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Article

Diatoms. A viable tool for quantifying surface water pollution

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Abstract

The current work focused on the water quality of the Bega and Timis rivers measured by two methods. One of them is the method by which the water was analyzed from a physical-chemical point of view, and the other aimed at quantifying the degree of water pollution by biological methods. In this sense, diatoms were used. In the study, samples of water and diatoms were taken using specific techniques from the Bega and Timis rivers, starting from near the area of their formation until near the border with Serbia. Four sampling points were chosen on the Timis River plus one sampling point on the Surgani River, which is a tributary of the Timis, and six sampling points on the Bega River. The points were chosen specifically, being located downstream of the major sources of pollution. In order to locate the points, information was collected from the studies carried out as part of an extensive monitoring that spanned several years. The abundance and diversity of diatom species were used to calculate the Biological Diatom Index (BDI) and the Saprobity Index (SI). These two indices provide valuable information about organic or heavy metal pollution of water bodies.

Keywords: *BDI, diatoms, heavy metals, organic pollution, SI*

INTRODUCTION

Brief description of diatoms

Diatoms are single-celled, very small organisms that belong to the Protista kingdom, Bacillariophyta phylum. They are photosynthesizing organisms, but there are some species that can survive in the dark, if the environment contains sufficient amounts of organic carbon. The size of these microorganisms is relatively small, starting from 5 µm and reaching approximately 0.5 mm. An important characteristic of diatom cells is that they are incorporated into a single cell wall made of silicon, called a frustule. These frustules have various shapes, but usually consist of two asymmetrical sides with a division between them, hence the name of the group [1]. The uniqueness of diatoms is given precisely by this silicon wall. The content of the cell is similar to that of eukaryotic algae, starting with the nucleus and continuing with chloroplasts and mitochondria. The rigidity of the cell walls is given by silicon. It has a role in reproductive aspects and participates in the conservation of fossil diatom frustules [2].

Hendey estimated a number of 600 planktonic species in the oceans [3], while in 1942, Huber-Pestalozzi suggested the existence of about 200 species present in fresh waters [4]. At the moment, the number of species is of the thousands order.

Some authors are of the opinion that these organisms are responsible for more than 45% [5] of the primary production in the oceans and that they represent a major source of food for higher trophic level organisms in intertidal areas [6]. Another important characteristic of them is that they produce 20% of the oxygen in the atmosphere [7].

Diatoms have been widely used to detect changes in surface water quality due to their specific sensitivity to a variety of ecological conditions. Their tolerances and preferences for pH, conductivity, salinity, moisture, organic matter, saprobity, trophic state, oxygen requirements, nutrients and current velocity in freshwater streams, rivers, lakes, wetlands and estuaries have been defined. The diatoms have also been used in paleolimnological studies [8, 9].

The importance of fresh water for the population

Globally, it is estimated that up to 80% of industrial and municipal wastewater discharges reach rivers without any prior treatment. This is even higher in least developed countries, where sewage treatment plants and systems of sewage are completely missing [10].

Aquatic ecosystems are threatened by various human activities around the globe, leading to considerable changes in sediment flux and flow patterns, declining water quality, and loss of biodiversity [11]. Due to urbanization, cities are permanent sources of water pollution, and wastewater is continuously produced by various human activities. In the industrialized areas of Europe, the discharge of wastewater into rivers and lakes has led to serious degradation of water quality due to contamination with a variety of chemical and biological products and to the death of aquatic biota [12].

