

GEOCHEMICAL EVALUATION OF QUALITY INDICATORS FOR THE WATER OF THE TANSA LAKE FROM THE JIJIA CATCHMENT, ROMANIA

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Abstract: The most important water quality indicators for the Tansa Lake, namely dissolved oxygen (DO), chemical oxygen demand (COD_{Cr}), biochemical oxygen demand (BOD₅), ammonia, nitrites, nitrates, total nitrogen, orthophosphate, total phosphorus, chlorophyll “a”, fixed residue, total suspended matter, chloride, sulphate, calcium, magnesium and detergents were analysed in order to achieve a geochemical evaluation and classification of water quality. The alkaline character of the water from the Tansa Lake was given by the pH values that ranged from 8.3 to 8.6, these being measured in the *middle lake* section in May, August and November 2010. Trace elements, namely Cd, Cr, Cu, Ni, Pb and Zn were analysed using Atomic Absorption Spectroscopy (AAS). The mean values of these do not exceed the limits of the 1st quality class of the water (Cd - 0.3 µg/L, Cr - 20 µg/L, Cu - 18 µg/L, Ni - 9.5 µg/L, Pb - 3.3 µg/L, Zn - 76 µg/L). In agreement with the current Romanian legislation and the Water Framework Directive - 60/2000/EC, the water quality classes were established. The overall water quality of the Tansa Lake fits into the 2nd quality class. This means that the water can be considered as being in a “good state”, but not suitable for drinking purpose. The Tansa Lake belongs to the hypertrophic lake category, in accordance with the analysis of the trophicity degree (total nitrogen - N, 1.11 to 1.23 mg N/L; total phosphorus – P, 0.05 to 0.21 mg P/L and chlorophyll "a", 8 to 36 µg/L).

Keyword: Jijia catchment, quality classes, Tansa Lake, trace elements, water quality indicators.

1. INTRODUCTION

Water and life are intricately linked. Water makes up about 70 percent of our bodies. More than half of the world's species of plants and animals live in water, and even our terrestrial derived food is totally dependent on and often largely composed of water. Civilizations have flourished and collapsed as a result of changing water supplies (Ball, 1999).

A water reservoir is an enclosed area for the storage of water to be used at a later date; it can also serve to catch floods, to protect valleys downstream of it; to establish an aquatic environment; or to change the properties of the water (Votruba & Broza, 1989).

In the literature, there are similar studies dealing with the geochemical evaluation of water quality indicators, carried on different water bodies by Simeonova et al., (2003), Karafistan & Colakoglu, (2005), Bucureșteanu et al., (2008), Marin et al.,

(2010), and Grigoraș & Dobnikar, (2010). Also, recent studies regarding the water quality from lakes or river systems in Eastern Europe have been carried out by Albulescu et al., (2010), Dughilă et al., (2010), Dragicevici et al., (2010), Szilassi et al., (2010), Benchea et al., (2011), Dăscăliță (2011), Ghervase et al., (2011) and Milanovici et al., (2011).

The present paper presents some of the results from the 2010 surveys, which allowed the assessment of water quality for the Tansa Lake. In this context, the water from the Tansa Lake could be placed within a specific quality class so as to determine its suitability for its main purpose: drinking water supply. The global study was carried out for a total of six storage lakes from the Jijia catchment, on water and sediment samples, in order to obtain a database which will be used as a reference point for the framing of the hydrogeochemical characteristics of the investigated lakes within the waters from the catchment.

2. GENERAL ASPECTS

2.1. Study area

The Tansa dam (Fig. 1), is a relatively small artificial lake located in the NE of Romania, in the Jijia catchment. The lake is a multi-purpose reservoir, being used as a drinking water supply for the Belcești village, an irrigation source for the farms in the area, a means of protection against floods, and for pisciculture. As a result, it can suffer large drawdowns in late summer and during drought years, which greatly affects the ecological balance of the water. Agricultural wastes, fertilizers, raw sewage effluents and road runoff constitute the predominant anthropogenic sources in the area.

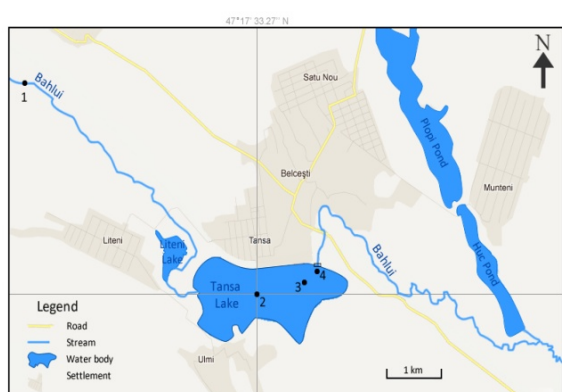


Figure 1. Location of Tansa Lake, with sampling points: 1–River, 2–middle lake, 3–upstream dam, 4–dam outtake

Every water reservoir is principally the reflection of the respective catchment area. If in the catchment area soil management, agricultural activities and the settlement of the inhabitants are properly regulated, then the conditions of the reservoir, water quality and required service life of the reservoir are also favourable (Votruba & Broza, 1989).

Table 1. Basic features of the Tansa Lake

Features	Tansa Lake
Coordinates	47° 17' 24' 35 N
Lake area (km ²)	3,52
Average depth (m)	3
Maximum depth (m)	7
Water quality (2004—2006) (2007—2010)	eutrophy hypertrophy
Elevation (m a.s.l.)	79
Jijia catchment area (km ²)	5.757

The Tansa dam was built on the Bahlui River, having become operational in 1975, with an area of 3.52 km² and a volume of 10 mil. m³. The depth of the lake varies between 6 and 7 m. Some basic features of the Tansa Lake are presented in Table 1.

