HYDROMETRIC AND QUALITATIVE ASPECTS OF THE UPPER BÂRZAVA RIVER, ROMANIA

Laura ȘMULEAC*, Silvica ONCIA*, Anișoara IENCIU*, R. BERTICI*, A. ȘMULEAC*, Carmen PEPTAN, P. SFERCOCI**

***Banat`s University of Agricultural Sciences and Veterinary Medicine „King Michael I of Romania" from Timișoara**

****National Railway Company „CFR SA", Regional CF Timișoara**

Abstract: *Water is the natural source most widespread on the Globe, and in humans, it plays extremely important roles in all economic fields. In these conditions, water should be protected and carefully monitored. However, human activities bring about pollution of the environment that is increasingly frequent, intense, complex and long lasting. This paper presents the flow regime and quality of the upper Bârzava River. To do it, we analysed the water flow and we sampled water from the hydrometric stations in Moniom Reşiţa and Vermeş Berzovia. Water was sampled in January, May, September and November 2013. The highest values of water flow were in spring, i.e. 40-50% of the annual flows, a period that corresponds to snow thawing and periods rich in rainfall that are the main source of water for the Bârzava River. In summer, there were the lowest water flows because of the lack of water in the rivulets and of high evapotranspiration levels. Results of chemical analyses were interpreted and compared with physico-chemical quality standards (Monitorul Oficial al României) that allow the classification of water in classes between I and V. The main determining quality indicators were pH, dissolved oxygen, conductivity, nitrate content, nitrite content, ammonia content, phosphate content, copper content, zinc content, cadmium content, hardness and turbidity. Following the analyses and result interpretation, we could see a pollution of the water with nutrients in the Moniom Reşiţa and Vermeş Berzovia sections because of the discharge of home and agricultural wastes from the vegetal and animal farms in the area, of using organic fertilisers and of storing wastes on the riverbanks.*

Key words: *Bârzava River, flow regime, water quality, oxygen regime, nutrients, salinity, toxic pollutants*

INTRODUCTION

In the last decades, the degradation of the environment continued taking forms that covered gradually the entire planet because of industrialisation; it went hand in hand with the supply of raw materials, with the development of transports and with urban crowding, finally triggering the current "ecological crisis". The main characteristic of watercourses is the variable (and, sometimes, appreciable) load of suspended matter and organic substances directly proportional with weather conditions. Loading increases during rainfall periods reaching a maximum during water currents and a minimum during frosting; the discharge of effluents not enough purified has lead to the alteration of water courses and the appearance of a wide range of pollutants such as organic substances difficult to degrade, nitrate compounds, phosphorus compounds, sulphur compounds, microelements (copper, zinc, lead), pesticides, organo-chloride insecticides, detergents, etc. The quality of waters is established according to standards due to the importance of this resource for life safety and for the development of economic activities.

MATERIAL AND METHODS

The Bârzava hydrographic basin is part of the Banat Hydrographic Area; it covers 1,202 km^2 and is located at 289 m altitude. In Romania, it measures 154 km and the medium slope of the hydrographic basin is 100 m/km. In this hydrographic basin, the multi-annual mean flow is between 1 l/s/km^2 and 40 l/s/km^2.

The flow regime and the quality of the water were monitored in three control sections: Gozna Crivaia, Moniom Reșița and Vermeș Berzovia.

Flow represents the amount of water or solid material that flows through the transversal section of a watercourse per time unit. This is the most important hydrologic parameter.

Analyses were carried out in the Water Quality Laboratory in Resita, Romania, within the Banat Water Basin Administration. To evaluate natural water quality, we use the Order no. 161/2006 for the acknowledgement of surface water quality in relation to watercourse ecological state. Results were interpreted and compared with physical and chemical quality standards (*Monitorul oficial al României*) allowing the classification in classes from I to V.

RESULTS AND DISCUSSIONS

Flow regime

When analysing mean monthly flow in the upper Bârzava River, we took into account the evolution of mean monthly flows in 2013 at the hydrometric stations Crivaia, Moniom Reșița and Gătaia. Figure 1 shows that the highest values were in spring, a period that corresponds to snow thaws and periods rich in rainfall, the main source of water supply for the Bârzava River. The highest values were in April at the hydrometric stations in Crivaia (3.01 m^3/s) and Moniom Reșița (9.67 m^3/s); at the hydrometric station Gătaia, the maximum was in March (15.7 m^3/s). The lowest mean flows were in August in all three hydrometric stations: 0.33 m^3/s in Crivaia, 1.07 m^3/s in Moniom Reșița and 1.05 m^3/s in Gătaia.