Because water is indispensable to human life, human history cannot be understood if its relationship with rivers, lakes and underground water is not also understood. People have lived along rivers and near lakes or wetlands since the beginning of their history. River waters have been and will be a direct source of food for people. They facilitate the exploration, transport and agricultural use of the fluvial lands, satisfy the hygiene needs of the communities and provide a source of energy or a space for relaxation [13]. Although at the national level, Romania has a sustainable system of water resources, at the regional and local level, problems can be observed regarding water reserves related to climate changes (aridity and drought, floods). The balance between water demand and availability in Romania, as well as in many other areas of Europe, will probably soon reach a critical level, resulting from simulated climate change scenarios. This balance decreased by 37% between 1990 and 2002-2005 in many eastern countries, such as: Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovak Republic and Slovenia. Due to these considerations, economic and demographic users must take into account several aspects, the most important of which are: the efficient use of water from both surface and underground sources; checking water storage and transport facilities to reduce or eliminate water losses; the increasing application of recycling techniques, etc. [14], or more efficient treatment of wastewater. Wastewater treatment can be achieved through a combination of non-invasive conventional and biological techniques (phytoremediation with aquatic plants) and their return to the public water supply system [15, 16].

Due to the wide distribution, the large number of species, the ease of preservation and the sensitivity to environmental changes, diatoms are effective as environmental indicators [17]. In Europe, the common exploitation framework is the Water Framework Directive, which regulates water exploitation policies in the 27 member states of the European Union. Through this directive, "biological quality elements" became the key component in monitoring the state of hydro systems by introducing the concept of ecological state and promoting the monitoring of the quality of water bodies through relevant biological methods [18].

This article presents the results of an extensive research project that spanned several years and whose research object was the monitoring of surface water quality through various biological techniques. Having said that, the purpose of the current study was to test and propose an alternative method of monitoring anthropogenic pollution with heavy metals and organic pollution using bioindicators. For this, studies were carried out on the benthic diatoms taken from the surface waters of the Western area of Romania. In the following, the Biological Diatom Index (BDI) and the Saprobity Index (SI) will be presented. Based on them, the river sectors can be classified in different degrees of pollution by diatom taxa.

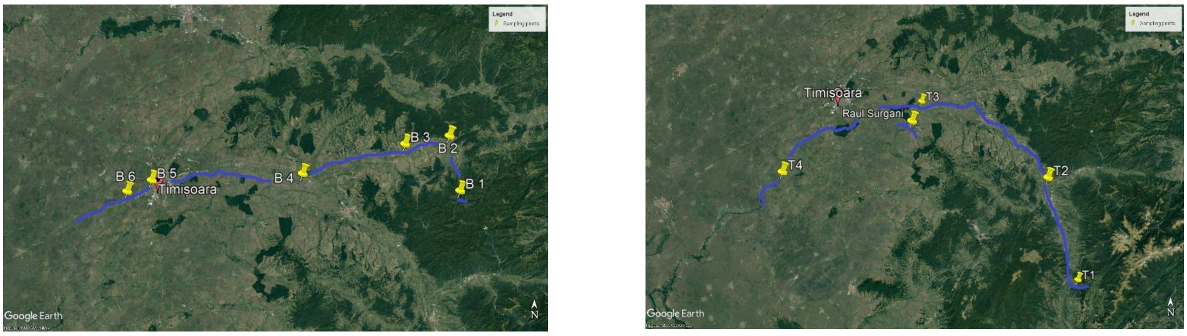
MATERIALS AND METHODS

Study area

In the study, samples of water and diatoms were taken using specific techniques from the Bega and Timis rivers, starting from near the area of their formation until near the border with Serbia. The investigated areas are diversified in terms of pollution sources.

Those located downstream of the major sources of pollution were chosen as sampling points, based on the information obtained from the studies carried out within of an extensive monitoring that spanned the years 2019 and 2020 [19].

Six sampling points along the course of the Bega River (B1, B2, B3, B4, B5, B6), four sampling points along the course of the Timis River (T1, T2, T3, T4) and one sampling point located on the river Surgani, a tributary of the Timis River were selected (figures 1a and 1b).



a) b)

Fig. 1. Positioning of the sampling points on the courses of the Bega (a), respectively Timis and Surgani rivers (b)

Methodology for sampling and processing water samples

In this study, two sampling campaigns were carried out for all the water courses presented above (April and May 2022). In each sampling point, three sample units were collected. The water samples were taken in compliance with the requirements contained in the SR ISO 5667-6/2017 standard - Guide for sampling in rivers and other watercourses. The water samples were processed and analyzed in accordance with the standards in force in an accredited laboratory.