2.2. Geological setting

From a geological point of view, the region of the Jijia catchment (Fig. 2) falls within the Moldavian Platform, the oldest platform, dating from the Middle Proterozoic, located in front of the Oriental Carpathians, overlapping the Hilly Plain of Moldova.

The Tansa Lake sedimentary blanket is composed of a layer of brown and grey clay 2.90 to 4.00 m thick, underlain by Sarmatian deposits consisting of alternating marls and fine sands located at a 6–8° angle in relation to the cuvette (Belecciu & Cazan, 1978).

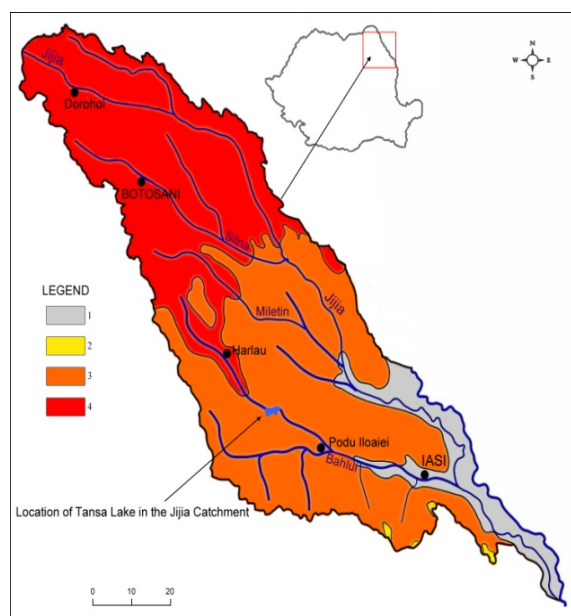


Figure 2. Geological map of Jijia Catchment (modified after Ionesi et al., 2005) 1. Quaternary; 2. Chersonian; 3. Basarabian; 4. Buglovan + Volhynian

The alluvial deposits of the floodplain, from which the dam was built, consist of an alternation of grey and yellowish-brown clays, with horizons of fossil soils and thin intercalations of stratiform and lenticular clayey powders, sandy powders and clayey sandy powders (Belecciu & Cazan, 1978). Drillings have revealed the groundwater level at a depth of about 4.00 m in the area downstream the lake and about 6.00 m in the area upstream, being influenced by the water level from the Bahlui riverbed. The floodplain is crossed by the minor riverbed (main course), meandered of the Bahlui River.

3. SAMPLES AND ANALYTICAL METHODS

3.1. Sampling stage and sample preparation

For the hydrogeochemical characterization of the Tansa dam, water samples were collected from

three sections across the lake: *dam outtake*, *middle lake*, *upstream dam*, along with a sample from the river that feeds the lake, namely the *Bahlui River*. The four sampling stations were selected in such a way as to provide a good local representation for each section.

The samples were collected during the year 2010, in February, May (only for nutrients), August and November, using a small motor boat for the *middle lake* and *upstream dam* sections, in the summer-autumn months; and when the weather did not allow access by boat, from the shore, in areas representative for the sections in question.

An open vessel was used as sampling equipment, allowing the filling of a 2000 mL polyethylene bottle, which had previously been rinsed with lake water. The water collection point was located at a depth of 10-15 cm, the container being completely full as to avoid further oxidative processes that can occur at the water-air interface. After sampling, the bottles were kept cold using ice packs in order to preserve them during transportation to the laboratory, where they were stored at low temperatures until analysis.

3.2. Analytical methods

For the determination of the targeted indicators, standardized methods* of analysis were used: for pH value - SR ISO 10523/2009; for dissolved oxygen - SR EN 25814/ISO 5814/1999; for biochemical oxygen demand - SR EN 1899-2/2002; for chemical oxygen demand - SR ISO 6060/1996; for fixed residue - STAS 9187/84; for suspended solids - SR EN 872/2005; for ammonium - SR ISO 7150-1/2001; for nitrite - SR ISO 6777:1996/A99:2002; for nitrate - SR ISO 7890-1/1998; for phosphorus - SR EN ISO 6878/2005; for calcium - STAS 3662-90; for magnesium - STAS 6674-77; for sulfate - EPA 9038/1986; for anionic surface agents - SR EN 903/2003; for chlorophyll "a" - SR ISO 10260/1996; for chloride - SR ISO 9297/2001.

The quantitative determination of certain pollution indicators (Ammonium, Nitrites, Nitrates, Phosphates, Sulphates) was carried out through spectrometry, using a spectrometer (UV 2-100, ATI UNICAM, measuring range: 190–1100 nm - visible spectrum), according to the methodology described by Mănescu et al., 1978.

For the determination of trace elements, lake

water samples were digested using a Berghof MWS-2-type microwave digestion oven. Concentrated nitric acid (5 ml, 65 % Merck Suprapur) was added to 25 ml of water sample in a digestion vessel; the mixture was allowed to react for 20 minutes, after which the vessel was closed and heated in the microwave oven using the following steps: Step 1: 160 °C for 5 min at 80 % power, Step 2: 200 °C for 5 min at 80 % power, and, finally, Step 3: 100 °C for 10 min at 80 % power.

The element levels in the digests were determined by means of a Shimadzu 6300 Atomic Absorption Spectrometer, equipped with an ASC-6100-type auto sampler (60 samples), used on flame analyses for Cu²⁺, Zn²⁺, and an GBC Avanta Atomic Absorption Spectrometer provided with a GBC-PAL-3000-type auto sampler (49 samples) used for graphite furnace analyses: Cd²⁺, total Cr, Ni²⁺, Pb²⁺.

