THE INFLUENCE OF HYDROPOWER FACILITIES ON THE ARGEŞ RIVER WATER QUALITY

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Abstract. Having a vast hydrographic system, with a discharge potential and located in a place that has all the forms of relief, the Argeș catchment area is, in the present moment, one of the most complex hydroelectric facility from all the pool rivers in the country. The research was conducted in 2014 on the Argeș River, downstream of Zigoneni, Budeasa and Golești hydroelectric reservoirs (which are among the largest reservoirs of the Arges catchment area). The following physico-chemical parameters were determined: oxygen regime (CO, BOD_5, COD-Cr, COD-Mn), nutrients regime (NH_4, NO_2, NO_3, orthophosphates), general ions (sodium, calcium, magnesium, total iron, total manganese, chlorides, sulfates) placing the water in the 1^{st} and 2^{nd} category of quality. In terms of seasonal variation of the saprobic index of phytoplankton, zooplankton, phytobenthos and macrobenthos there was determined that these sections are included in the β-mezosaprobic zone and in the 2^{nd} class of quality.

Keywords: Argeș river, hydrotechnical reservoir, physico-chemical parameters, biological indices, pollution.

Rezumat. Influența obiectivelor hidroenergetice asupra calităţii apei râului Argeş. Ca urmare a faptului că prezintă un sistem hidrografic vast, cu potențial de revăsare, localizat în toate formele de relief, râul Argeş este în prezent unul dintre cele mai complexe râuri amenajate hidroenergetic. Cercetările au avut loc în 2014 pe râul Argeş, în aval de lacurile de acumulare Zigoneni, Budeasa și Golești (care reprezintă unele dintre cele mai mari lacuri de acumulare de pe râul Argeş). Au fost determinaţi următorii indicatori fizico-chimici: regimul de oxigen (CO, CBO_5, CCO-Cr, CCO-Mn), regimul nutrienților (NH_4, NO_2, NO_3, ortofosfați), ionii generali (sodiu, calciu, magneziu, fier total, mangan, cloruri, sulfaţi), conform cărora apele se încadrează în categoria I și a II-a de calitate. Din punct de vedere al variației sezoniere a indicelui saprob al fitoplanctonului, zooplanctonului, fitobentosului şi macrobentosului s-a stabilit că aceste secțiuni se încadrează în zona β-mezosaprobă și în clasa a II-a de calitate.

Cuvinte cheie: râul Argeș, acumulare hidrotehnică, indici fizico-chimici, indicatori biologici, poluare.

INTRODUCTION

In our country the activity of protection and preservation of the water quality is regulated by a series of laws and regulations, including: The Environmental Protection Law (137/1995) as amended by Law 294/2003; Water Law (107/1996), as amended by Law 310/2004; Law 112/2006 and Law 458/2002 on drinking water quality; Order 161/2006 regarding the approval of the regulations on surface water quality classification in order to determine the ecological status of water courses.

Currently, as a member of the European Union, Romania has to harmonize the water policy with the one at the European level, being important the Framework Directive of the European Parliament and of the Council 2000/60/EC, whose fundamental objective is to conserve the existing healthy ecosystems and to rehabilitate the affected anthropogenic ecosystems of the EU countries until 2015. At the same time, the Directive aims to achieve a "good status" for all water bodies in Europe, so that all citizens enjoy similar living conditions in terms of water (VARDUCA, 2000; PĂTRU et al., 2006).

The main purpose of the construction of dams is to provide water reserves for irrigation, power generation, water supply for cities, etc. The effects of river engineering upon the environment are numerous, profound, both positive and negative. Quantifying these effects is more difficult because most often they occur simultaneously and in their analysis several criteria must be taken into consideration. The main analysed anthropogenic pressures are considered the point sources of pollution (industry, human settlements and agriculture), diffuse sources of pollution, hydromorphological pressures, accidental pollution and gravel pits. These pressures can lead to the change of physico-chemical composition of water, causing also the biocoenoses change (ROȘU, 1980; RĂDOANE & RĂDOANE, 2003; SAVIN, 2001; MITITELU, 2010).

