MONITORING PHYSICO-CHEMICAL AND BIOLOGICAL PARAMETERS FROM THE MOTRU HIDROGRAPHIC BASIN UNDER THE INFLUENCE OF ANTHROPIC FACTORS

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Abstract. Fresh water is a finite resource, essential for human existence, for agriculture and industry. It has been unambiguously demonstrated that good quality water is of crucial importance for sustainable socio-economic development. Aquatic ecosystems are affected on a global level by a range of pollutants such as waste, chemical fertilizers or poor water management. They are also populated by hydrobionts that are harmful and pathogen for people, plants, animals, that can bring significant damage to the economy, especially when affecting water sources. In this context, a range of physicochemical and biological analyses were performed to establish the water quality category of the Motru River in three sections, which was monitored between 2015-2018. Depending on these values, water was classified in the categories of I (SI) and II (SII) quality. Biological indicators show positive deviations from the reference values of the five invertebrates groups, with the prevalence of oligochaetes (60%), followed by coleoptera (15%), ephemeroptera, odonata (10%) and diptera (5%).

Keywords: hydrographic basin, the Motru River, physicochemical and biological analyses, saprobic index, biocoenotic indices.

Rezumat. Monitorizarea unor parametri fizico-chimici şi biologici din bazinul hidrografic Motru sub influenţa factorilor antropici. Apa proaspătă este o resursă finită, esenţială pentru existenţa umană, pentru agricultură şi industrie. S-a demonstrat uniechivoc că apa de bună calitate este de o importanţă crucială pentru o dezvoltare durabilă socio-economică. Ecosistemele acvatice sunt afectate la scară mondială de o serie de poluanţi cum ar fi: deşeurile, îngrăşămintele chimice sau de un slab management al apei. Ele sunt populate şi de hidrobionţi dăunători şi patogeni pentru om, plante şi animale, ce pot aduce prejudicii însemnate economiei, mai ales atunci când afectează sursele de apă. În acest context s-au efectuat o serie de analize fizico-chimice şi biologice stabilind categoria de calitate a apei râului Motru în 3 secţiuni, aceasta fiind monitorizată în perioada 2015-2018. În funcţie de aceste valori apa s-a incadrat in categoria I (SI) şi II de calitate (SII). Indicatorii biologici prezintă abateri pozitive faţă de valorile de referinţă la cele 5 grupe de nevertebrate, dominante fiind oligochetele (60%), urmate de coleoptere (15%), efemeroptere, respectiv odonate (10%) şi diptere (5%).

Cuvinte cheie: bazin hidrografic, râul Motru, analize fizico-chimice şi biologice, indicele saprobic, indici biocenotici.

INTRODUCTION

Hydrobiology has grown and developed to the extent that man is increasingly in need of aquatic and water basin products, and the apparent abundance of water has led the society to ignore the need to develop a viable management of water reserve, according to their limited availability (BREZEANU & GĂŞTESCU, 1996; JOHNSON, 1999; BREZEANU et al., 2011; PACEŞILĂ, 2015).

On the Motru Valley, the aspect of the relief is given by the alternation of isolated hills with high hills and the dividing valleys that widen in the confluence zone, giving the appearance of a small depression (the confluence between Ploştina Stream and Motru River). The average altitude of the relief is comprised between 200-300m, with the highest being Tâlvei Peak of 415 m at NE from Roşiuta village. The Motru municipality is located at an altitude of 185m, the lowest slope is 171m in the Merişului meadow, located upstream from the commune of Broşteni. The relief ensemble is given by the high pools of the NE sector with rounded aspect and the valleys that widen towards confluence. A brief overview of the map shows us the existence of high fragmentation surfaces in the N part due to the branching of the tributary reception basins, with a density between 0.1-1km/km^2 in the Motru Meadow, in the south part of the peak between Motru and Peşteana. The Motru River is the main hydrographic artery and has an orientation given by the appearance of the relief. The hills have heights between 200-300m, the slopes occupying very large surfaces with inclinations between 0-30%, the more pronounced being produced by human activity is intense (Fig. 1). After water treatment, the recorded values for suspensions and detergents are over the allowable limits. The most significant exceedances are observed in the NH_4^+ and CBO_5 indicators, the recorded values are well above the permissible limits and demonstrate an inefficiency of the biological treatment of the station in the Motru municipality (GAVRILESCU & OLTEANU, 2003; CIOBOIU, 2005).

The Motru River Valley is the largest occupying a central place in the landscape of the relief and due to the ubiquitous anthropic activity in the region an anthropic specific relief has been created. The Motru River presents a winding course with changes of direction (NV-SE at Glogova, N-S at Meriş). The important tributaries of the Motru River – on the left side, Ploştina and Lupoiţa, on the right side, Crainici and Peşteana – gave rise to the valleys bearing their name, rather narrow valleys in the upper sector and wide to the place of discharge. The Motru Valley is centrally oriented within the Motru Coal Basin. The Motru Coal Basin is located within the Motru Perimeter, presenting specific features within a Piedmontese aspect determined by the geological structure of the surface deposits arranged monoclinically, by the general inclination of the relief in the region from NV to SE. From a geographic point of view, the Motru River Basin is located in the western part of the Getic Piedmont and covers an area of 691 km^2 (Fig. 2).

Figure 1. The location of the Motru River – General Overview (Google Earth, accessed: March 5, 2019).