All the measurements for water quality indicators, as well as the analyses for trace elements through atomic absorption spectrometry (AAS), were carried out in the *Chemical Laboratory* of the "Romanian Waters" National Administration – Prut-Bârlad Water Branch, Iași.

4. RESULTS AND DISCUSSIONS

Water quality was monitored by interpreting the physico-chemical results obtained on the samples collected during the February, May, August and November 2010 surveys. The assessment of the ecological and chemical status of the water, as well as the classification of the monitored sections based on their quality classes (Table 2), was carried out in agreement with the current Romanian legislation (Order no. 161/16.02.2006 of the Romanian Ministry of Environment and Forests - *Normative regarding the classification of surface waters in order to establish the ecological status of water bodies*), which stipulates 6 categories of parameters:

1. Thermal and acidification regime (2 parameters);
2. Oxygen regime (5 parameters);
3. Nutrients (9 parameters);
4. Salinity (7 parameters);
5. Specific toxic pollutants with natural origin (13 parameters);
6. Other relevant chemical indicators (3 parameters).

The general principle of water framing, corresponding to the ecological status for the Tansa Lake, was applied to these six groups of indicators by evaluating the weighted effect of all the indicators, based on the arithmetic mean. The global quality characterization, at section level, is the result of the evaluation carried out on the group with the most unfavourable situation.

* SR EN represents the Romanian version of the English text of the European standards, and SR ISO is label for translated ISO methods. STAS is a Romanian standard whose application is mandatory by law, in general, or by a exclusive reference from a regulation. EPA 9038 is an international method for sulfate determination, in all water types, elaborated by the US Environmental Protection Agency.

Table 2. Water quality classification according to *Order no. 161/2006*

Class	Characteristics
I	Very good
II	Good
III	Moderately
IV	Bad
V	Very bad

Physical, chemical, and biological processes control the chemistry and chemical evolution of water in natural and contaminated systems. Advances in our ability to quantify these processes will improve the ability to manage water resources, help us identify potential sources of contamination, and find potential solutions to water-quality problems (Zhu & Schwartz, 2011).

4.1. Acidification regime

• *pH* values highlight the acidic or alkaline character for waters. In order to establish the qualitative status of water bodies, according to the *Normative regarding surface water quality classification*, the *pH* has to be between 6.5 and 8.5 (*Order no. 161/2006*).

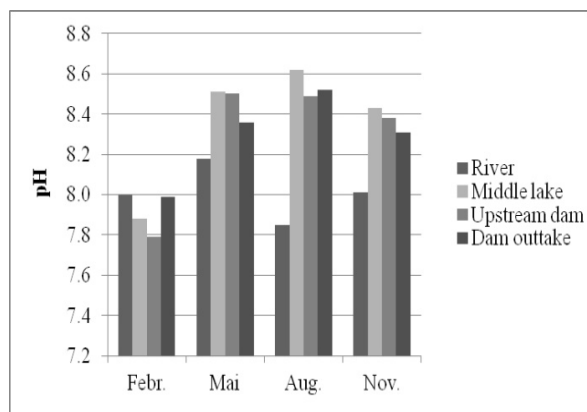


Figure 3. *pH* values in the monitored sections of the Tansa Lake

The analyses performed for this parameter are illustrated in figure 3, and it becomes obvious that the values obtained do not fit entirely within the quality categories. The alkaline character of the water from the Tansa Lake is given by high *pH* values recorded in May, August and November, with a maximum *pH* value of 8.6, recorded in August for the *middle lake* section.

4.2. Oxygen regime

• *Dissolved oxygen* (DO) plays an important role in the development of plant and animal associations, representing one of the most important gases dissolved in lakes water and a key indicator in

assessing the water quality of lakes and rivers.

Changes in the DO concentration are dependent on water temperature, the turbidity level of the liquid flow volume, the presence or absence of aquatic vegetation etc.

Throughout the year, there is a strong (opposite) dependence between the average variation of the oxygen content and the air temperature. The highest oxygen content is recorded during the cold period, due to the fact that low temperatures reduce oxidation and favour the dissolution of oxygen from the air into the water.

The lowest oxygen content is recorded during the warm period, when high temperatures have a negative effect on its solubility, favouring the growth of bacteria, large consumers of oxygen.

The discharge of wastewater, untreated or insufficiently treated, can reduce the dissolved oxygen content, up to its total depletion (Zaharia, 1999).

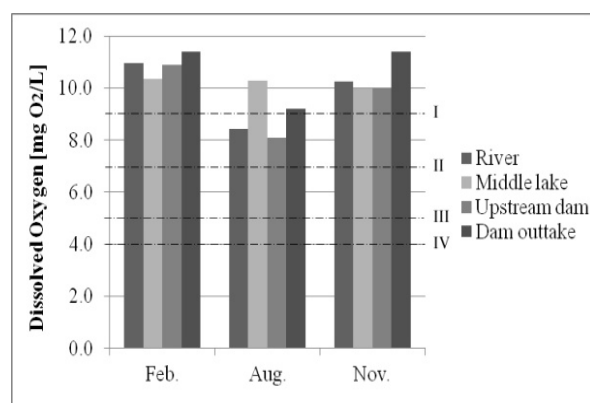


Figure 4. Dissolved oxygen values in the monitored sections of the Tansa Lake

The DO content in the Tansa Lake varied between 11.4 mg O₂/L in February and 8.1 mg O₂/L in August, with an average value of 10.2 mg O₂/L for the three monitored sections across the lake. In terms of water quality for this indicator, the lake falls within the 1st quality class (Fig. 4).