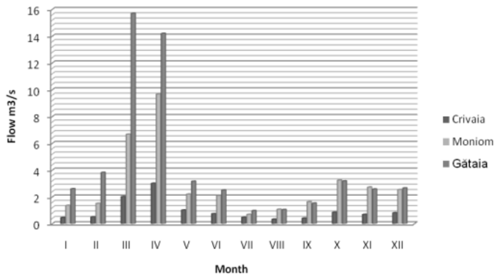

Fig. 1 Evolution of mean monthly flow in the three hydrometric stations in the upper Barzava hydrographic basin

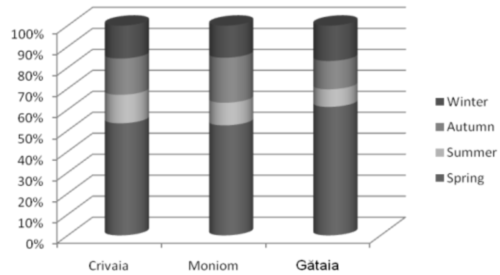

Fig. 2 Mean seasonal flows in 2013 in the upper Barzava hydrographic basin

Knowing the distribution per seasons of the flow is of great importance in the analysis of the flow regime. The Bârzava hydrographic regime is under the influence of hot Mediterranean air masses that determine partial thawing of the snow layer that is the main water source of the river. Though there are large amounts of water in the rivulets, winter flow is not superior to spring flow.

In spring (March-May), when the air temperature raises suddenly, there is snow thawing. During this period, the mean flow reaches the highest values ranging between 40 and 50% of the annual flow (Figure 2). In summer, there are the lowest flows because of the lack of water supply from the rivulets (low rainfall) and of high evapotranspiration levels.

Maximum flow is of particular importance in both anticipating flooding and designing hydrotechnical works along watercourses. Figure 3 shows that maximum flows in March in the hydrometric stations Crivaia (9.24 m^3/s) and Gătaia (77.8 m^3/s) and April, respectively, in the hydrometric station Moniom Reșița (28.1 m^3/s).

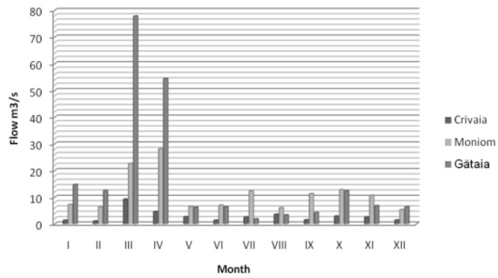

Fig. 3 Mean monthly flows in the upper Barzava hydrographic basin

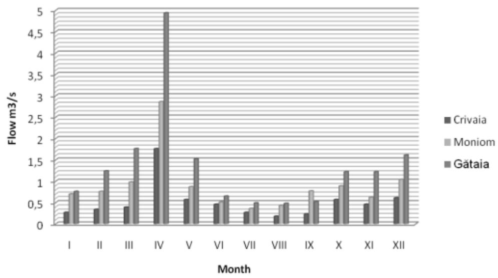

Fig. 4 Minimum monthly flows in the upper Barzava hydrographic basin

Knowing minimum flows is of practical importance for water reserves at water supply sources. Nowadays, minimum flow is most affected by human activities both quantitatively (consumption) and qualitatively (pollution). Figure 4 shows that the lowest water flows were in August in the hydrometric stations Crivaia (0.18 m^3/s) and Gătaia (0.48 m^3/s), and July in the hydrometric station Moniom Reșița (0.36 m^3/s).

Evolution of quality indicators in the hydrometric station Crivaia

To monitor water quality in the upper Bârzava River, we sampled water at the hydrometric station Crivaia in January, May, September and November. The main indicators were pH, dissolved oxygen, conductivity, nitrate content, nitrite content, ammonia content, phosphate content, copper content, zinc content, cadmium content, hardness and turbidity.