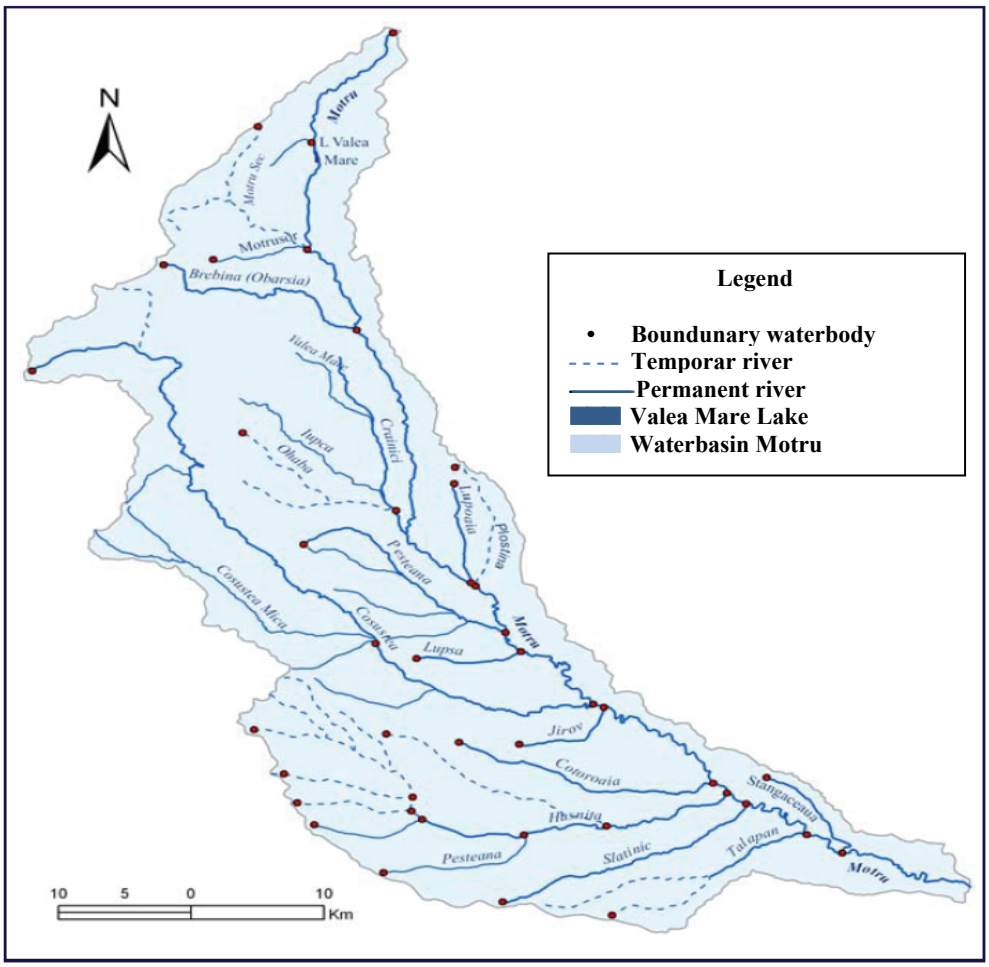

Figure 2. Surface water bodies in the Motru River Basin (processing after topographic map 1:25.000, 1979).

MATERIAL AND METHODS

The research carried out aimed at assessing the water quality of the Motru River, which was appreciated from a physical, chemical and biological point of view. The study was conducted in three areas, located on the upper, middle

and lower course of the river. Physical (temperature, conductivity, pH, fixed residue) and chemical (chlorides, sulphates, nitrogen, ammonium ions) characteristics were determined from the water samples collected according to the regulations in force. Also, biological monitoring of invertebrates was performed using the B.M.W.P (Biological Monitoring Working Party) method. Invertebrates were collected using a colonization sample and stored in the field by adding 4% formaldehyde until the animals are completely submerged. The value of B.M.W.P. is effective in highlighting small changes in water quality and varies between 1 and 10. The method is based on the number of invertebrate groups found in the water samples. According to their sensitivity to pollution, they are assigned a certain value between 1 and 10.

The more sensitive the group is to pollution, the higher the number will be. As more groups may appear in the water, the B.M.W.P index does not have the maximum limit, although values over 150 are rare. In order to calculate the B.M.W.P index, 50 samples were taken, followed by the numerical values of the examined groups. In a more precise calculation, the B.M.W.P. of water is divided by the number of invertebrate groups identified in the samples. The data were then analysed using different techniques: a) The Trent index; b) the Shannon-Weiner index; c) The dominance K (SAVIN, 2004; ROBESCU, 2008; GAVRILESCU & GAVRILESCU, 2009).

RESULTS

In assessing surface water quality for rivers in Romania, indicators of the thermal and oxygen regime were used, such as temperature and dissolved oxygen (SAVIN, 2001). The water temperature of the rivers in the Motru hydrographic basin is characterized by a fairly large variability both in terms at space and time, being directly proportional to the thermal regime of the air and inversely proportional to the altitude.

In the graph of the monthly variation of the surface water temperature in the basin (Fig. 3), in addition to the influence of the climatic factor (the highest values were recorded in June – 23^0C, Broşteni; 22^0C, Fața Motrului and Gura Motrului and the lowest values in february - 2^0C, Corcova), the correlation of its values with the altitude can be seen (average annual values of water temperature decrease with the altitude - 9^0C, Cloşani; 13,6^0C, Broşteni; 13,8^0C, Gura Motrului).