Sampling and preservation of diatom samples

The samples were taken in two different campaigns, in April and May, of the year 2022. At each sampling, three sub-samples/sample units were collected. For the diversity of the samples, three stones of different structure and size were searched (fig. 2a), taken from places where the water depth remains relatively constant, both during periods of drought and those with increased precipitation. Diatom samples were collected by brushing and washing the stones with water (fig. 2b). Brushing over as large a surface of the stone as possible was pursued for the diversity of species. Where the stones were in muddy substratum, only the accessible surfaces of the stone were brushed. The samples were placed in Falcon tubes and treated with 3 ml of formaldehyde for preservation.

a) b)

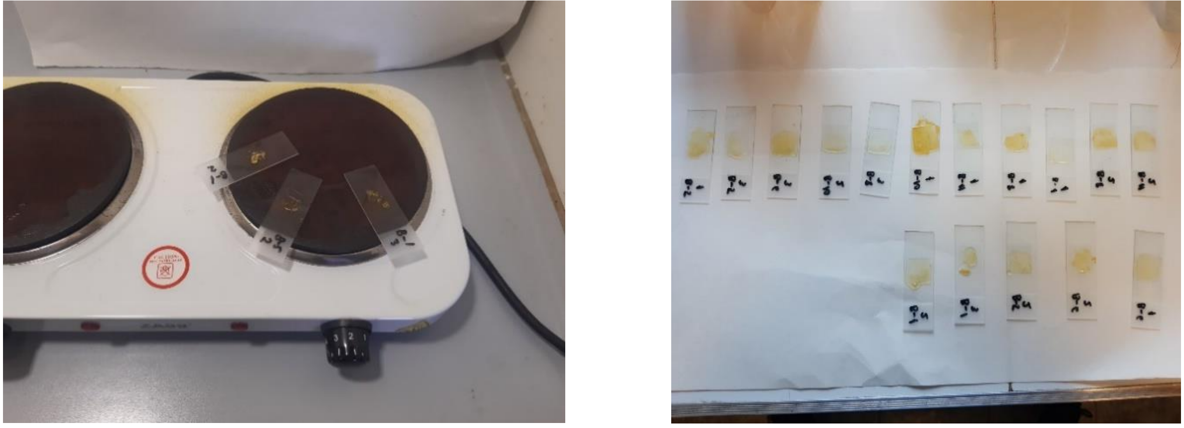
Fig. 2. The substrate (a) and the method of sampling diatoms (b)

Processing of diatom samples

The processing of the diatom samples included several stages. The first of them concerned the removal of substrate particles remaining in the samples. This operation was carried out by repeated washings and decantations and by aspirating the supernatant with a vacuum tube. The second stage concerned the elimination of organic matter from the samples by: successive treatment with HCl (20%) 5 ml and HNO_3 (37%) with a volume equal to that of the samples (nitric acid was added in two phases at an interval of 48 hours), respectively by burning the samples on a metal plate at a temperature of 80-90°C, for 6-8 hours (see fig. 3). Degreased slides were placed on the plate with a small amount of sample spread very well over its entire surface. The burned blades were left to dry for 24 hours.

Fig. 3. Burning the slides with the diatom samples on the electric hob

In the third stage, the diatom frustules were mounted on microscopic slides with the help of rosin. A thin layer of rosin was spread on the slides with the sample and heated (at 60-70°C). After liquefying the rosin, the slide was placed, obtaining the "microscopic preparation" (see fig. 4).



a) b)

Fig. 4. Mounting the diatom frustules by adding rosin (a) and the microscopic preparations (b)

The identification of the species was carried out with the optical microscope Olympus CX 43 (2019), at the 40x objective and at the 100x immersion objective (see fig. 5). To identify the species, the following online determinants were used: https://diatoms.org/species [20], https://www.biodiversitylibrary.org/item/23911#page/1/mode/1up [21].