The experts that take into account especially the negative elements of the impact of dams on the environment consider that: the changes done to the environment through the construction and operation of large dams cause irreversible degradation of natural ecosystems; dams have a profound impact on natural biodiversity of the affected areas (GÂȘTESCU & ZĂVOIANU, 2000; BREZEANU et al., 2011); the variability in water level downstream the dams profoundly affect the related biocoenoses; the lack of passages specifically designed for fish migration cause a decrease in fish stocks changing the structure of ichtyofauna; most dams are more vulnerable to eutrophication than the natural water courses.

In recent years, due to the industry development, a series of pollution incidents have produced, a fact reflected by the changed physico-chemical indicators of water from reservoirs. From the point of view of biological and bacteriological properties one can appreciate that they deteriorate in lower areas.

MATERIAL AND METHODS

In this paper, three reservoirs on the upper Arges River were studied. In the Arges catchment area, there are 38 reservoirs from which 7 with complex use, the most important being Vidraru, followed by Zigoneni, Vâlcele, Budeasa, Goleşti, Mihăileşti.

In 2014, we have studied Zigoneni, Budeasa and Goleşti reservoirs (Fig. 1).

Zigoneni reservoir has a total volume of 13.300 million cubic meter; energetic useful volume 8.150 million cubic meter; the reservoir surface 182 ha; the length of the reservoir 3.10 km; the headroom 27.00 m (Fig. 2).

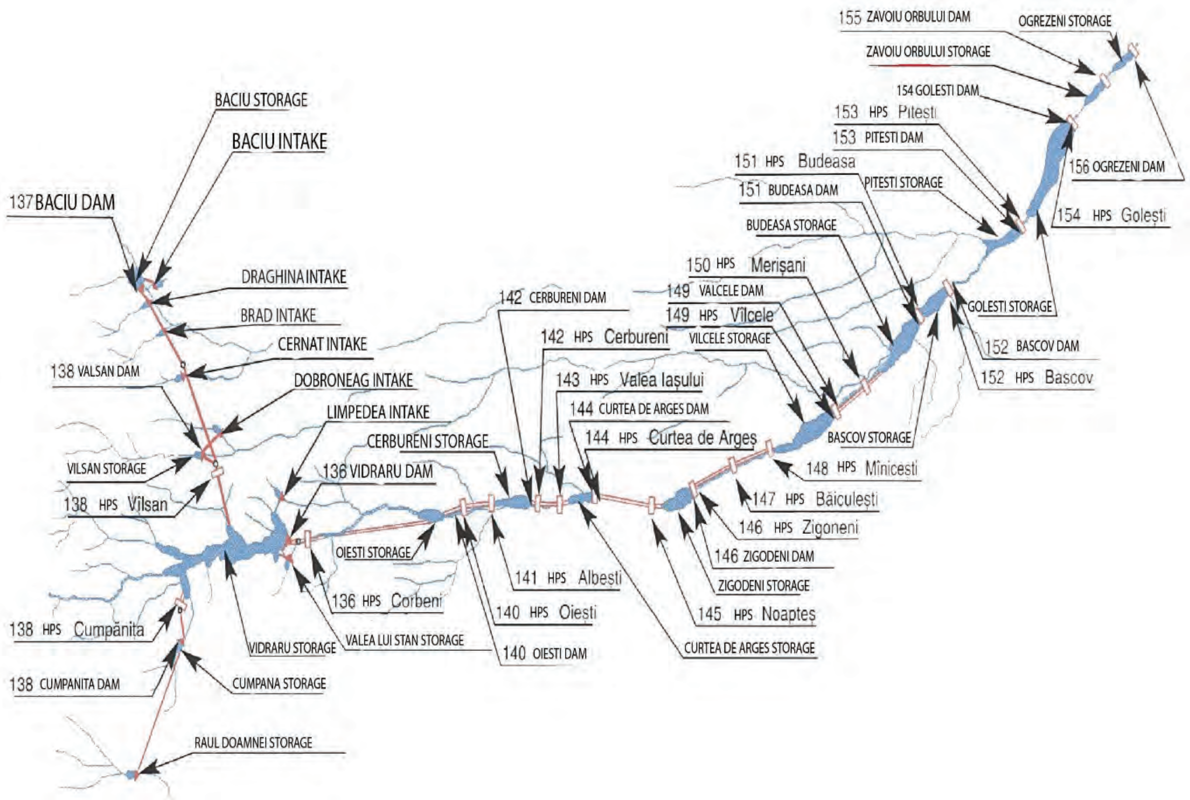

Figure 1. The Equipment Scheme of the Argeş River (MARCU, 2014).

