mineralization with water quality evaluation.

Water course/ Station	Value	Na mg/l	K mg/l	Ca Mg/l	Mg mg/l	SO4 mg/l	EC μS/cm	Indicator USSL	Indicator Mark
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
J. Morava	Max	8.5	5.1	82.2	22.7	60	460	C1S1	V. good
Grdelica	Min	3.2	1.8	30.5	0	22	200	C2S1	Good
Vlasina	Max	8.4	1.5	59.7	18.4	60	700	C1S1	V. good
Stajkovac	Min	4.3	0.9	30.1	0	17	190	C2S1	Good
Veternica	Max	7.6	6.7	52.1	49.7	40	500	C1S1	V. good
Leskovac	Min	3.3	3.0	28.8	7.1	11	180	C2S1	Good
Jablanica	Max	59.0	14.2	69.7	22.7	70	740	C1S1	V. good
Pečenjevce	Min	9.2	4.0	25.2	4.1	24	230	C2S1	Good
Pusta reka	Max	21.0	6.3	59.0	18.9	45	650	C2S1	Good
Brestovac	Min	9.0	4.3	50.1	9.9	30	390	C2S1	Good

Based on the obtained results, it can be concluded that the irrigation is not limitation for sustainable rural development in the Juzna Morava basin. The similar irrigation water quality is observed in other Serbian regions (14).

CONCLUSION

The paper analyses the sustainable rural development concept. It provides the definition of the sustainable development. The procedure of indicators development, organizing and training is given. Observation of the sustainable development is impossible without the development of additional ecological indicators.

A special attention in the paper has been paid to the irrigation water quality indicator. The reason for this is the lack of the universal classification that makes the application of this indispensable indicator difficult. For the time being the USSL classification with the division in four quality groups is proposed. In Serbia, the irrigation is not limitation for sustainable rural development.

In the further studies, the attention will be redirected to FAO classification and Water Quality Index (WQI) (9). Testing of the UNCSD indicator set which has been conducted in many countries shows that there is a need for adoption of one water quality indicator. WQI can serve as such indicator. That is why it is very important to explore the possibility of WQI application in evaluation of the quality of water used in agriculture, and which has its particularities.

References

(1) Avakumović,D., Irrigation (in Serbian), Gradjevinski fakultet Univerziteta u Beogradu, 1994.

(2) Ayers, R. S., and Westcot, D. V., Water quality for agriculture. FAO Irrig. and Drain. Paper 29, Rome, Italy, 1985.

(3) Belic, S., Savic, R., Belic, A., Water usability for irrigation (in Serbian), Vodoprivreda, 35(1-2), 37-49, 2003.

(4) Manas, F., Ramos, A. B., Cortes, C. F., Gonsales, D. F., Corcoles, H. L., Improvement of irrigation management towards the sustainable use of groundwater in Castilla-La Mancha, Spain, Agricultural Water Management 40 (2-3), 195-205, 1999.

(5) Motorsi, M. - Dell'Arciprete, M., Acque irrigue della regione Emilia-Romagna. Variazione della qualita nel ventennio 1970-1990., Irrigazione e Drenaggio, 38(2), 15-27, 1991.

(6) OECD, OECD core set of indicators for environmental performance reviews, Enviroment Monographs 83, OECD, 1993.

(7) Simonović, S. P., Decision Support Systems for Sustainable Management of Water Resources : 1. General Principes, Water International, 21, 223-232, 1996.

(8) Sivakumar, M. V. K., Gommes, R., and Baier, W., Agrometeorology and sustainable agriculture, Agric. and Forest Meteor., 103(1-2), 11-26, 2000.

(9) Scottish Development Department, Development of a Water Quality Index, 1976.

(10) Skorić, M., i Berić, M., Quality of phreatic water in Vojvodina (in Serbian), Vodoprivreda, 26 (4-6), 113-118, 1994.

(11) Smith, M., The application of climatic data for planning and management of sustainable rained and irrigated crop production, Agric. and Forest Meteor, 103(1-2), 99-108, 2000.

(12) UNCED, Agenda 21. An action plan for the next century., Rio de Janeiro, UN, 1992.

(13) US Salinity Laboratory, Saline and Alkali Soils, Agriculture Handbook 60, USDA, 1954.

(14) World Commission on Environment and Development, Our Common Future, Oxford University Press, Oxford, U.K., 1987.