• The *biochemical oxygen demand* (BOD₅) in the Tansa Lake (determined using the standard of five days and 20 °C), varied between 4.4 mg O₂/L in February and 9.5 mg O₂/L in August, with a mean value of 7.1 mg O₂/L, framing the water quality within the 4th class. BOD₅ is an important chemical parameter in the assessment of water quality (Fig. 5).

The poor chemical status of the Tansa Lake is dictated by the discharge of insufficiently treated wastewater into the Bahlui River, as well as the use of nitrogen-containing chemical fertilizers that were widely used prior to 1990, leading to the appearance of high values of biochemical oxygen demand as a result of their infiltration into the groundwater and

then along the river and into the lake.

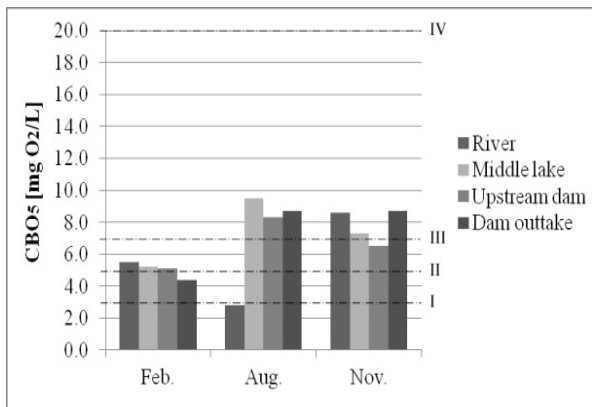


Figure 5. Biochemical oxygen demand values in the monitored sections of the Tansa Lake

- *Chemical oxygen demand* (determined as *COD-Cr*) is an important parameter in water analysis; its determination provides information on water pollution with organic matter.

All values recorded during the 2010 surveys in the lake monitoring sections have an average of 27 mg O₂/L and, therefore, place the Tansa Lake in the 3rd quality class. The *river* section has an average value of 30 mg O₂/L (Fig. 6).

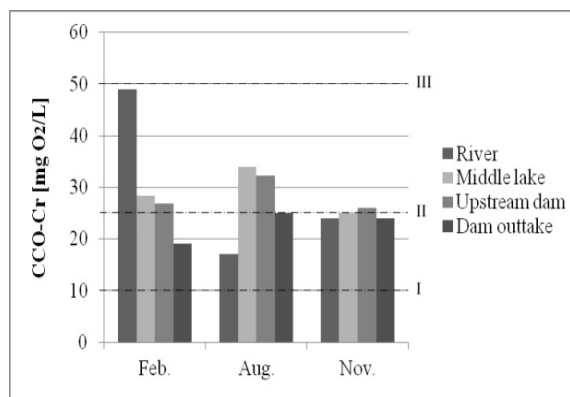


Figure 6. Chemical oxygen demand values in the monitored sections of the Tansa Lake

4.3. Nutrient regime

The nutrients most responsible for water quality degradation via eutrophication are nitrogen and phosphorus. They are found in the aquatic environment as dissolved inorganic or organic forms and are the most limiting factors for phytoplankton growth (Karafistan & Colakoglu, 2005).

- *Ammonium* ($N-NH_4^+$), the ionized form of ammonia gas, is insoluble in water and is found in natural surface waters and groundwater's. NH_4^+ occurs in lake water as a result of the decomposition of organic wastes and the use of chemical fertilizers in agriculture.

The ammonium values for the Tansa Lake (Fig. 7) vary between 0.1 mg N/L and 1 mg N/L (in February), with an average of 0.03 mg N/L, placing the lake in the 1st quality class. For the *Bahlui River*, values range from 0.1 mg N/L to 0.8 mg N/L, with an average of 0.4 mg N/L (Fig. 7).

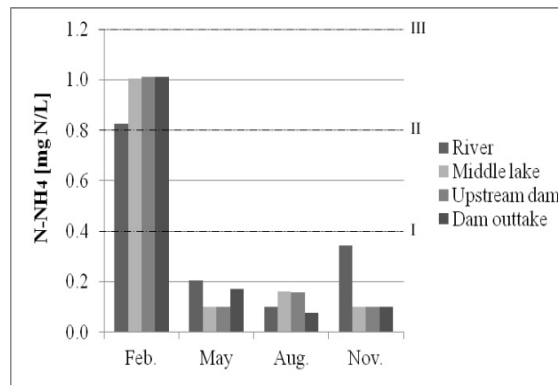


Figure 7. Ammonium values in the monitored sections of the Tansa Lake

- *Nitrite* ($N-NO_2$) is an intermediate product obtained through the oxidation at microbial level of ammonia, or as a result of bacterial nitrate-reduction processes.