Laboratory analyses of the water from the Bârzava River show that at the hydrometric station in Crivaia, water pH had very good values, slightly basic. There was a slight increase from 7.3 in January to 8.1 in May and September, and the a slight decrease to 7.9 in November (Figure 5).

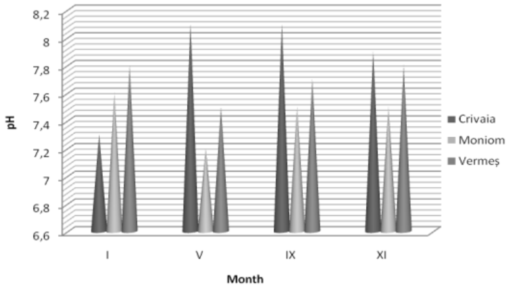

Fig. 5 Evolution of pH

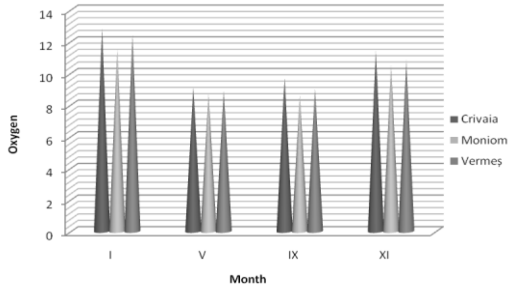

Fig. 6 Water oxygen content

Water oxygen content (Figure 6) had high values in winter (12.8 mg/l in January and 11.4 in November) and slightly lower values in summer (9.1 mg/l in May and 9.7 in September), all of them characterising the water as very good quality. The values of biochemical consumption of oxygen were very low, which makes the water higher quality: the highest value was in November (1.8 mg/l) classifying water 1st quality (Figure 7). Chemical consumption of oxygen (the Cr method) describes 1st quality water in January (9.5 mg/l), while the rest of the values (Figure 8) classify water 2nd, with the highest value in November (11.6 mg/l).

Fixed residue was low in all studied months, i.e. between 30.1 and 55 mg/l, which made it a 1st quality water. Calcium and magnesium contents were very low, between 5.2 mg/l Ca in May and 5.61 mg/l Ca in January, and between 0.45 mg/l Mg in May and 8.57 mg/l Mg in January.

As for nutrient regime, ammonia content (Figure 7) increased from 0.031 mg/l in January to 0.063 in September, but these values are very good. In nitrites (Figure 8), the values were increased (0.04 mg/l in September and November and 0.052 mg/l in January), which classifies water 3rd quality. There were higher values in nitrates (Figure 9) in January and May, classifying water 3rd quality, with lower values in the second half of the year, when water was 2nd quality.

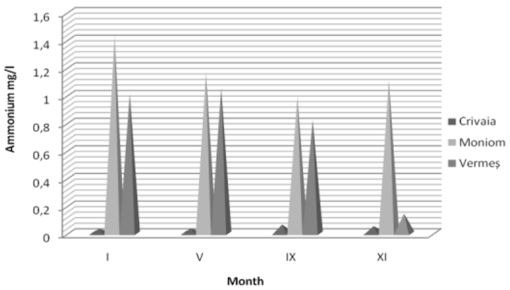

Fig. 7 Ammonium content

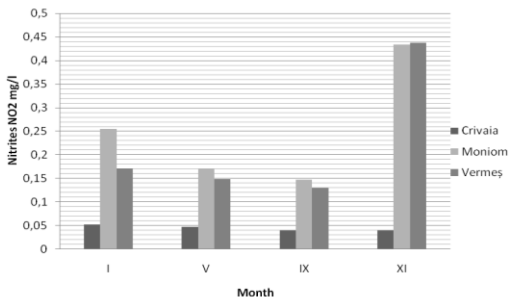

Fig. 8 Nitrites content

The analysis of toxic pollutants shows that zinc content classified water 1st quality. Copper content (Figure 10) classified water 1st quality only in September (9.8 µg/l), 2nd quality in May and November and 4th quality in January (53.3 µg/l). Cadmium content (Figure 11) had low values except for May (5.15 µg/l0, which classified water 5th quality.