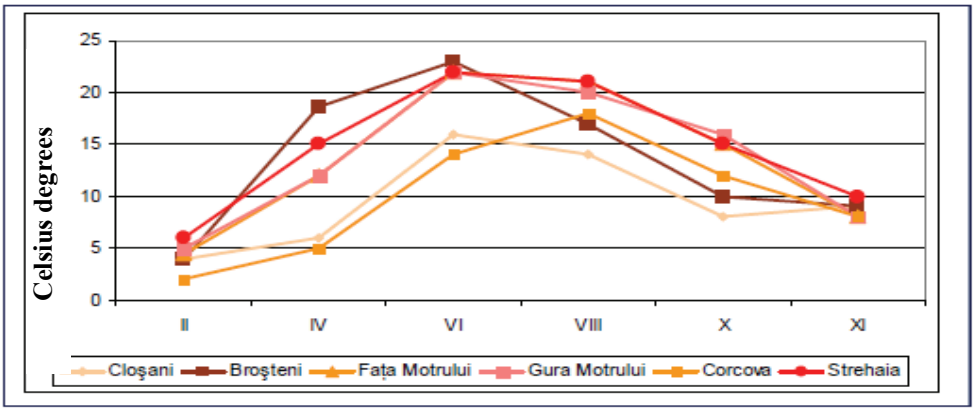

Figure 3. Monthly variation of surface water temperature in the Motru Hydrographic Basin (source: ABA Jiu).

The chemistry of surface waters in the Motru River Basin was assessed by the values of nutrients, salinity and other relevant chemical pollutants and it was found that monitoring stations such as Brosteni (located downstream of the town of Motru) and Gura Motrului (station located upstream from the Jiu River) constitute a monitoring section of the entire basin for reception. In terms of pollution sources, it was found that significant values are recorded at the level of the two urban settlements Motru and Strehaia. The waste water is discharged in the Motru River (for the town of Motru), in the Huşniţa stream (for the city of Strehaia) and in Brebina (for the city of Baia de Aramă), and the pollution of the aquatic environment is due to the organic loading to which nutrients and suspensions are added (SAVIN, 2008).

The industrial activity in the Motru River Basin consists of the extraction and preparation of lower coal at the units of the E.M.C. Motru. Lupoiţa and Ploştina can be considered a point source of pollution, registering the following exceedances: in domestic waters - NH4 (0.420 mg / l), and in technological waters - suspensions (32 mg / l) and calcium (98.400 mg / l). Other sources of pollution are: the administration of chemical fertilizers, especially phosphorus, most communes falling below 0.5 kg / ha x year; the specific quantity of nitrogen used at the commune level is mostly below 5 kg / ha x year; the growth of animals and cattle, respectively, is the most important source of diffuse pollution due to the impact of elements such as ammonia, nitrogen (nitrates) and phosphorus (phosphates) from animal manure.

The use of land in the Motru River Basin, according to Corine Land Cover 2010 (Calculated Area by GIS techniques) is characterized by the predominance of the following areas: 48.1% agricultural areas, 45.6% forests and semiarid areas and 5.7% areas anthropized (Fig. 4). Sources of anthropogenic pollution present a particular importance and are the main cause of contamination by the Motru Hydrographic Basin.

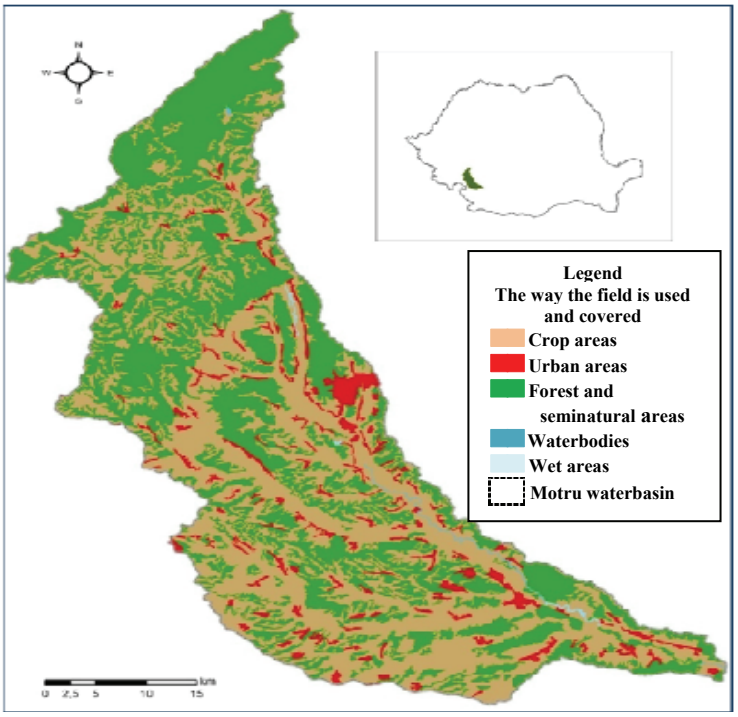

Figure 4. The degree of human intervention on the land of the Motru Hydrographic Basin (processing after Corine Land Cover 2010, ABA Jiu).