Figure 2. Zigoneni Reservoir (adapted after Google Maps).

Budeasa reservoir has a total volume of 25 cubic KM; the length of the reservoir is 5.5 km, the height of the dam is 33 m (Fig. 3).

Figure 3. Budeasa reservoir (adapted after Google Maps).

Goleşti reservoir is the largest on the Argeş river after Vidraru; it has an area of 646 ha, a total volume at normal retention level of 45 million m^3, a length of 5.15 km and a maximum depth of 16.5 m (Fig. 4).

Figure 4. The Golești Reservoir (adapted after Google Maps).

This paper aimed at highlighting some physico-chemical parameters and structuring the biocoenoses considering the accidental discharge of potentially polluting substances (petroleum) by OMV Petrom, S. C. Arpechim S. A. Pitești, S. C. Conpet S. A., S. C. Automobile Dacia SA units, etc.

To assess the physico-chemical water quality overall, there were calculated the following indicators: the oxygen regime (CO, BOD, COD-Cr, COD-Mn), the nutrients scheme (NH_4, NO_2, NO_3, orthophosphates) the filterable dry residue, general ions (sodium, calcium, magnesium, total iron, total manganese, chlorides, sulfates, hardness). The values obtained were compared with the values stipulated by Order no. 161 of 16 February 2006. The determinations were carried out in accordance with current regulations, using both mobile kits for water sample collection (for current measurements, but also for biological measurements) and accessories for measurements in situ or ex situ (Figs. 5; 6).

Figure 5. Kit for water sample collection equipped with suction-lift pump.

Figure 6. Portable kit for determining the water analysis in situ.

RESULTS AND DISCUSSION

The determination of oxygen regime.

To establish the oxygen regime of water there were analysed spatial and temporal peculiarities of oxygen regime indicators: dissolved oxygen, biochemical oxygen demand and chemical oxygen demand. The evolution of these parameters was observed in the catchment area, in the three studied sectors. The oxidation processes are designed to provide the necessary energy for the biochemical processes, which are vital to the maintenance of aquatic life. The degree of pollution of a river is measured by the oxygen content. A good water quality should be nearly saturated with dissolved oxygen. The microbiological activity leads to a reduction in oxygen content in the presence of these oxidizable materials.

