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# DYNAMICS OF SOME PHYSICAL AND CHEMICAL INDICATORS OF SUCEAVA RIVER WATER IN 2009

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**Keywords:** pollution, water quality indicators, polluters

**Abstract:** For a physical-chemical evaluation of global quality of Suceava river water, water samples were collected every two months during 2009, on the following sections (sites, locations):
• Brodina at 142 km distance from mouth; • Mihoveni, 45 km distance from mouth; • Tişăuţi, 34 km distance from mouth.

The values obtained from physical - chemical analyzes of water were processed and compared with the limit values of quality grades, provided by the norm on surface water quality classification, in order to determine the ecological status of water bodies according to Order nr.161/2006. Along Suceava river, the water flows increase from upstream to downstream: the maximum value 4.47 $m^3/s$ at Brodina (14.07.2009) increase at Mihoveni, the maximum value being 13.22 $m^3/s$ (14.07.2009) and at Tişăuţi, the flow recorded on 14.07.2009 is 13.7 $m^3/s$.

The annual average flows have fluctuated on very wide limits, depending on pluviometrical characteristics of rainfall on each year. Usually, the highest average flow is recorded in April, followed by June (Maxim, 2012). Higher levels of flow in these months can be explained by strong contribution of rainwater supply to which is added the water from snowmelt. The smallest amounts of water are flowing in winter and autumn.

This paper systematizes the results concerning the dynamics of some experimentally determined physical and chemical indicators during 2009, on Suceava river water. (PH, OD, $CBO_5$, CCOMn, CCOCr).In order to have an accurate picture of analyzed physico-chemical parameters, the average values of these indicators were presented for comparison. Thus, the concentration of hydrogen ions (pH) has values between 8 in the lower course and 8.3 at the upper course, at Brodina. At this value, the waters are favourable for the organisms development. *The medium content of dissolved oxygen* decreases from February to July and then increase until December - January, the average values ranging between 10.53 mg/l and 14.25 mg/l. *Biochemical oxygen demand* has an average value of 1.45 mg/l in the upper course and 6.25 mg/l at the mouth. *The chemical oxygen demand* falls between 2.34 mg/l at Brodina and 4.67 mg/l at mouth, on Suceava. In 2009, Suceava River in the control sections Brodina, Mihoveni and Tişăuţi was framed in quality classes I and II for all analyzed indicators.

## INTRODUCTION

Suceava River belongs to the group of eastern rivers of Romania, being a right affluent of Siret River. It is the third in importance after Bistriţa and Moldova and the only more important river that drains its waters on the surface of a single county, excluding the area that belongs to Ukraine. Suceava river springs from the northern extremity of Obcina Feredeului, specifically from the northern side of Culmea Alunişului, from the altitude of 1200 m, consist of two affluents: Izvor and Aluniş that join at Izvoarele Sucevei. It flows into the Siret River at Roşcani-Liteni. Suceava river has a length of 173 km, being the fifth in size among the main affluents of Siret, after Buzău (302 km), Bistriţa (283 km), Moldova (213 km) and Bârlad (207 km) (Frăsineanu, 2007).


**Figure 1. Sampling points on the Suceava river water**

Artificial pollution of surface waters from Suceava river basin is better highlighted than natural pollution, especially in downstream sectors, by the major users which discharge significant quantities of harmful substances. The old and poorly maintained deposits from SC Ambro (cellulose and paper) can cause unwanted accidents.

A strong anthropogenic influence on the development of Suceava river bed is the exploitation of ballast (sands and gravels) for construction materials industry. In Suceava river basin there are 63 gravel pits representing a large potential for transforming the minor riverbeds (Răduianu, 2009).

The objectives of the National Implementation Plan of stipulations of Stockholm Convention from May 22, 2001 - regarding persistent organic pollutants, concern to reduce or eliminate the emissions of waste and waste dumps, stopping the production of POPs, restricting the use of DDT, reducing the accidental emissions of dioxins, HCBs and PCBs generated by social and economic activities. According to data submitted by companies from Suceava County, in 2009 there were no transactions of import/export of persistent organic pollutants.