Physicochemical indicators were determined on three distinct sections of the river Motru: Motru at Apa Neagră (S1), Motru upstream of the town Motru (S2), Motru downstream of the Motru city (S3), namely: pH, conductivity, fixed residue, chlorides, sulphates, nitrates, nitrates, ammonium ions in each season in the period 2015-2018 (CIOBOIU, 2003). The pH and conductivity of the evacuated water have values within the limits allowed by the Normative regarding the discharge of urban waste water in natural receivers (Figs. 5, 6).

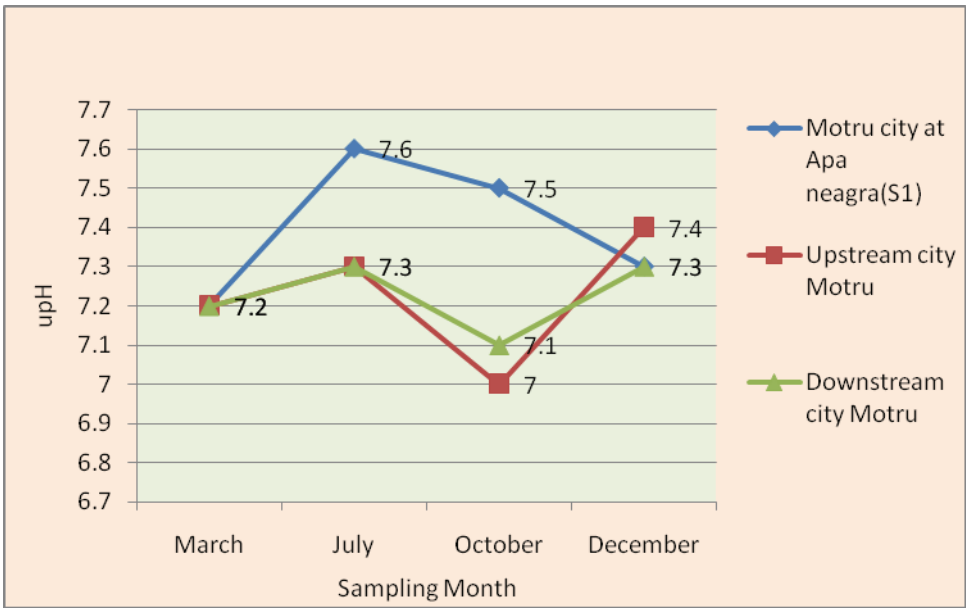

Figure 5. The evolution of pH in the Motru Hydrographic Basin.

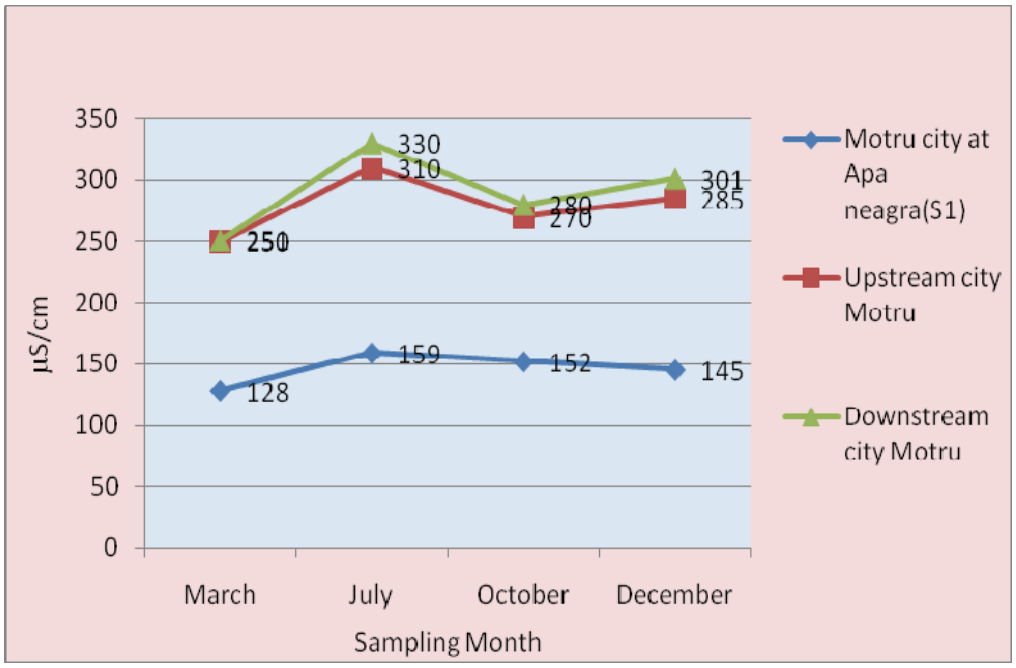

Figure 6. The evolution of conductivity in the Motru Hydrographic Basin.

Thus, in the section of the Motru River at Apa Neagră for fixed residue indicators, chlorides and sulphates, the obtained values are below the limits set for quality class I. At the fixed residue indicator, the highest value obtained (114 mg / l) represents only 22.8% of the limit for the quality of the class I (CÎRȚÎNĂ, 2005; GAVRILESCU & BUZATU, 2014).

As for the other indicators – nitrates, nitrates, ammonium – the obtained values fall within the second quality class. Results were interpreted according to the Order of the Ministry of Environment and Water Management no. 161/2006 for the approval of the Normative regarding the classification of surface waters in order to establish the ecological status of the water bodies. Also, in section (S2), the characteristic values of the quality class II were recorded in the indicators regarding the regime of nutrients in water, namely, nitrogen, nitrogen and ammonium, which indicates an organic pollution. Furthermore, this finding can be observed in section (S3), where the urban waste water from Motru municipality is discharged, in a sub-dimensioned sewage treatment plant, with a very low efficiency (Figs. 7, 8, 9, 10, 11 , 12).