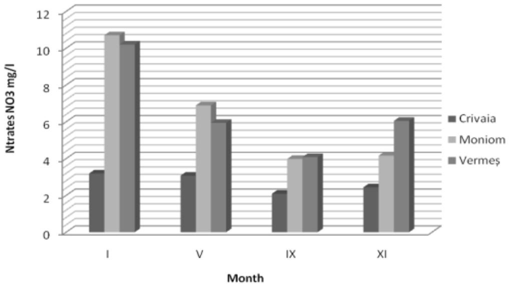

Fig. 9 Nitrates content

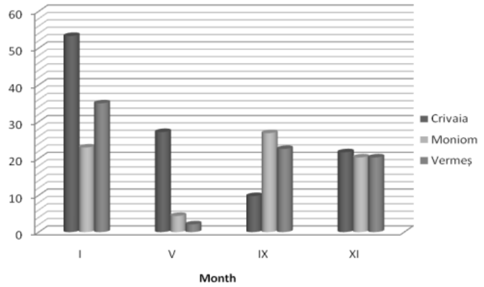

Fig. 10 Copper content

Water hardness varied from soft (6.07^0G) in January to hard (22.7^0G) in September (figure 12).

Water turbidity ranged between 2.03 in May to 8.29 in November.

Evolution of quality indicators in the hydrometric station Moniom Reșița

Analyses carried out by the Water Quality Laboratory in Resita showed that in the four months of 2013, the values of pH did not alter significantly: they maintained almost constant, slightly basic, and ranged between 7.2 and 7.6 pH units.

Oxygen content had very good values in January and November, unlike May and September, when water classified 2^{nd} quality, between 8.6 and 8.7 mg/l, respectively.

Biochemical consumption of oxygen had low values in all four studied months, classifying water 1^{st} quality. Chemical consumption of oxygen (the Cr method) had slightly increased values: from 15.6 mg/l in May to 17.3 mg/l in January, classifying water 2^{nd} quality.

Fixed residue had lower values in summer, from 118 to 166 mg/l in May and higher values in winter: from 269 mg/l in November to 308 mg/l in January, all of the below 1^{st} quality.

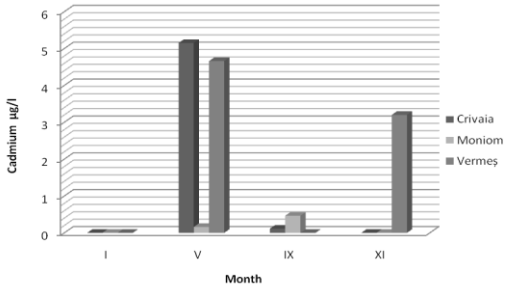

Fig. 11 Cadmium content

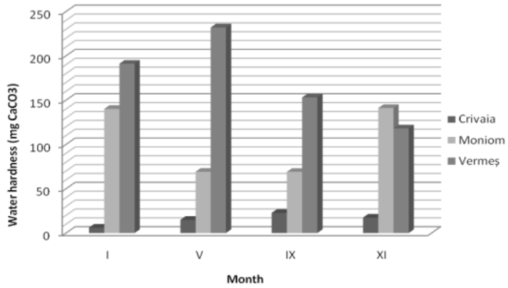

Fig. 12 Water hardness

Calcium and magnesium contents were low, which makes water better quality.

Analysing nutrient regime, we can see that ammonia values were high in January (1.43 mg/l) making water 4^{th} quality, decreasing to values that made water 3^{rd} quality. Nitrite content was high, from 0.147 mg/l in September to 0.255 mg/l in January, which made water 3^{rd} quality. Nitrate content in January and May classified water 4^{th} quality, with values that decreased in September and November making water 3^{rd} quality.

Phosphate content classified water in winter 3^{rd} quality unlike summer when its values decreased below 1^{st} quality.

Copper content had an oscillating value classifying water above 1^{st} quality, except for May when its value decreased much below 1^{st} quality (4.4 µg/l). Zinc and cadmium contents were very low, much below 1^{st} quality in all four studied months.

Water hardness was high, from 69^0G in September to 141^0G in November.

Turbidity oscillated from 2.37 NTU in May to 6.21 NTU in November.