## RESULTS AND DISCUSSION

The study of water quality variation is based on specific quantitative and qualitative indicators, which change according to environmental conditions in the concerned area.

Opposed to 2008, the pH is higher downstream than upstream, maintaining approximately at the same values during 2009. In May, at the location Brodina the pH value of 8.4 indicate water pollution with inorganic compounds (Figure 2).

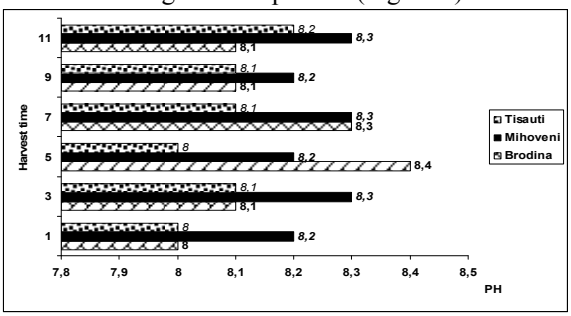


***Figure 2. PH dynamics in Suceava river, location: Tişăuţi, Mihoveni and Brodina, during 2009***

Hydrogen ion concentration from water is an important factor that determines the reactivation capacity of water, its aggressiveness, its ability to provide environments for the development of different organisms.

When waters have a high content of alkali and alkali earth carbonates, so have an alkaline character (pH>7), as in this case, it will solubilise the rocks with acidic minerals (sulphates, nitrates): $FeSO_4 + 2H_2O = Fe(OH)_2 + H_2SO_4$ $Al_2(SO_4)_3 + 6H_2O = 2Al(OH)_3 + 3H_2SO_4$

By their pH, the rivers waters from Suceava basin are favourable to the development vegetal and animal organisms.

Lower pH values at Brodina section, may have natural causes, such as draining of soil by the affluents, but also anthropogenic causes, such as shedding of wastewater with high content of mineral acids, the timber and logs depot and the sawmill what works near Suceava river.

Given that, in most cases, in all three sites, Suceava water pH is less than 8.3 (field of value 8 – 8.3), the overall alkalinity is the same as the content of $HCO_3^-$. The alkalinity ($HCO_3^-$ and $CO_3^{2-}$) of water bodies refers to the amount and type of dissolved ions (anions) which aims the pH displacement on alkaline scale.

The alkalinity indirectly measures the concentration of anions in water. It is caused or attributable to the presence of bicarbonates, carbonates, hydroxides, borates (less frequent) silicates and phosphates (McNeely, 1979), indicating the absence of acidic precipitation (Semb, 1976; Forland, 1973) and their negative impact on ecosystems (Wright, 1976).

***Dynamics of dissolved oxygen (DO)***

Oxygen is an indispensable element for all living conditions of the various aquatic organisms. Oxygen is a soluble gas and it is dissolved in water as $O_2$ molecules, the presence of oxygen in water conditioning the existence of most aquatic organisms.

Changes in dissolved oxygen concentration indicate changing in conditions in water mass. From experimental data plotted in Figure 3 is observed that the water from Suceava river is rich in dissolved oxygen in all three locations, in the early 2009, framing in waters of quality I.

***Table 1. Dynamics of dissolved oxygen in Suceava river water, locations: Tişăuţi, Mihoveni and Brodina, during 2009***

| Data / Site | U.M. | 12.01 /2009 | 11.03/ 2009 | 12.05/ 2009 | 14.07 /2009 | 16.09 /2009 | 12.11 /2009 |
|---|---|---|---|---|---|---|---|
| **Brodina** | **$mgO_2/l$** | **12.92** | **11.46** | **10.34** | **9.64** | **9.25** | **10.25** |
| **Mihoveni** | **$mgO_2/l$** | **14.21** | **13.42** | **10.42** | **8.21** | **8.52** | **10.63** |
| **Tişăuţi** | **$mgO_2/l$** | **12.98** | **12.54** | **10.23** | **6.34** | **5.25** | **9.84** |

Since July, the concentration of dissolved oxygen decreases upstream, standing still within the frame of quality I, but downstream decreases below the maximum allowed limit for water quality I, Suceava River water being a quality II water at the location Mihoveni (figure 3).