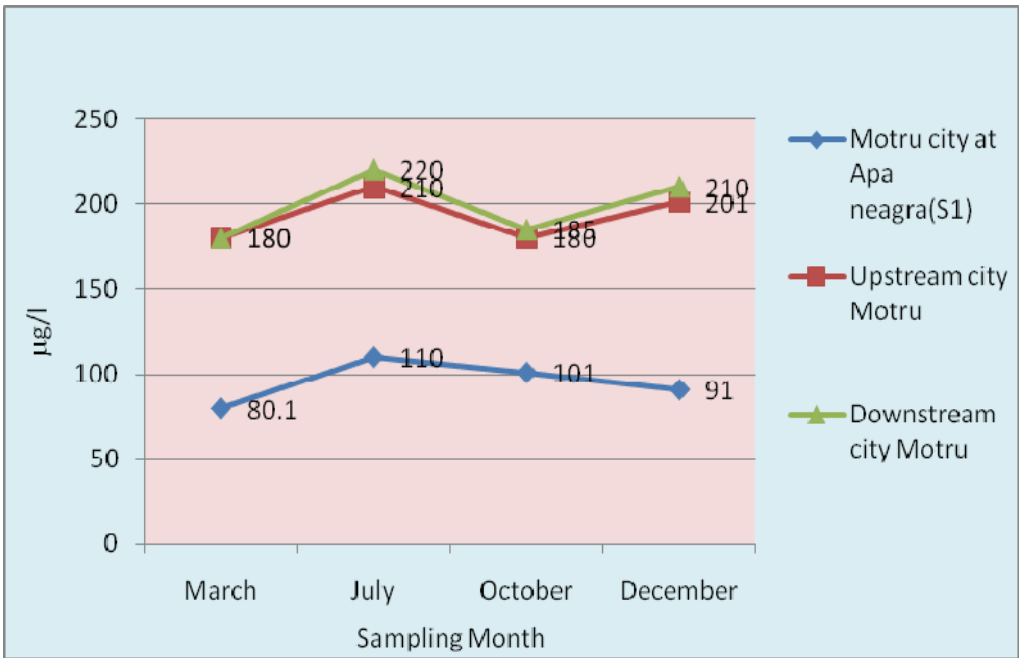

Figure 7. The evolution of the fixed residue in the Motru Hydrographic Basin.

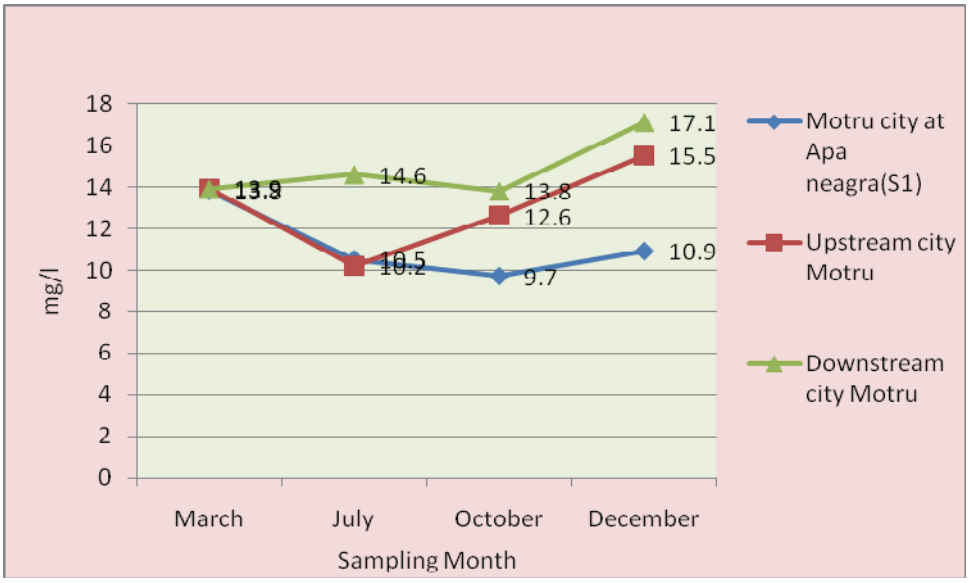

Figure 8. The evolution of chlorides in the Motru Hydrographic Basin.