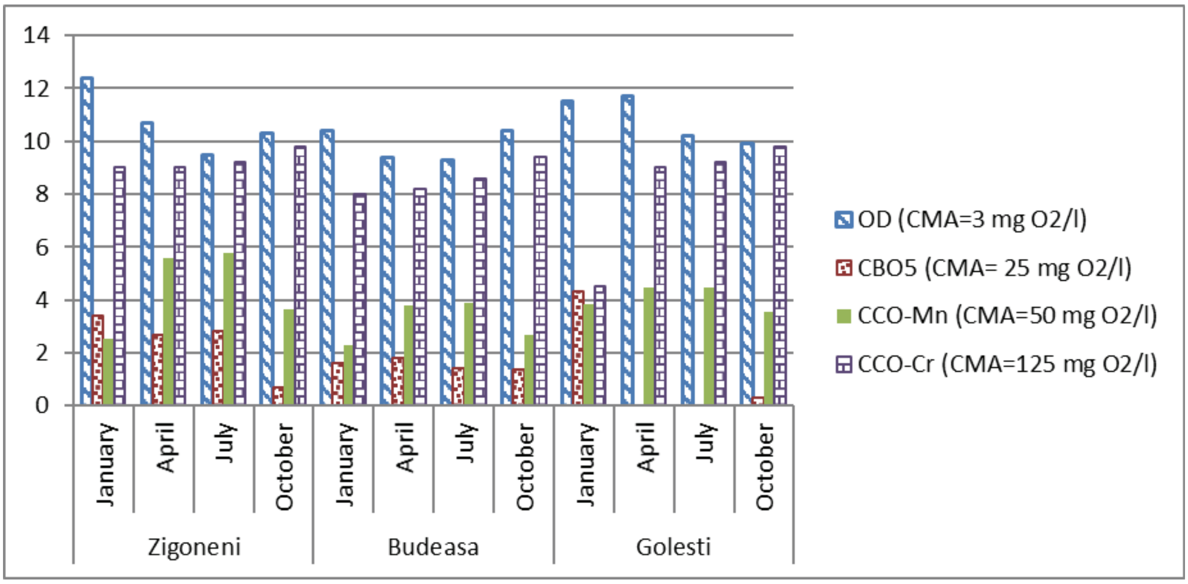

Figure 7. The chemical indicators of the oxygen regime.

The dissolved oxygen is a key indicator in determining water quality. The average amount of dissolved oxygen ranges between 3.9 mg O_2/l at Budeasa and 11.7 mg O_2/l at Golești in April. There are observed higher values during the summer months (Fig. 7).

The biochemical oxygen demand (BOD) (TRUFAŞ & TRUFAŞ, 1975) indicates how much of this gas is necessary for the decomposition of organic material present in the rivers. The performed determinations showed lower values (1.4 mg/l at Budeasa, during summer) and higher than 4 mg/l at Golești during winter, which makes the water be included in the 1st category of quality.

The chemical oxygen demand COD-Mn is the power of permanganate oxidation and corresponds to the amount of oxygen consumed by substances in the water with a reducing role without interfering with the living materials (GÂŞTESCU & RUSU, 1980). The determined values are lower at Budeasa reservoir, regardless of the season, compared to the other two reservoirs, where the average values range between 4.07 and 4.37 mg / l COD-Cr and show similar variations for COD-Mn.

The hardness is the presence of calcium and magnesium cations in water (PIŞOTA & ZAHARIA, 2001, cited by VIŞAN, 2010). We see that in all cases the hardness ranges between 4.7 average value for Budeasa and 6.17 for Zogineni reservoir.

The nutrients or secondary ionic constituents regime.

The minor ions are evidenced by: nitrates, nitrites, ammonia and iron. It can be concluded that on the whole catchment area, there can be distinguished in some way the vertical zoning of ionic constituents the concentration of which increases, in general, from upstream to downstream.

In terms of ammonium, nitrates, nitrites, iron and orthophosphates, they placed the water in the 1st category of quality (NH_4 value does not exceed 0.2 mg N/l; NO_2 records values of 0.104 mg N/l at Golești, exceeding 10 times the maximum limit, MAC = 0.01 mg N/l). Regarding the nitrogen, significant contents were recorded at Budeasa reservoir (1.51 mg N/l) and at Golești reservoir (1.61 mg N/l), which is why those waters were included in the 2nd category of quality (Fig. 8). The orthophosphates show significant values in all the studied reservoirs, the water being included into the second category of water quality. These nitrates and orthophosphates cause a slight increase of eutrophication of the studied waters.