Fig. 5. The assembly used to determine the species of diatoms

The Saprobity Index (SI) and the Biological Diatom Index (BDI)

Organic pollution and metal pollution of surface waters is best quantified by the Saprobity Index (SI) and Biological Diatom Index (BDI) values. Based on them, the river sectors can be classified in different degrees of pollution by means of diatomic taxa. Thus, pollution with heavy metals, reflected mainly by the values of the total iron indicator in the water, was correlated with BDI, while organic pollution, reflected by the chemical oxygen demand indicator (COD), was correlated with SI.

$$\text{SI} = (\sum(sxh))/(\sum h) \tag{1}$$

where:

s= the saprobic value of individual species;

h= absolute frequency, respectively the number of individuals belonging to each taxon in the sample

$$\text{BDI} = \sum_{j=1}^{n} ajsjvj \,/\, \sum_{j=1}^{n} ajvj \tag{2}$$

where:

aj= is the relative abundance (proportion) of species j in the sample;

sj= is the pollution sensitivity of species j;

vj= is the indicator value of species j;

n= is the number of species counted in the sample.

Starting from the classification proposed by Eduardo A. Lobo et al. in 2016 [8], which reports four pollution zones in correlation with the SI values (1.0÷1.5 Oligosaprobic - negligible pollution; 1.5÷2.5 β-Mesosaprobic - weak organic pollution; 2.5÷3.5 α-Mesosaprobic - strong organic pollution and 3.5÷4.0 Polysaprobic-very strong organic pollution), the river sectors were classified based on the Saprobity Index values obtained by us, into three water quality classes, as follows: low pollution where the index values are between 1.30 and 1.80, moderate pollution where the index has values between 1.80 and 2.20 and high pollution when the index is between 2.20 and 2.60 (own classification).

Based on the values of BDI, the water courses can be classified into five categories as follows: a) 1.0÷2.0 severe pollution: only a few tolerant species survive, very little diversity; b) 2.0÷3.0 strong pollution: only pollution-resistant species dominate, sensitive species severely reduced; c) 3.0÷4.0 moderate toxic pollution or nutrient enrichment (eutrophication); d) in the range 4.0 to 4.5 very light pollution, almost normal communities; e) higher than 4.5 no pollution, the best biological quality.

It is highlighted that water pollution is directly proportional to the values of the Saprobity Index (high values of the index indicate high pollution), while in the case of the Biological Diatom Index, the correlation between water quality and the values of the index is inversely proportional (low values of the index indicate pollution raised).

RESULTS AND DISCUSSION

Physical-chemical analysis of surface waters

The Timis-Bega hydrographic basin was characterized from the point of view of the indicators and quality classes present in Romanian Order no. 161/2006 [22]. This order presents five water quality classes and is the cornerstone of protecting and maintaining the surface waters in Romania in as natural a state as possible.

Timis River

Table 1. Physical-chemical analysis of water from the Timis River (T) and the classification of each sampling point into one of the 5 quality classes (I to V)