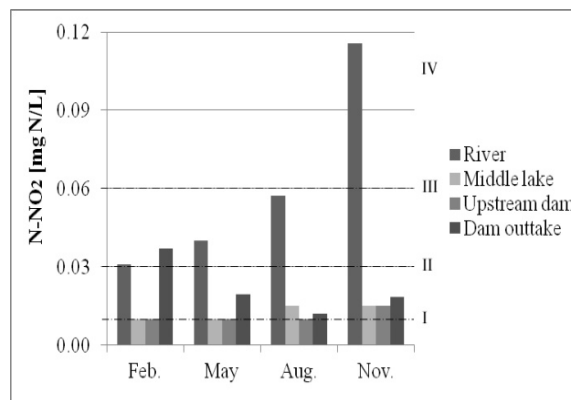


Figure 8. Nitrite values in the monitored sections of the Tansa Lake

The average content of nitrites (below 0.03 mg N/L) in the Tansa water allows its framing within the 2nd quality class. However, as regards the measurements for the *Bahlui River*, they justify a downgrade in quality (Fig. 8), down to the 4th quality class (below 0.3 mg N/L), because of contamination sources located upstream of the dam, namely SC Cotnari SA and the city of Hârlău, dischargers of insufficiently treated wastewater into the Bahlui River.

- *Nitrate* ($N-NO_3$) occurs in the water of the Bahlui River as a result of the decomposition of organic wastes. The main source lies in the use of nitrogen fertilizers in agriculture and the discharge of wastewater from commercial companies or from wastewater treatment plants.

The nitrate content recorded throughout 2010 for the Tansa Lake reveals a growth during the winter period (due to a lower rate of organic decomposition), and a decrease during the warm period (due to intensified biogenic processes) (Fig. 9). However, this natural evolution is conditioned by water drainage systems, including anthropogenic activity.

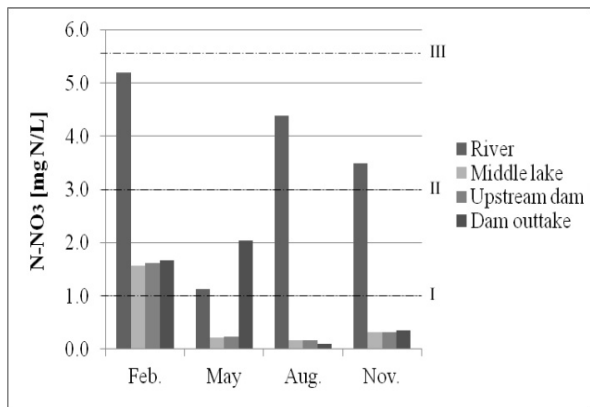


Figure 9. Nitrate values in the monitored sections of the Tansa Lake

The mean values recorded for this parameter (0.7 mg N/L) place the lake water in the 1st quality class. For the *River* section, the levels remain high throughout the year (as a result of the use of nitrogen fertilizers in agriculture and the discharge of wastewater from commercial companies and from wastewater treatment plants), falling within the 3rd quality class.

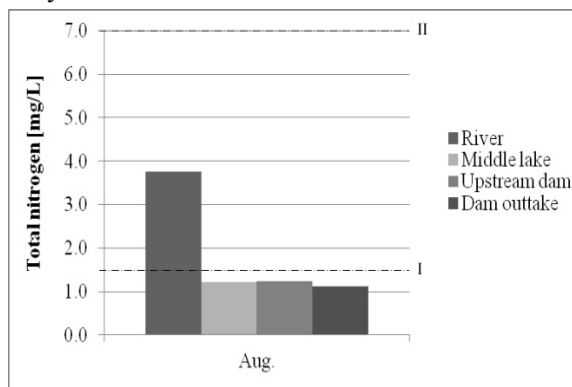


Figure 10. Total nitrogen values in the monitored sections of the Tansa Lake

- *Total nitrogen (N)* varies between 1.11 mg N/L and 1.23 mg N/L, the average value – 1.19 mg N/L – placing the water from the Tansa Lake in the 1st quality class, but, in terms of trophicity, in the eutrophic lake category (Fig. 10).

"Eutrophic" waters are characterized by high nutrient concentrations, resulting in high productivity of plant growth. Such waters are often shallow, with algal blooms and periods of oxygen deficiency. Slightly or moderately eutrophic water can support a complex web of plant and animal life.

However, such waters are generally undesirable for drinking and other needs.

- *Orthophosphate (P-PO₄³⁻)*, sometimes referred to as "reactive phosphorus," is the most stable kind of phosphate, and is the form used by plants. Orthophosphate is produced through natural processes and is found in sewage. Under normal conditions, in aquatic environments, phosphates are present in very small quantities (below 0.1 ppm).

Because of the very large variation in composition of flowing water, and depending on the formations crossed over the river, increased levels of natural input may occur, but they are quickly consumed by phytoplankton. In algal cells, phosphates are concentrated several times and then transferred as organic compounds into the animals that feed on phytoplankton.

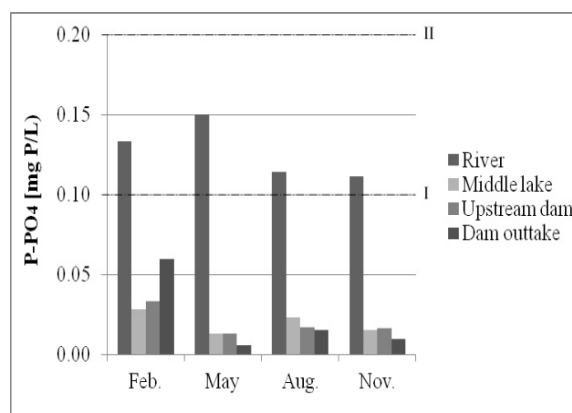


Figure 11. Orthophosphate values in the monitored sections of the Tansa Lake

The values determined for this indicator allow the placement of the Tansa Lake water in the 1st quality class (Fig. 11). The average value in the *River* section is 0.13 mg P/L, making the latter suitable for the 2nd quality class.