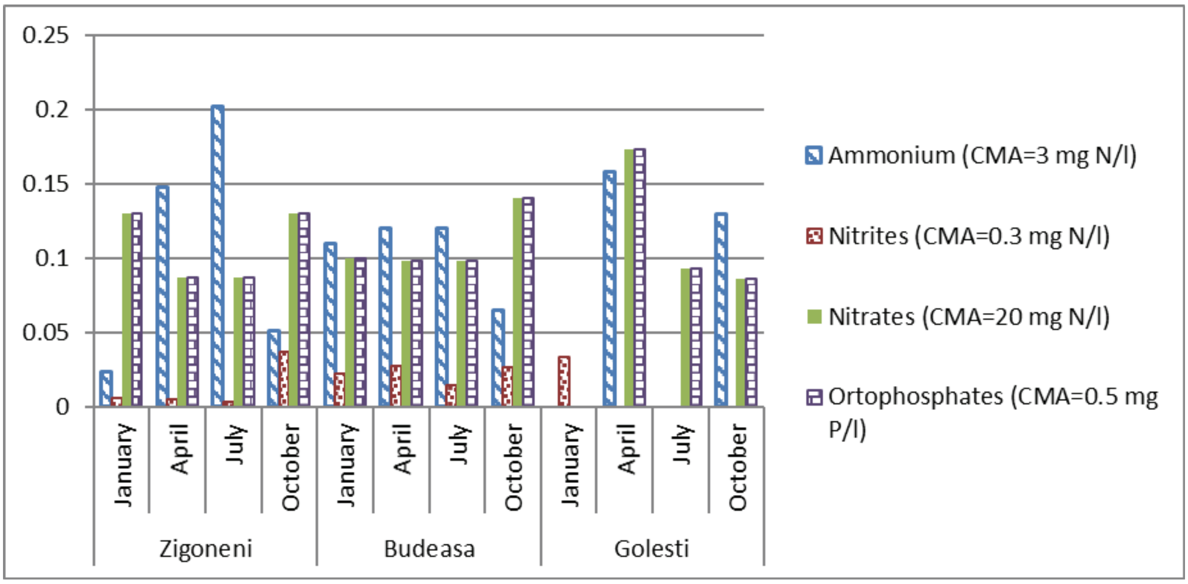

Figure 8. The nutrients content.

The general ionic constituents are represented by calcium cations (Ca^{++}), Magnesium (Mg^{++}), sodium (Na^{+}) and sulfate anions (SO_4-), chlorine (Cl^{-}), which do not exceed the maximum allowable concentration, which include the three studied reservoirs within the 1st quality category (Fig. 9).

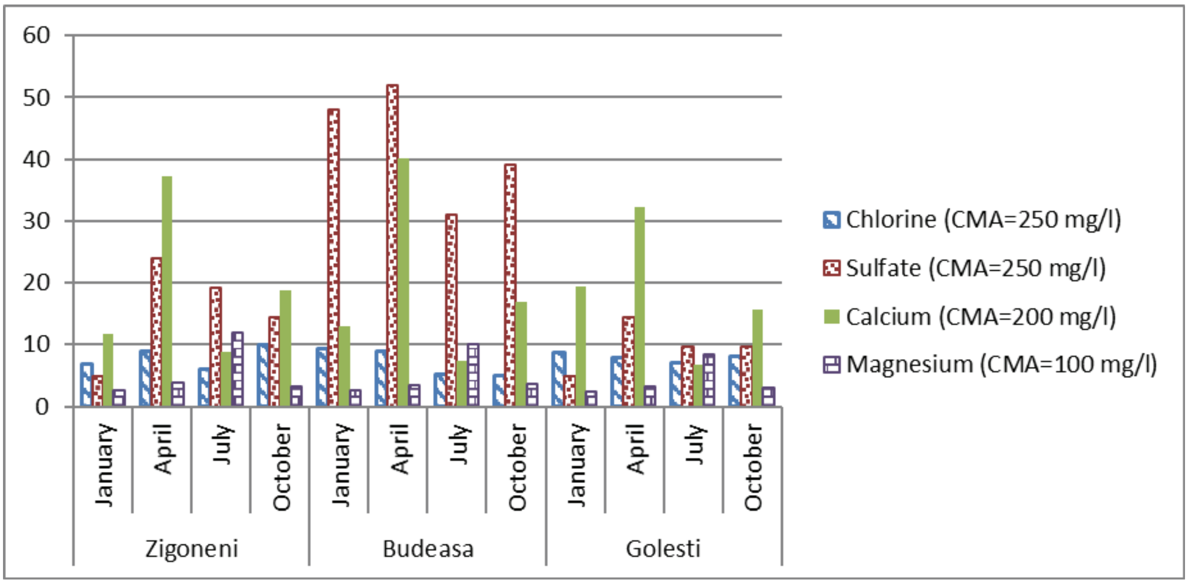

Figure 9. The ions content.