Parameter	Unit	T1	T2	T3	T4	Surgani River
pH	pH units	7.1 (I)	7.0 (I)	6.2 (I)	7.0 (I)	6.9 (I)
COD	mgO_2/L	5.09 (I)	6.78 (I)	3.39 (I)	33.2 (III)	37.7 (III)
Ammonium ($N-NH_4$)	mg/L	<0.028 (I)	0.088 (I)	0.036 (I)	<0.028 (I)	0.035 (I)
Nitrites ($N-NO_2$)	mg/L	<0.15 (I)	<0.15 (I)	<0.15 (I)	<0.15 (I)	0.377 (V)
Nitrates ($N-NO_3$)	mg/L	1.56 (II)	1.26 (II)	0.732 (I)	0.493 (I)	0.848 (I)
Total nitrogen	mg/L	<1 (I)	<1 (I)	<1 (I)	<1 (I)	<1 (I)
Total phosphorus	mg/L	<0.05 (I)	<0.05 (I)	<0.05 (I)	<0.05 (I)	0.641 (III)
Dry filterable residue at 105^o C	mg/L	92 (I)	84 (I)	97 (I)	113 (I)	512 (II)
Chloride	mg/L	<5 (I)	<5 (I)	<5 (I)	<5 (I)	<5 (I)
Sulphur	mg/L	15.4 (I)	20.3 (I)	14.5 (I)	6.47 (I)	26.2 (I)
Calcium	mg/L	24.0 (I)	22.4 (I)	25.6 (I)	28.1 (I)	99.3 (II)
Magnesium	mg/L	14.5 (II)	13.5 (II)	15.5 (II)	7.6 (I)	17.2 (II)
Sodium	mg/L	1.25 (I)	3.24 (I)	2.45 (I)	4.2 (I)	90.3 (III)
Total chromium	mg/L	<0.5 (I)	<0.5 (I)	<0.5 (I)	<0.5 (I)	<0.5 (I)
Copper	mg/L	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)
Zinc	mg/L	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)
Lead	mg/L	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)
Cadmium	mg/L	<0.11 (I)	<0.11 (I)	<0.11 (I)	<0.11 (I)	<0.11 (I)
Iron	mg/L	<0.10 (I)	<0.10 (I)	0.206 (I)	0.226 (I)	0.281 (I)
Manganese	mg/L	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)
Nickel	mg/L	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)
Anionic detergents	mg/L	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)

*Results marked with "<" represent the values situated below the determination limit of the method

Considering the principle of the worst situation, we assess the quality of the Timis River as quality III (moderate), due to the concentration of the COD indicator measured at sampling point T4. Applying the same principle for the Surgani River, which is a tributary of the Timis, it was observed that its quality falls into class V (bad) quality caused to the concentration of nitrogen. It is found that this does not degrade the water quality of the Timis River.

The degradation of the water quality related to the T4 sampling points and the Surgani River can be attributed to the livestock farms in the area. The northwestern part of Timis County is famous for animal farms; here, since the communist period, activate one of the largest producers of pork on the territory of Romania. Another cause can be the water treatment plant in Buzias, which presents a risk of pollution by discharging water into the Surgani River.

Bega River

Considering the principle of the worst situation, the quality of the Bega River was situated in the IIIrd (moderate) quality state, due to the concentrations of the COD and Fe quality indicators (table 2). The organic pollution present in these sampling points and quantified by the COD indicator and the presence of heavy metals, quantified by the iron indicator, is generally due to the localities through which the river bed makes its way and their related activities, among which we mention: a former factory in the organic chemical industry – which, due to the bad management of wastewater, still presents the risk of contamination of the water table and indirectly of the Bega river (B2); some wood processing factories specific to the city of Faget (B3) and the city sewage treatment plant, as well as the industry present on the territory of the city of Timisoara (B5 and B6).

Table 2. Physical-chemical analysis of water from the Bega River (B) and the classification of each sampling point into one of the 5 quality classes (I to V)