Evolution of quality indicators in the hydrometric station Vermeș Berzovia

Laboratory analyses of the water samples from the hydrometric station in Vermeș Berzovia pointed out the basic character of the water: from 7.5 pH units in May to 7.8 in winter.

The water was rich in oxygen, ranging between 8.9 and 12.4 mg/l, which made water high quality. Biochemical consumption of oxygen kept constant around 2.2 mg/l, which confirms the high quality of the water. Chemical consumption of oxygen (the Cr method) classified water 2nd quality, with values of about 14.5 mg/l.

Fixed residue was low, from 210 to 339 mg/l in May, much below 1st quality limits.

Calcium content was low, between 33.8 and 48.1 mg/l, except for the value 66.8 mg/l in May, which classified it 2nd quality. Magnesium content was low only in November (6.28 mg/l), while the values of the other three months made water 2nd quality, i.e. from 15.8 to 17 mg/l.

Nutrient regime had no good values, particularly in ammonia, where in January, May and September water classified 3rd quality, and in November 1st quality, with 0.142 mg/l. Nitrites had values between 0.13 and 0.171 in the three studied months, which classified water 4th quality, while in November the value was 0.437 making water 5th quality. The nitrate regime either did not point to high quality water: in September alone water was 3rd quality (4.08 mg/l), while in the other months it was 4th quality. From the point of view of phosphate content, water classified 2nd quality in January and November, while in May and September it was higher quality.

Copper content was high in January (35 µg/l) which made it 3rd quality, decreasing to 2.1 µg/l in May (1st quality) and increasing slightly to 2nd quality (between 20.3 and 22.6 µg/l). Zinc content maintained low, below the limits of the 1st quality. Cadmium content was below 1st quality limits in January and September, increasing to 3rd quality (3.2 µg/l in November and 4.66 µg/l in May, respectively).

Water hardness was rather high in this hydrometric station, and turbidity maintained between 2.89 in November and 6.48 in May.

CONCLUSIONS

1. Water flow regime in the upper Bârzava River basin was measured with mean monthly flows in 2013 at the hydrometric stations Crivaia, Moniom Reșița and Gătaia. The highest values were in spring, i.e. 40-50% of the annual flow, a period that corresponds to snow thaw and periods rich in rainfall, the main source of water for the Bârzava River. In summer, there were the lowest water flows because of the lack of water supply from the rivulets (low rainfall) and of the high level of evapotranspiration.
2. To monitor water quality in the upper Bârzava River we sampled water at the hydrometric stations Crivaia, Moniom Reșița and Vermeș Berzovia in January, May, September and November 2013.
3. At the hydrometric station Crivaia, water pH had very good values, being slightly basic; oxygen regime had very good values making water high quality; calcium and magnesium contents were very low; nutrient regime pointed out values of nitrites and nitrates above normal values, making the water 3rd quality; analysis of toxic pollutants showed values above admitted limits in copper, making the water 4th quality in January; cadmium levels made water 5th quality; and water hardness varied from soft in January to hard in September.
4. Water samples from the hydrometric station Moniom Reșița had very good pH levels, being slightly basic; oxygen content had very good values in January and November, unlike May and September, when water was 2nd quality; chemical

consumption of oxygen made water 2nd quality; calcium and magnesium contents were low; analysis of nutrient regime pointed out a 4th quality water in January and a 3rd quality water in the other studied months; phosphate content made water 3rd quality in winter and below 1st quality in summer; toxic pollutant content was low, and water hardness was high.

5. Laboratory analyses of water samples from the hydrometric station Vermeș Berzovia pointed out the basic character of the water; oxygen regime was very good, with little values above admitted limits chemical consumption of oxygen; fixed residue was low, much below the limits of the 1st quality; calcium content was low, and magnesium content had values slightly above admitted limits; nutrient regime had no good values, particularly in ammonia, where in January, May and September water classified 3rd quality; nitrites characterised water 4th and 5th quality, and nitrates classified it 4th quality; phosphate content made water 2nd quality; zinc content maintained at low levels unlike copper and cadmium that had values above admitted limits making the water 2nd quality, and water hardness was rather high.
6. In the hydrometric stations Moniom Reșița and Vermeș Berzovia, there was water pollution with nutrients because of the discharge of home and farm used waters in the area, of the use of organic fertilisers and of the storage of wastes on the riverbanks.

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