The hardness is the presence of calcium and magnesium cations in the water bodies of the studied catchment area, which determine the hardness degree. In the studied catchment area, the total average water hardness values of the main water ranged between 4.8 and 5 German degrees. These values correspond to waters which may be included into the category of soft (4-8° G), semi-hard (8-12° G) and quite hard (12-18° G) waters (PIŞOTA & ZAHARIA, 2001) (Fig. 10).

The fixed residue is determined by the presence of dissolved mineral salts in the river water. For this parameter the water from the studied reservoirs is included in the 1st category of quality.

The content of Na, Mn ions does not exceed the admitted MAC, the water being included in the 1st category of quality (Fig. 10).

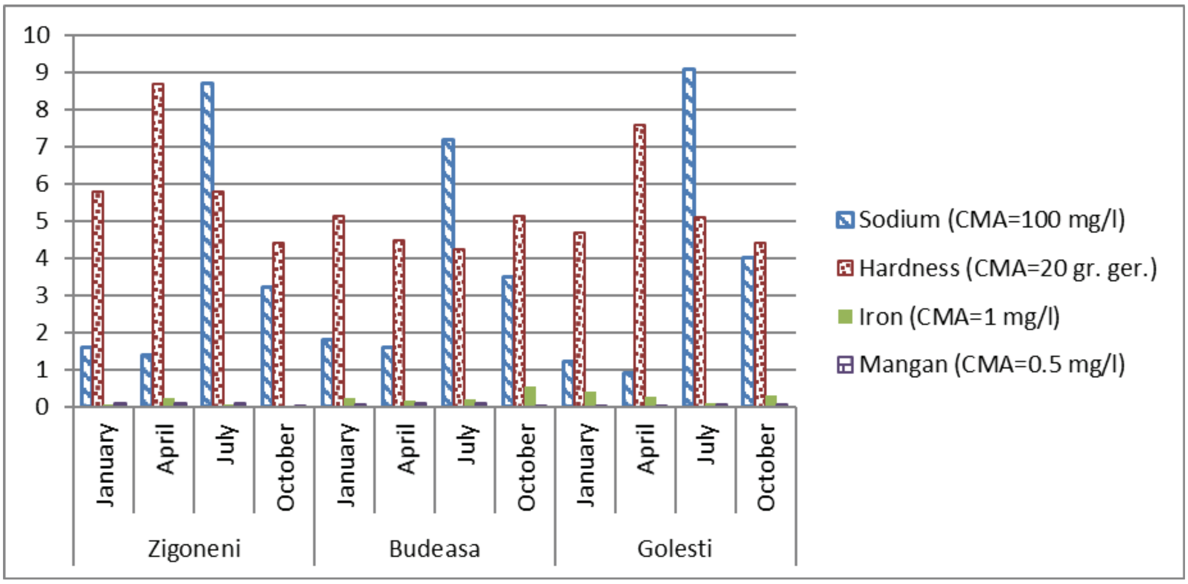

Figure 10. The ions content.

In the period 2010-2013, there occurred phenomena which generated emergencies (floods, accidental pollution, drought). The highlighting of the specific biological peculiarities was made in 2014 by studying the main water and biotic communities. This study was conducted as a result of pollution in 2013 due to the discharge of petroleum products (fuel oil) from OMV Petrom and S. C. Arpechim S. A., a situation solved quickly. In 2014, samples were taken seasonally from the representative sections for the evolution of such phenomena from an aquatic ecosystem: from the upstream dam (Zigoneni, Budeasa, Golești). The samples were collected from the surface horizon.

From the point of view of ecological status, the studied waters are characterized by a very good status in the upper sectors of the Argeș River and satisfactory in the lower sector, in the south-east area of Pitești. The variation of the saprobic index of the phytoplankton shows higher values at Golești (<2.5) compared with Budeasa, where it recorded > 1.87 (Fig. 11).