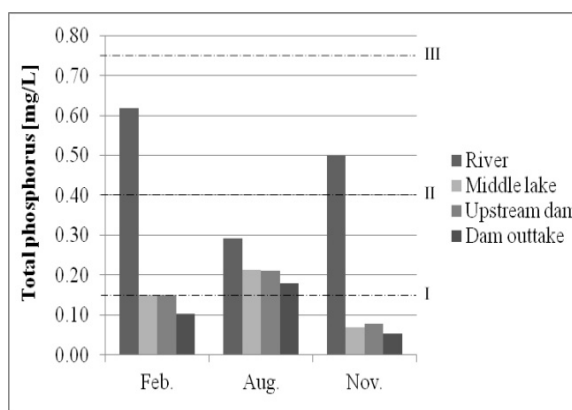


Figure 12. Total phosphorus values in the monitored sections of the Tansa Lake

- *Total phosphorus (P)* ranges from 0.05 mg P/L to 0.21 mg P/L, with a mean value of 0.13 mg P/L, placing the water of the Tansa Lake in the 1st

quality class, but in terms of trophicity, in the category of hypertrophic lake (Fig. 12).

- *Chlorophyll "a"* is the essential photosynthetic pigment of green algae. The chlorophyll "a" content of a water body is an indicator of its trophic status.

The determination of chlorophyll "a" provides information regarding the biomass and the potential photosynthetic activity of the algae. Chlorophyll "a" ranges from 8 µg/L to 36 µg/L, with a mean value of 25 µg/L, placing the water of the Tansa Lake in the 1st quality class, but in terms of trophicity, in the category of eutrophic lake (Fig. 13).

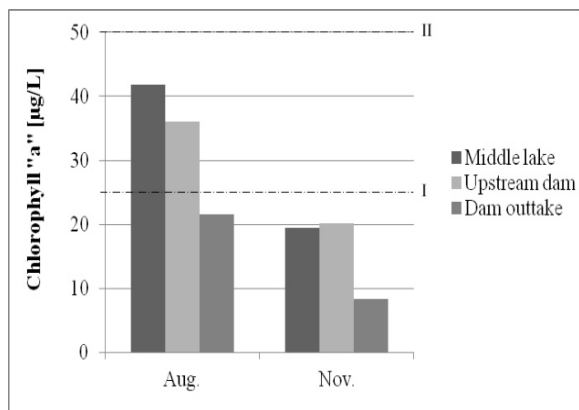


Figure 13. Chlorophyll "a" values in the monitored sections of the Tansa Lake

4.4. Salinity

Salinity indices indicate water mineralization, i.e. the concentrations of Ca^{2+} , Mg^{2+} , Cl^- and SO_4^{2-} , and their source lies in natural alteration processes (Bucureşteanu et al., 2008).

- *Fixed residue.* The temporal variation of fixed residue is closely linked to climatic factors (particularly rainfall and air temperature), which determine the type of supply source, and the lithological characteristics of the catchment. The influence of wastewater discharged into rivers, as well as the harvest time (usually in the summer), should not be neglected, either. The values for this indicator allow the placement of the water from the Tansa Lake (with a fixed residue under 500 mg/L) within the category of medium mineralization. The *River* section, however, must be placed in the category of high mineralization (with a fixed residue value above 750 mg/L). In terms of water quality, the water from the Tansa Lake fits in the 1st quality class (Fig. 14).

- *Total suspended matter (TSM)* contents for the *Bahlui River* (with values between 181 and 254 mg/L) are high, compared to the values registered within the three sections of the Tansa Lake (9 - 57 mg/L, with an average of 30 mg/L) (Fig. 15).

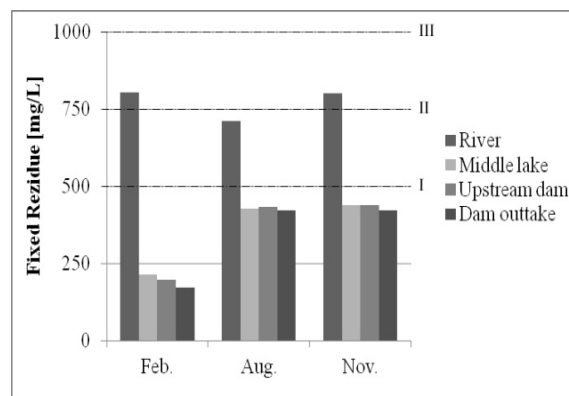


Figure 14. Fixed residue values in the monitored sections of the Tansa Lake

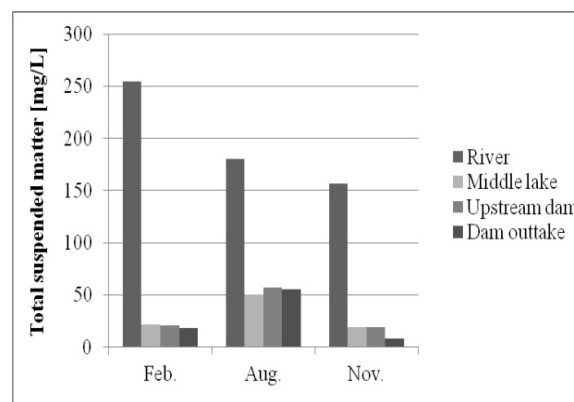


Figure 15. Total suspended matter in the monitored sections of the Tansa Lake

Knowledge about the content of suspended materials and fixed residue is necessary in the design of reservoirs, in desanding and treatment facilities, in order to function at optimum parameters (Zaharia, 1999). Drinking water should not contain suspension. Organic and inorganic fine suspensions are difficult to remove and create problems such as filter clogging; unpleasant taste and smell; disinfection disruption, transport of toxic, heavy metals, various pollutants; BOD_5 increase.