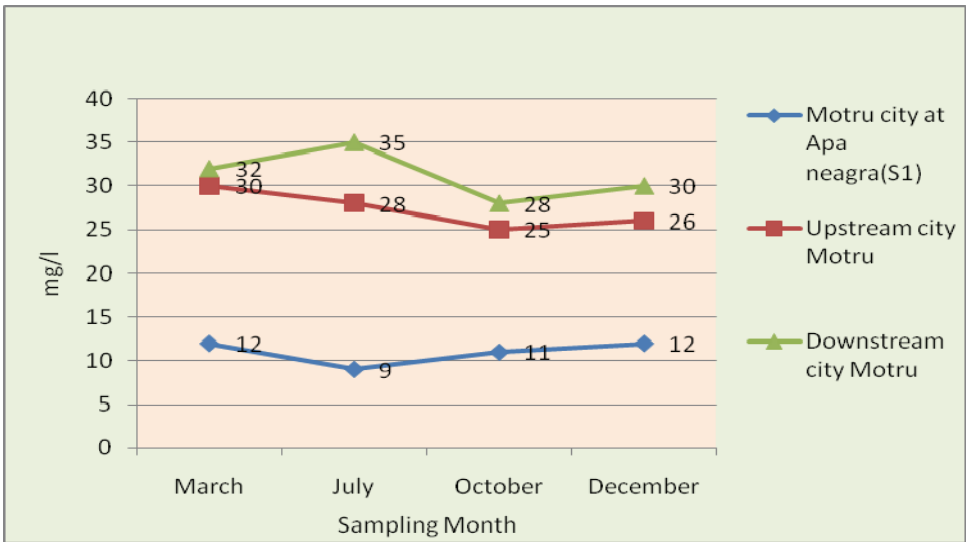

Figure 9. The evolution of sulphates in the Motru Hydrographic Basin.

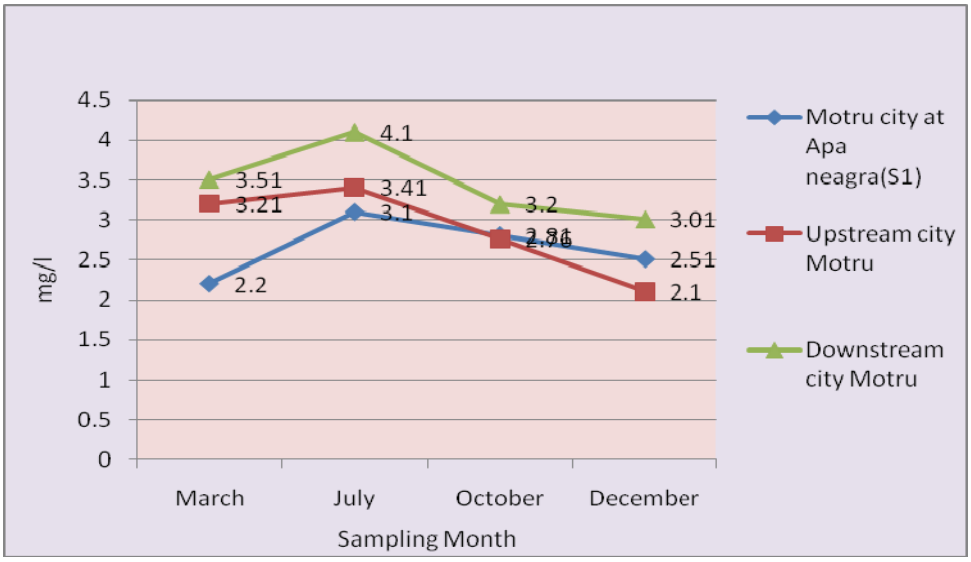

Figure 10. The evolution of nitrates in the Motru Hydrographic Basin.

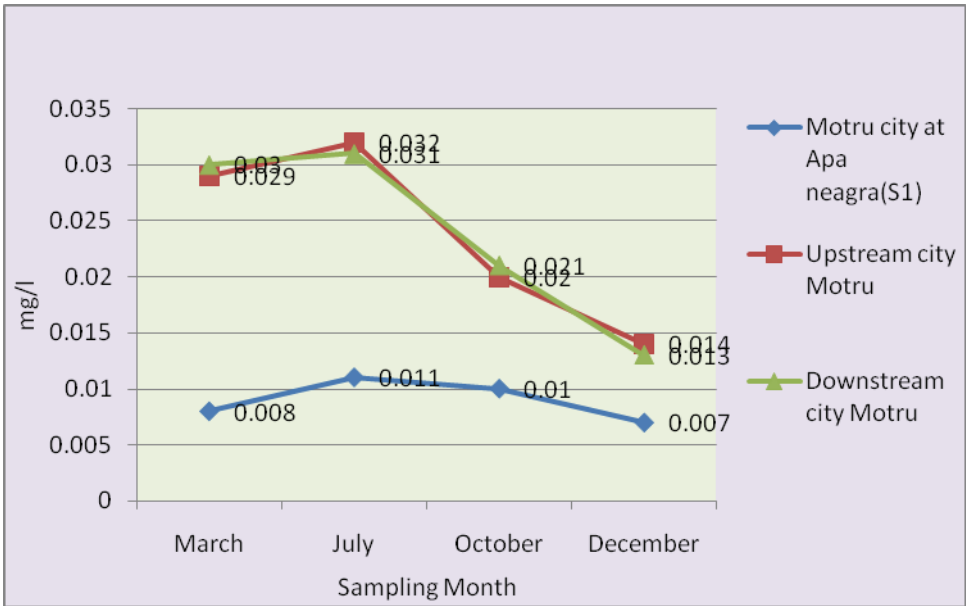

Figure 11.The evolution of nitrates in the Motru Hydrographic Basin.