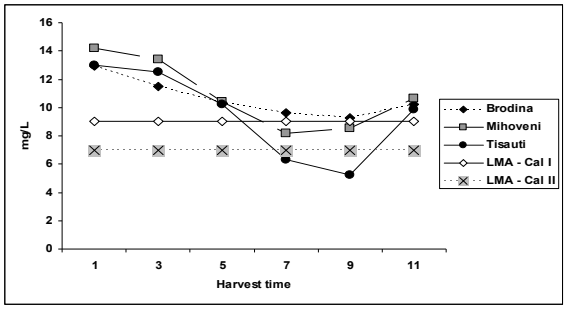


***Figure 3. Dynamics of dissolved oxygen concentration in Suceava river water, locations: Tişăuţi, Mihoveni and Brodina, during 2009***

In the site Tişăuţi, in September, the water flow being very low (3.76 $m^3/s$) that decreases also the total amount of oxygen available for the consumption by the aquatic creatures, Suceava river water being of quality III. In waters without oxygen or in mud, many species of anaerobic bacteria grows. There are various biochemical processes which diminish the oxygen concentration in water. Thus, by breathing or by biochemical oxidation of organic and inorganic unstable substances which tend to oxidize, an oxygen deficit is created.

In November, the value of this parameter increases, Suceava river water being again of quality I. The average content of dissolved oxygen decreases from upstream to downstream, as in 2008, data observed also by Davies (2008), Hart (2005), because of industrial and insufficiently treated wastewater from ACET Station Suceava, which flows into the Suceava river. Along water courses there is a natural tendency of decreasing in monthly average values of dissolved oxygen with increasing water temperature.

***Biochemical oxygen consumption:***

Biodegradable organic compounds (described by $CBO_5$) are represented by carbohydrates, proteins, fats, amino acids, urea, and synthesis organic compound.

From data presented in Figure 4 and Table 2, it appears that, in terms of biochemical oxygen demand, Suceava river waters were enrolled in Class I quality at Brodina location throughout the year 2009, not exceeding the maximum allowable limit of 3 mg $O_2/l$.

In the other two locations, the distribution of organic compounds is similar, the maximum concentration of $CBO_5$ parameter being reached in July, exceeding the maximum allowed indicator value for water of quality III, the quality of investigated water being IV. In this case there is a punctual pollution, pollutants coming either from domestic wastewater or industrial ones, food industry (dairy, cannery FACOS located downstream of Mihoveni) or

alcoholic beverages industry (beer factory BERMAS, the alcohol wine factory, upstream of Tişăuţi), biosynthesis industry. These have the particularity that can quite easy decompose in the presence of microorganisms in water, being used by these as a food source.

***Table 2. Dynamics of parameter $CBO_5$ in Suceava river water, locations: Tişăuţi, Mihoveni and Brodina, during 2009***

| Data / Site | U.M. | 12.01 /2009 | 11.03/ 2009 | 12.05/ 2009 | 14.07 /2009 | 16.09 /2009 | 12.11/ 2009 |
|---|---|---|---|---|---|---|---|
| **Brodina** | **$mgO_2/l$** | **1.86** | **1.75** | **1.23** | **1.81** | **1.05** | **1.45** |
| **Mihoveni** | **$mgO_2/l$** | **2.92** | **2.54** | **2.68** | **8.23** | **2.21** | **1.92** |
| **Tişăuţi** | **$mgO_2/l$** | **3.51** | **3.22** | **3.29** | **13.56** | **2.75** | **2.34** |