Parameter	**Unit**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**
pH	pH units	6.8 (I)	7.0 (I)	6.9 (I)	7.1 (I)	6.9 (I)	7.0 (I)
COD	mgO_2/L	17.1 (II)	28.6 (III)	32.4 (III)	22.8 (II)	22.3 (II)	27.4 (III)
Ammonium ($N-NH_4$)	mg/L	<0.028 (I)	<0.028 (I)	<0.028 (I)	<0.028 (I)	<0.028 (I)	<0.028 (I)
Nitrites ($N-NO_2$)	mg/L	<0.15 (I)	<0.15 (I)	<0.15 (I)	<0.15 (I)	<0.15 (I)	<0.15 (I)
Nitrates ($N-NO_3$)	mg/L	1.38 (II)	1.69 (II)	1.70 (II)	1.31 (II)	0.732 (I)	0.791 (I)
Total nitrogen	mg/L	1.25 (I)	1.34 (I)	1.44 (I)	1.29 (I)	<1 (I)	<1 (I)
Total phosphorus	mg/L	<0.05 (I)	<0.05 (I)	<0.05 (I)	<0.05 (I)	0.142 (I)	0.078 (I)
Dry filterable residue at 105 °C	mg/L	190 (I)	164 (I)	188 (I)	142 (I)	335 (I)	184 (I)
Chloride	mg/L	<5 (I)	<5 (I)	<5 (I)	<5 (I)	<5 (I)	<5 (I)
Sulphur	mg/L	3.08 (I)	3.75 (I)	8.07 (I)	9.01 (I)	16.2 (I)	14.8 (I)
Calcium	mg/L	30.2 (I)	32.1 (I)	25.6 (I)	28.9 (I)	30.4 (I)	27.5 (I)
Magnesium	mg/L	1.2 (I)	3.32 (I)	2.1 (I)	3.6 (I)	6.5 (I)	7.2 (I)
Sodium	mg/L	4.25 (I)	3.65 (I)	3.08 (I)	3.84 (I)	17.8 (I)	24.1 (I)
Total chromium	mg/L	<0.5 (I)	<0.5 (I)	<0.5 (I)	<0.5 (I)	<0.5 (I)	<0.5 (I)
Copper	mg/L	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)
Zinc	mg/L	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)
Lead	mg/L	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)
Cadmium	mg/L	<0.11 (I)	<0.11 (I)	<0.11 (I)	<0.11 (I)	<0.11 (I)	<0.11 (I)
Iron	mg/L	<0.10 (I)	<0.10 (I)	0.337 (II)	0.204 (I)	0.382 (II)	0.744 (III)
Manganese	mg/L	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)	<0.10 (I)
Nickel	mg/L	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)	<0.12 (I)
Anionic detergents	mg/L	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)	<0.2 (I)

*Results marked with "<" represent the values situated below the determination limit of the method

Abundance of diatom species

There is a number of diatom species specific to each sampling point. The following graphs show the number of species on each studied river area.

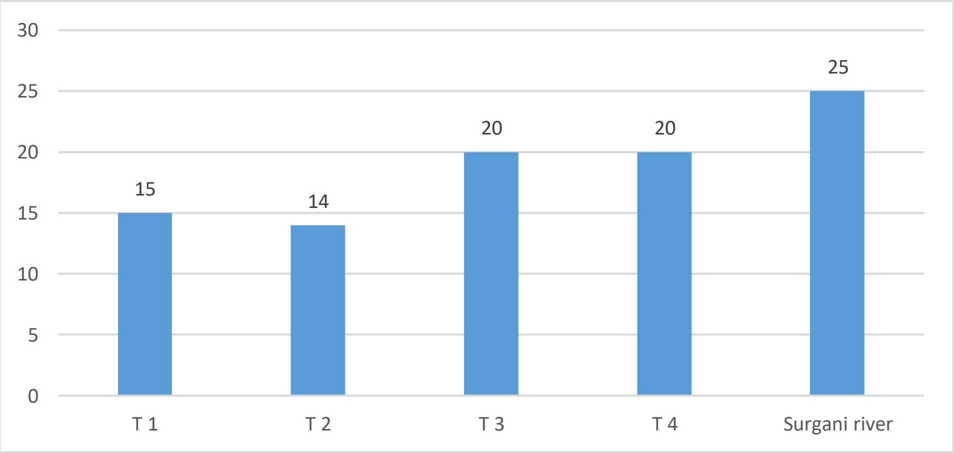


Fig. 9. The number of diatom species related to each sampling point on Timis and Surgani Rivers