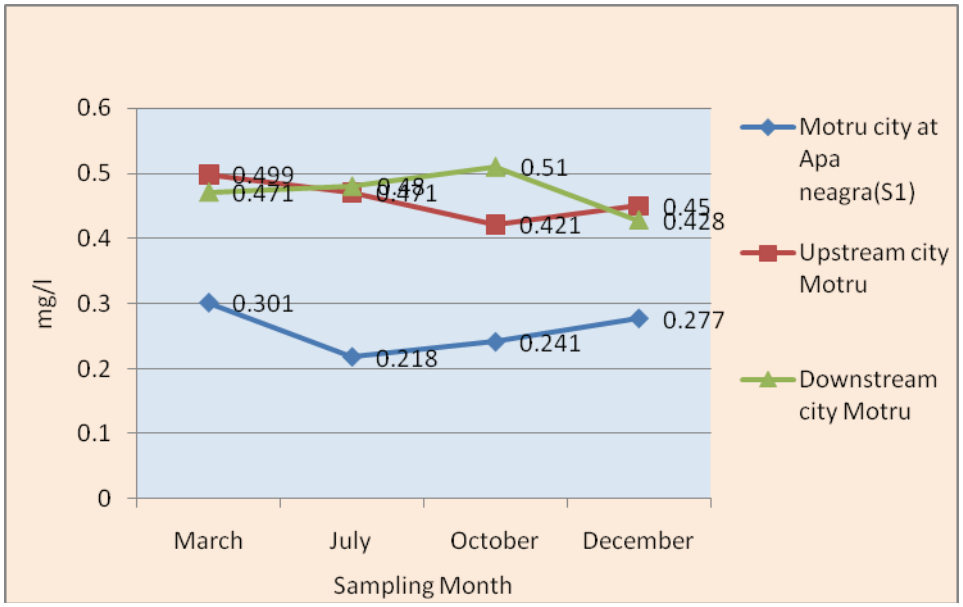

Figure 12. The evolution of ammonium in the Motru Hydrographic Basin.

Biological indicators. The assessment of the ecological status by invertebrate groups was performed by interpreting the values of the biological indices presented in the Specific Reference Conditions (JOHNSON, 1999; CIOBOIU & BREZEANU, 2002; BREZEANU et al., 2011). Some of them reported positive deviations from the benchmarks (Shannon-Wiener Diversity Index - 2.87). As for biological indicators, they were analysed at the Fața Motrului monitoring station. In 2018 it was found that the saprobic index 30% had the value of 2.2, while the reference value was 1.55; insect index: Ephemenoptera, Odonata and Diptera 10% is 0.43 while the reference value is 0.3; the Shannon-Wiener diversity index 20% is 2.87 while the reference value is 1.9; the index of the number of families 10% is of 13.33 while the reference value is 14; the Oligochaeta – Chironomidae 10% index is 0.31 while the reference value is 0.25; the index of the 10% functional groups is 0.34 while the reference value is 0.3; the 10% water flow preference index is 0.97 while the reference value is 0.9; the multimeter index of macroinvertebrates is 0.929 while the reference value is 0.921, all indicating a good ecological status (Source: ***. Ord. 161/2006; National Institute for Research and Development for Environmental Protection - ICIM Bucharest, 2012).

The analysis at the monitoring station upstream of Motru city presents exceedances of the following biological indicators: Saprobic index, Insect index, Shannon-Wiener diversity index, Family number index, ecological status being good. Thus, in the Motru to Apa Neagră section, the obtained values fit in the section S1 and S2 for the first class of quality, and in the section S3 for the second class of quality (Figs. 13, 14, 15).

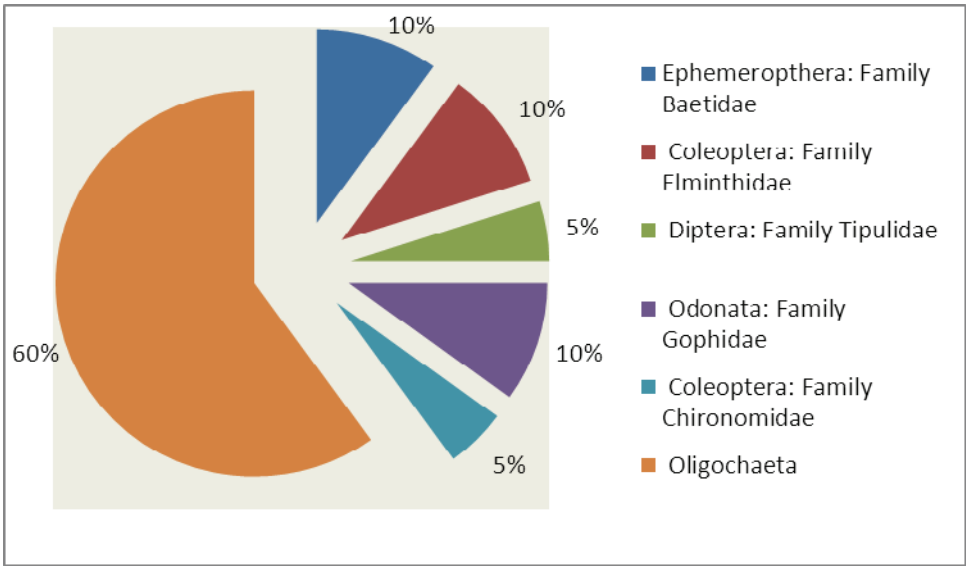

Figure 13. The percentage composition of the invertebrate groups in the Motru Hydrographic Basin.