High concentrations in total suspended matter are measured during floods caused by strong rain, which causes the intensification of slope erosion, or in the loading degree with the solid substances of the wastewater discharged into water.

- *Chloride (Cl^-)* shows an upward trend, with values ranging from 14 mg/L, recorded in the *dam outtake* section in February, and 40 mg/L, in the same section, in November. The mean values allow the placement of the water from the Tansa Lake within the 2nd quality class (Fig. 16). The occurrence of chloride ions is conditioned by the dissolved marine salts which have impregnated the Sarmatian sedimentary rocks, and by the washing of the saline and salinized soils.

- *Sulphate (SO_4^{2-})* values fluctuate between 108

mg/L in August and 226 mg/L in February; the mean value (151 mg/L) allows the framing of the lake water within the 3rd quality class. The sulphate ion is present in considerable quantities in the waters from the Jijia catchment due to clay-marl Sarmatian deposits in which gypsum lenses are present; in smaller quantities, sulphates also derive from biochemical processes and wastewater (Fig. 17).

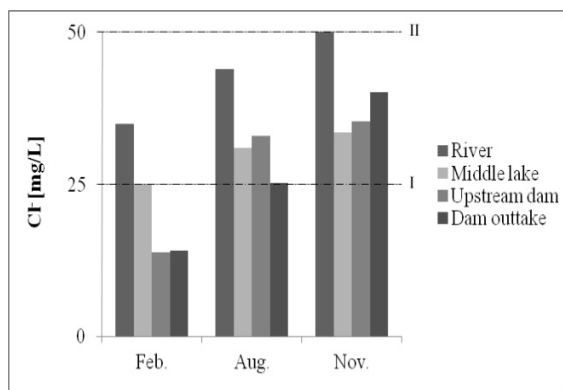


Figure 16. Chloride values in the monitored sections of the Tansa Lake

- The maximum *calcium* (Ca^{2+}) value measured (156 mg/L, in May) on the *Bahlui River* was registered during the maximum leakage period, being determined by the intake of water coming from the slopes, bringing with it high calcium content, through washing the rocks and the soil cover.

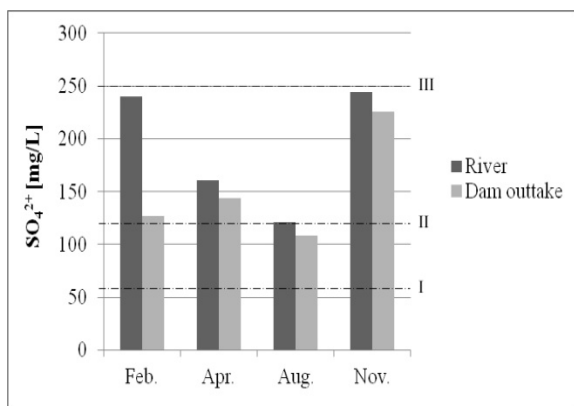


Figure 17. Sulphate values in the monitored sections of the Tansa Lake

The minimum values (38 mg/L, in August) were noted during minimum leakage, when the supply from precipitation is low and leakage from the slopes is reduced. The mean values for calcium allow the framing of the water from the Tansa Lake within the 1st quality class. The river section displays an average of 71 mg/L, falling within the 2nd quality class (Fig. 18).

- *Magnesium* (Mg^{2+}) has the lowest values of all the major cations; having the same origin and the same regime as calcium, magnesium has maximum

values during periods of extensive drainage, and minimum values during low-drain periods.

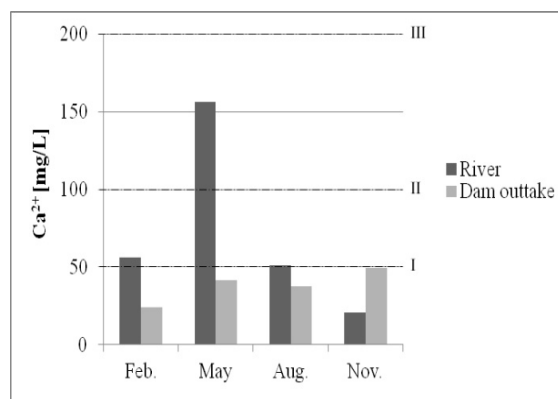


Figure 18. Calcium values in the monitored sections of the Tansa Lake

The mean values for magnesium allow the framing of the water from the Tansa Lake within the 2nd quality class. The *river* section displays an average of 38.5 mg/L, falling within the 2nd quality class (Fig. 19).

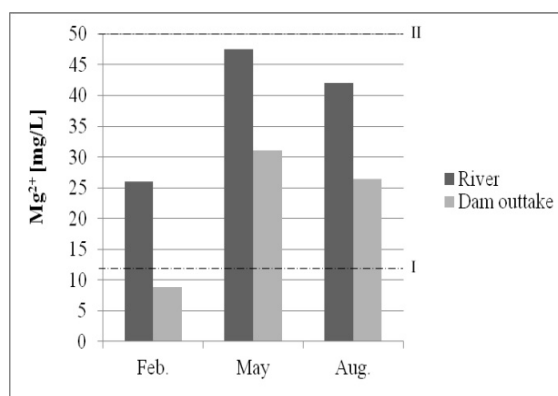


Figure 19. Magnesium values in the monitored sections of the Tansa Lake

4.5. Specific toxic pollutants

Since the Tansa Lake is primarily used as a drinking water supply, the water quality from this lake poses a particular importance. As a result, for the *dam outtake* section, specific chemical indicators (toxic) were also analysed on trace elements ions: Cd^{2+} , total Cr ($Cr^{3+} + Cr^{6+}$), Cu^{2+} , Ni^{2+} , Pb^{2+} , and Zn^{2+} . The mean concentrations were calculated for the values registered in the monitoring periods and are presented in Table 3.