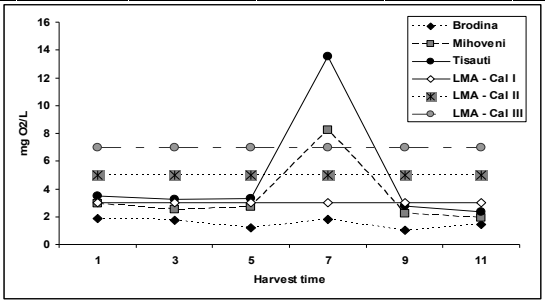


***Figure 4. Dynamics of parameter $CBO_5$ in Suceava river water, locations: Tişăuţi, Mihoveni and Brodina, during 2009***

After Hastenrath (1985) and Ajao (2002), upstream of Suceava river the water is clean (BOD = 1-2 $mgO_2/l$), at Mihoveni site the river water is quite clean (BOD = 3-4 $mgO_2/l$) excluding month of July when the river water is doubtful and downstream the river water is as in Mihoveni quite clean except in July when water is much polluted. (BOD=13.56 $mgO_2/l$);

The presence of organic compounds in the investigated water has a negative influence on concentration of dissolved oxygen, which by its decreasing has a negative influence on chemical and biological oxidation processes , reduces the ability of self-cleaning, modifies the organoleptic characteristics of water.

***Table 3. Dynamics of CCO-Mn, in Suceava river water, locations: Tişăuţi, Mihoveni and Brodina, during 2009***

| Data / Site | U.M. | 12.01 /2009 | 11.03/ 2009 | 12.05/ 2009 | 14.07 /2009 | 16.09 /2009 | 12.11 /2009 |
|---|---|---|---|---|---|---|---|
| **Brodina** | **$mgO_2/l$** | **1.58** | **3.42** | **2.25** | **2.74** | **1.67** | **2.48** |
| **Mihoveni** | **$mgO_2/l$** | **2.54** | **4.65** | **2.83** | **4.78** | **2.21** | **2.45** |
| **Tişăuţi** | **$mgO_2/l$** | **3.63** | **4.51** | **3.46** | **6.89** | **3.46** | **4.25** |

In waters polluted with organic substances there is a strong multiplication of microorganisms. It develops pathogenic species of bacteria and fungi, proliferate also saprophytic bacteria and fungi which decompose organic substances up to minerals. The density of these microorganisms does not decrease downstream the point of discharge of organic substances until the reduction of these substances in water (Gavrilescu, 2007).

As regards the chemical oxygen demand (CCO-Mn), in Table 3 and Figure 5, we notice that the values of this parameter were below the maximum permissible limit for surface waters of quality I, throughout the year 2009, in sections Brodina and Mihoveni, so a reduced presence of organic substances dissolved in water.

In the next period, there was a deterioration in the quality of these waters, the site Tişăuţi (with a maximum CCO-Mn of 6.89 mg $O_2/l$ in July,) corresponding to Class II of quality.

Organic compounds in water oxidize and decompose, or lodged as particles on bottom water. (Maxim, 2012*)*

Because dissolved oxygen is insufficient in Suceava river water, in July are taking place anaerobic processes such as denitrification, deamination, sulphate reduction, fermentation.

These produce the necessary oxygen for decomposition of organic substances but also undesirable compounds such as hydrogen sulphide, methane. As in 2008, in 2009 the consumption of oxidant is higher downstream than upstream, throughout the year, due to insufficiently treated wastewater and domestic water coming from SC ACET which flows into Suceava river.