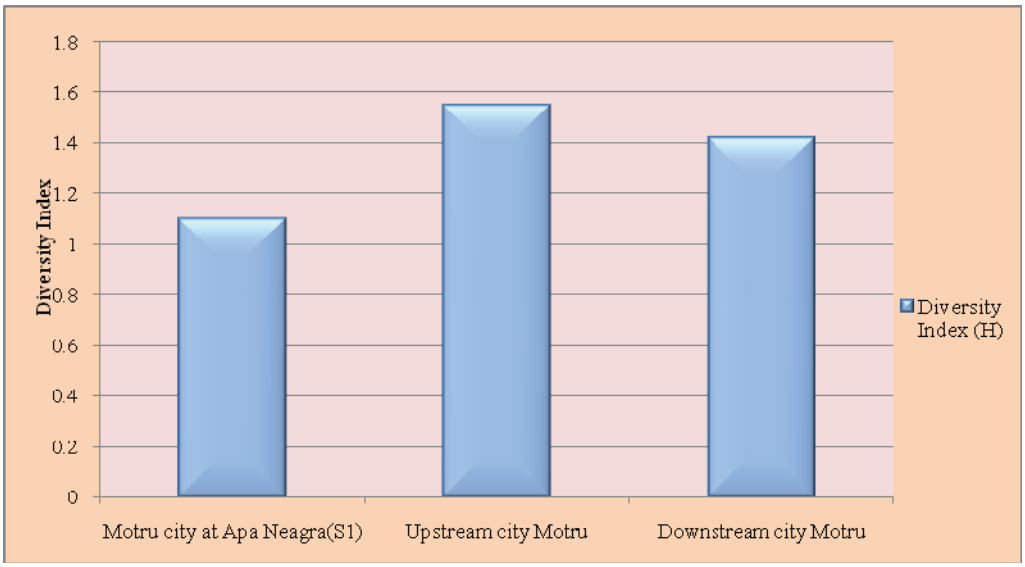

Figure 14. The variation of the Shannon-Wiener diversity index on the course of the Motru River.

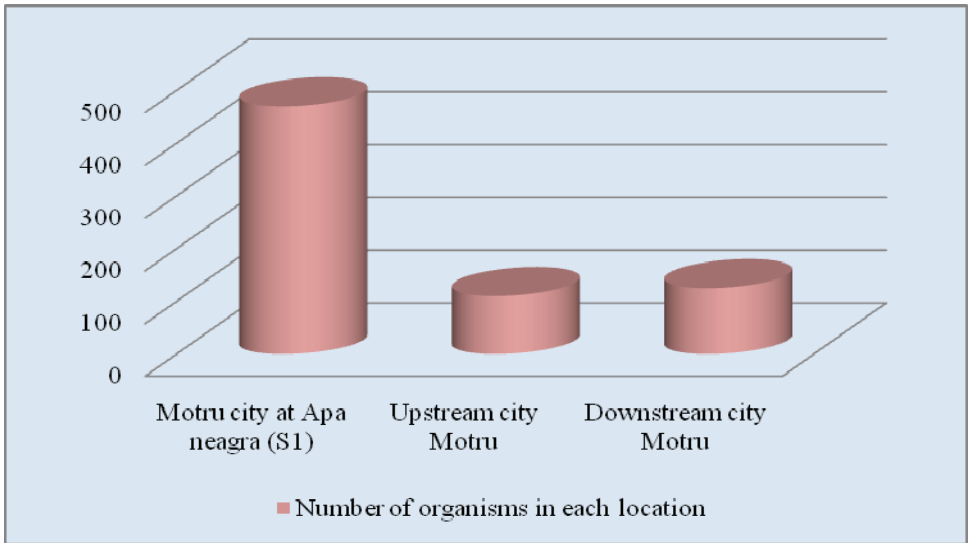

Figure 15. The numerical density of invertebrate populations from sites along the Motru River.

DISCUSSIONS

The modification of the biocoenosis composition entails structural and functional changes of the whole ecosystem leading to a change in its informational content. The dynamic balance that characterizes the integrity of the open systems, like aquatic ecosystems, is achieved through complex mechanisms of self-regulation, which work on the basis of the cybernetic principles of direct and reverse connection (GAVRILESCU, 2007; CIOBOIU et al., 2017; CIOBOIU & CISMAȘIU, 2018; CISMAȘIU et al., 2017).

Also, aquatic organisms have a highest diversity than terrestrial ones, dominating those with a simpler morphophysiological structure, so that the influence of environmental conditions is more strongly felt. These characteristics are particularly important for the biology of polluted basins, as the physicochemical composition of the water and the hydrological and hydrographic conditions of the basins are essential factors in determining the quantitative and qualitative composition of biocoenoses. (PĂTROIESCU et al., 1980; BREZEANU & GRUIȚĂ, 2002).

CONCLUSIONS

Sources of anthropogenic pollution present a special importance and they are the main cause of the contamination of the Motru River (the waters resulting from then household activities of the population, from public institutions and public food, as well as those from the mining units in the area).

The biological indicators analysed at the monitoring station upstream of Motru city show exceedances of the following biological indicators: the Saprobic Index, the Insect Index, the Shannon-Wiener diversity Index, the Number Index of families, the ecological status being good. In the section of the Motru River to Apa Neagră, the biological indicators analysed at the monitoring station upstream of Motru city show exceedances of the following biological indicators: Saprobic index, Insect index, Shannon-Wiener diversity index, Index of the number of families, the ecological status being good. the obtained values falling in the section of S1 and S2 in the first class of quality, and the section of S3 in the second class of quality. From a biological point of view, we highlight the presence of a large number of oligochaetes with less susceptible organisms and indicators of industrial contamination.

In order to achieve an advanced treatment, in order to reach the required level of treatment, it is necessary to expand and rehabilitate the treatment plant in the municipality of Motru.

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