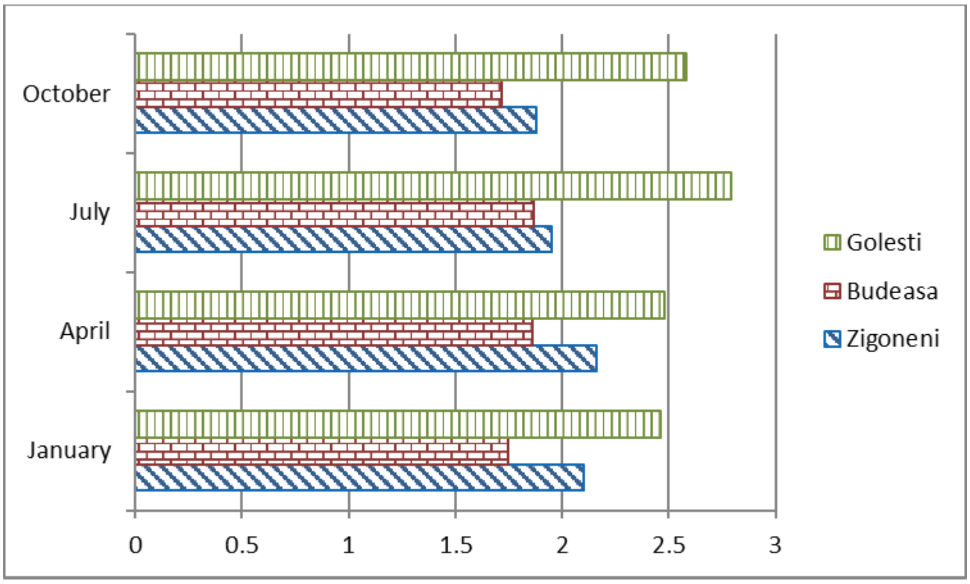

Figure 11. The seasonal variation of the saprobic index of phytoplankton.

The saprobic index of zooplankton shows the same trend at Golești (<2.5) and decreasing at Zigoneni (> 1.83) and Budeasa (> 1.16) (Fig. 12).

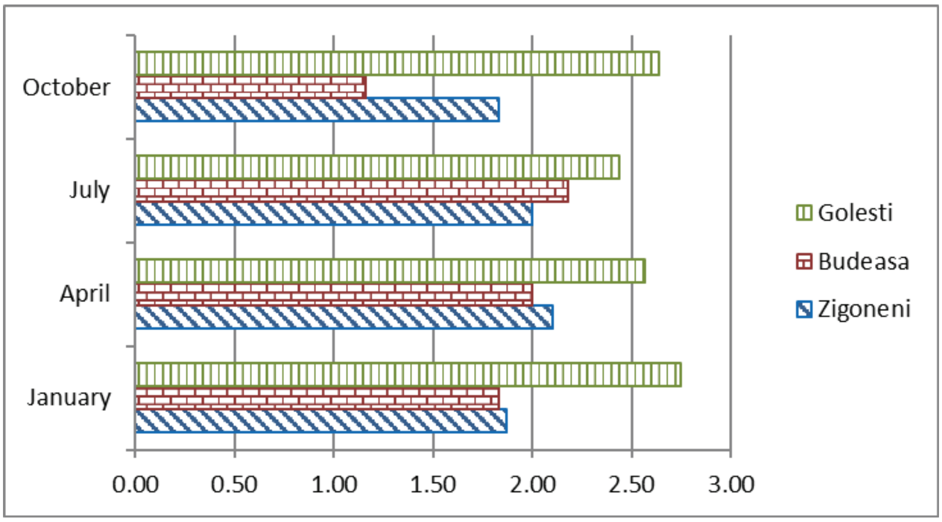

Figure 12. The seasonal variation of the saprobic index of zooplankton.

The saprobic index of phytobenthos exceeds 2.3 at Golești and it is below 2 at Zigoneni and Budeasa (Fig. 13).