The analyses were performed through atomic absorption spectrometry, as presented earlier in the present paper. It can be concluded that the concentration of none of the six trace elements analysed was found to exceed the limit of the 1st quality class.

Table 3. Mean values of trace elements ($\mu\text{g/L}$) in the dam outtake section during the sampling periods in 2010.

Trace elements	Cd^{2+}	Cr	Cu^{2+}	Ni^{2+}	Pb^{2+}	Zn^{2+}
Tansa Lake	0.3	20	18	9.5	3.3	76
1 st class quality limit *	0.5	25	20	10	5	100

* Order no. 161/2006 of the Romanian Ministry of Environment and Forests

4.6. Other relevant chemical indicators

- *Surface agents (detergents)*. Anionic and non-ionic surface active substances, generally called “surface agents”, are used in the synthesis of products that are typically used for cleaning. Anionic and synthetic surface agents are determined as substances reactive to methylene blue (MBAS) and are measured as MBAS index, a global parameter. This indicator exceeds the first quality class for the River section, showing a load of 120 $\mu\text{g/L}$ in February and August.

Surface agents display a relatively rapid decrease in concentration, which is a symptom of their good biodegradative power (Siviński et al., 1998). This could be easily observed during two of the monitored periods (April and August), when the loads coming from the River section were degraded before reaching the lake (this could not be possible during the colder period due to the lower rate of decomposition of organic substances). The water from the Tansa Lake fits, therefore, in the 1st quality class as presented in figure 20.

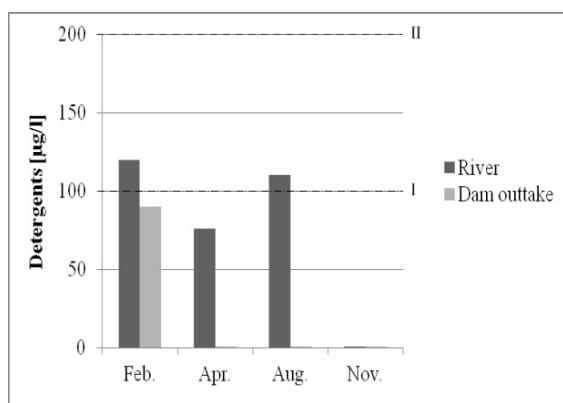


Figure 20. Detergent values in the monitored sections of the Tansa Lake

4.7. Global characterization of Tansa Lake water quality

The general classification of water quality has been carried out by taking into consideration the following five groups of indicators: oxygen regime, nutrients regime, salinity regime, specific toxic pollutants of natural origin (PTSON), and other relevant indicators.

The effects of all the indicators were considered similar, and the global characterization of the lake water was calculated based on the arithmetic mean (Fig. 21).

The analysis of the physico-chemical indicators, based on their average value, for the five groups of indicators shows that the Tansa dam, whose main purpose is to act as a drinking water supply for the Belcești village, can be placed within the 3rd quality class for the oxygen regime, and within 2nd quality class for the salinity regime. Nutrients, PTSON and other indicators maintain the water from the Tansa Lake in the 1st quality class.

The global characterization of the Tansa Lake places the water in 2nd quality class.

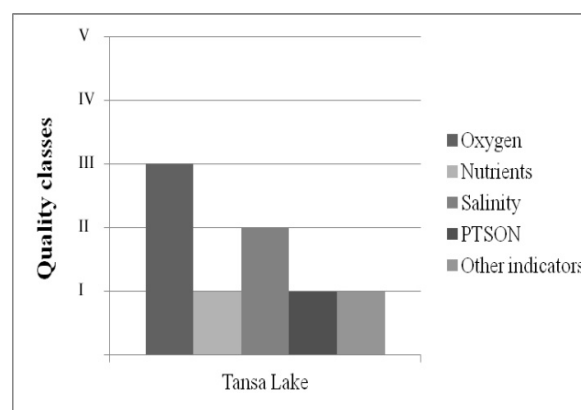


Figure 21. Tansa Lake classification by groups of indicators

5. CONCLUSIONS

The amount of oxygen required for the oxidation of organic matter indicates an oxygen deficiency above the allowable limits, consumption exceeding aeration by diffusion from the atmosphere. The nutrient regime, especially in the case of phosphorus, is good, the latter being found in quantities that indicate a positive development, the organic matter being sufficient to absorb it within the biomass.

The intake of organic matter and nutrients contained in salts is high (fixed residue - 389 mg/L, chlorides - 28 mg/L, sulphates - 151 mg/L), being of both natural and anthropogenic origin, the latter being represented by controlled and diffuse upstream discharges, waste waters from Hârlău City, the Cotnari Winery, the human settlements in the area, diffuse leakage from stock-raising activities developed after 1997, and runoff from manure incorporated into the adjacent soil between 1983 and 1992, when the AEICIP Belcești complex, which counted 30,000 pigs, was closed.

The global characterization of the Tansa Lake places the water within the 2nd quality class, and, according to the analysis of the degree of

eutrophication, within the category of hypertrophic lake. As a result, the water collected from the Tansa Lake does not meet the criteria for drinking water. It appears that the water evacuated from the lake as servitude debits does correspond qualitatively to the classification “in a good state”, but it is not suitable for drinking.

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