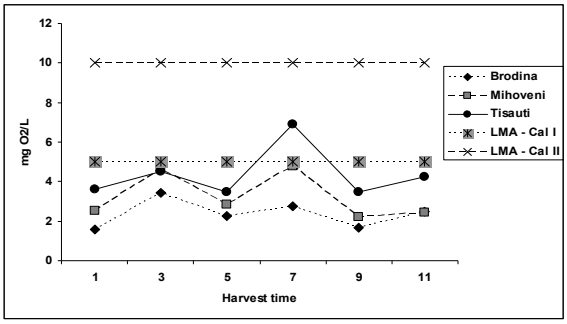


***Figure 5. Dynamics of CCO-Mn, in Suceava river waters, location: Tişăuţi, Mihoveni and Brodina, during 2009***

The biodegradable substances are clearly non-conservative and can be quickly oxidized, retained, decomposed either in treatment plant or in water courses by physico-chemical or biological processes.

Dynamics of the CCO-Cr, Figure 6, presents a look almost similar to dynamics of CCO-Mn, the values increase downstream being higher in late summer to autumn, when the oxygen level present in water is low and the water temperature is high.

***Table 4. Dynamics of CCO-Cr, in Suceava river water, locations: Tişăuţi, Mihoveni and Brodina, during 2009***

| Data / Site | U.M. | 12.01 /2009 | 11.03/ 2009 | 12.05/ 2009 | 14.07 /2009 | 16.09 /2009 | 12.11 /2009 |
|---|---|---|---|---|---|---|---|
| **Brodina** | **$mgO_2/l$** | **4.28** | **5.89** | **5.68** | **4.26** | **8.12** | **7.44** |
| **Mihoveni** | **$mgO_2/l$** | **8.25** | **8.97** | **6.58** | **17.25** | **8.21** | **6.94** |
| **Tişăuţi** | **$mgO_2/l$** | **9.56** | **9.21** | **6.85** | **21.87** | **11.34** | **10.85** |

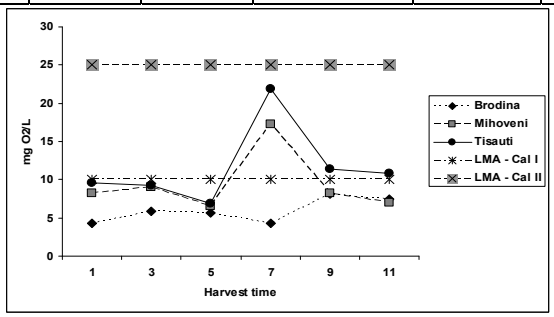


***Figure 6. Dynamics of CCO-Cr, in Suceava river water, locations: Tişăuţi, Mihoveni and Brodina, during 2009***

The degradation of water quality in downstream in July, reaching a maximum of 17.25 $mgO_2$/l at Mihoveni and 21.87 $mgO_2$/l at Tişăuţi, may be due to the presence of persistent organic pollutants, such as pollutants resulting from paper manufacturing processes, compounds obtained from incineration of municipal waste and industrial.

The non-biodegradable organic compounds are represented by: halogenated compounds of hydrocarbons, mono-and polynuclear aromatic compounds (Denis shoe factory situated on the right bank of the River Suceava, near the bridge at lţcani).

These compounds have a very high resistance to biological degradation, the biodegradation is possible only under normal conditions and in the presence of specialized organisms for a long time: it strongly influences the water quality by consuming the dissolved oxygen, slowing or blocking the biological process of self-purification and have negative effects on flora and aquatic fauna due to their toxicity. They have a toxic and/or carcinogenic and mutagenic character and present an effect of bioaccumulation in living organisms.

## CONCLUSIONS

At an approximately constant PH, the amount of dissolved oxygen decreases with increasing temperature and with increasing flow and is lower in summer. Changes in levels of OD may also result from the activity of plants and other organisms present in the water;

COD is a quick method to quantify the pollution and CBO5 is a method to quantify the biodegradable pollution, by bacteria from the environment;

Greater content of non-biodegradable organic substances present in river water certified by higher values of the parameter CCO-Cr, decreases with increasing the amount of dissolved oxygen and increases with increasing temperature.

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