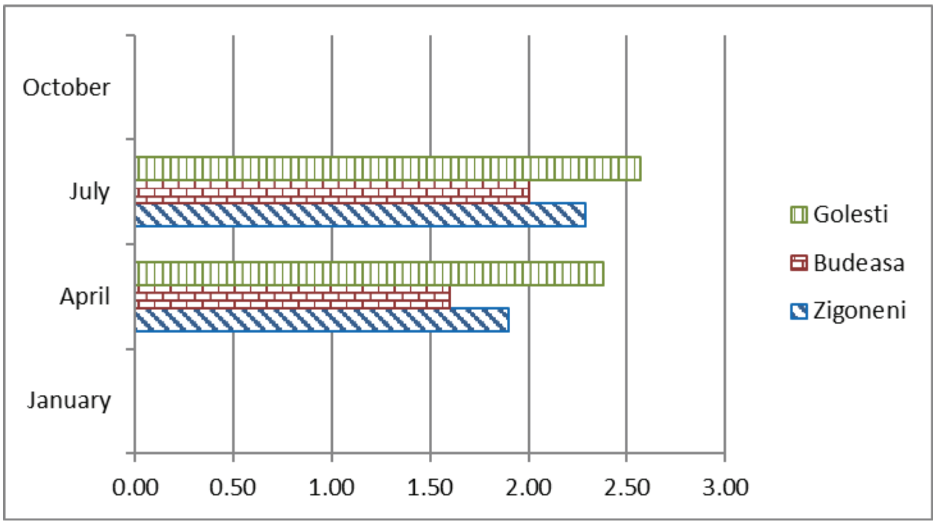

Figure 13. The seasonal variation of the saprobic index of phytobenthos.

The saprobic index of macrobenthos exceeds 3.1 at Golești and the lowest values were recorded at Budeasa (1.67) (Fig. 14).

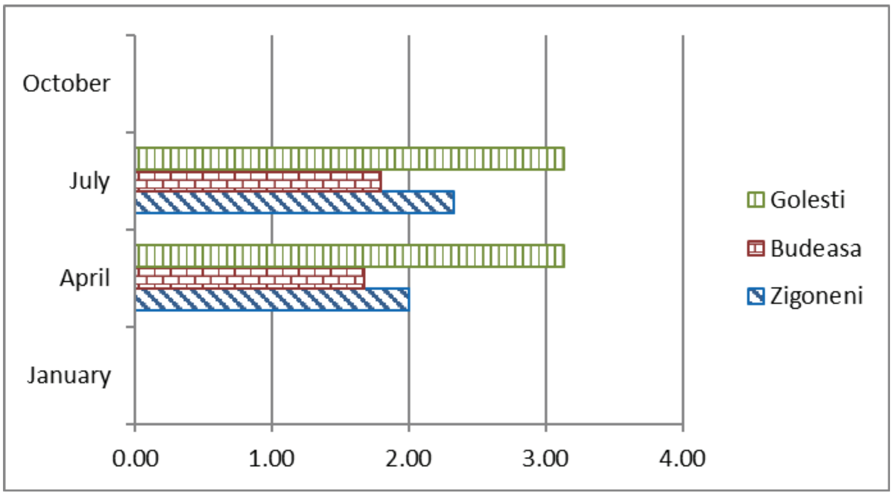

Figure 14. The seasonal variation of the saprobic index of macrobenthos.

Regarding the quality of water reservoirs in the county, the expertise shows that most of them were included within the limits of the 1st quality category with a trophic degree characteristic to oligo-mesotrophic types.

In terms of biological and bacteriological perspective, the degree of relative cleanliness shows that the water from the majority of the Argeș catchment area reservoirs is included in the area of β-saprobe from the saprobity viewpoint, a water of good quality (ZĂVOIANU, 1999; VARDUCA, 2000).

CONCLUSIONS

By their particular importance in the context of current concerns of the environmental policies, the water resources deserve attention and interest in the scientific research.

The studies conducted on the 3 reservoirs of the Arges river lead to the appreciation of the fact that there are no significant pollution sources today.

The water by the determined physico-chemical and biological values is included in the 1st and 2nd category of quality (with exceedings for the nitrates and orthophosphates).

The continuous monitoring and increasingly severe measures will increase the level of civic consciousness of the population, which is reflected in the reduction of anthropogenic pollution risk.

The reconsideration of the water quality in human communities will restore the biotopes and biocoenoses and the development of relations between macrophyte coenoses and other compartments: the biotic and zooplankton, with beneficial effects for the whole ecosystem.

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