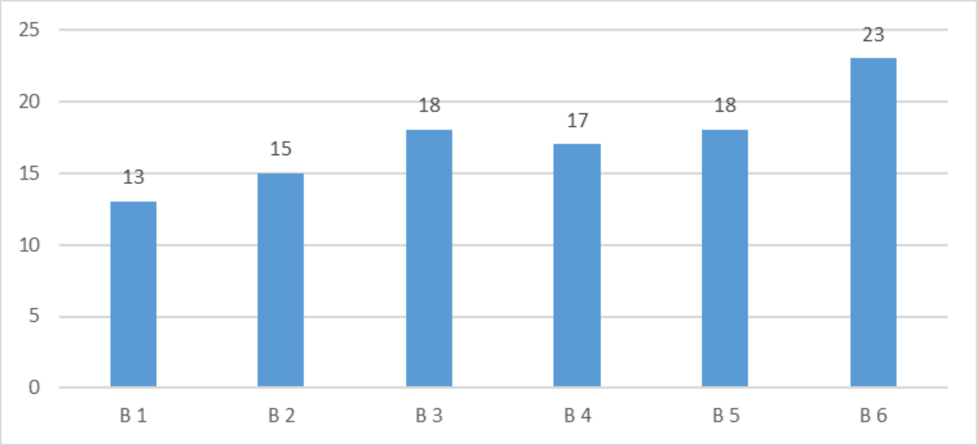


Fig. 10. The number of diatom species related to each sampling point on the Bega River

From the analysis of the data presented in these graphs, we notice that at the level of the number of species, the two hydrographic basins behave similarly. In both cases the trend is upward with a maximum of species in the sampling points on the lower course of the rivers and a minimum of species on the upper course. These data correlate with the physical-chemical analyses presented in the tables above. Where the number of species is higher and where we have species tolerant to certain pollutants. the respective pollutants are also in higher concentrations (see the concentration of iron, COD, in the middle and lower points of the rivers).

Correlation of diatom-based indices with water quality from a physical-chemical point of view
Tables three and four show the results of iron and COD in correlation with the values of diatoms quality indices (BDI and SI) for the sampling points of the Timis River.

Table 3. Correlation of iron in water with the BDI values in Timis and Surgani Rivers

Sampling point	BDI	Iron quality class*
T1	3.73- moderate toxic pollution	I-very good (<0.10 mg Fe/L)
T2	3.92- moderate toxic pollution	I-very good (<0.10 mg Fe/L)
T3	2.47- strong pollution	I-very good (0.206 mg Fe/L)
T4	2.70- strong pollution	I-very good (0.226 mg Fe/L)
Surgani River	2.65- strong pollution	I- very good (0.281 mg Fe/L)

*Romanian Order no. 161/2006 [22]

Regarding the BDI values, we observe a gradual degradation of the water with a maximum of pollution in the sampling points T4 and the Surgani River. Although the values determined for total iron place the water in the first quality class according Romanian legislation [22], however, some higher values of iron can be observed in sampling points T3, T4 and the Surgani river. A satisfactory correlation of the results determined on the basis of BDI with the values of total iron in the water is highlighted. Where the amount of iron is increasing, the water quality class based on BDI is different, reaching from a moderate toxic pollution to a strong pollution.

Table 4. Correlation of COD in water with the SI values in Timis and Surgani Rivers

Sampling point	SI	COD quality Class*
T1	2.04- moderate pollution	I- very good (5.09 mgO2/L)
T2	1.73-low pollution	I- very good (6.78 mgO2/L)
T3	1.80- low pollution	I- very good (3.39 mgO2/L)
T4	1.94- moderate pollution	III- moderate (33.2 mgO2/L)
Surgani River	2.34- high pollution	III- moderate (37.7 mgO2/L)

*Romanian Order no. 161/2006 [22]

In the case of both methods of determining the pollution, we observe a considerably higher water quality in the upper part of the river compared to the lower area. There is a small exception, namely, at sampling point T1, the SI value (2.04) is attributed to a moderate pollution that can be attributed to the droppings produced by wild animals. This sampling point being located in a mountainous area. It was observed a good correlation of the results determined based on the SI with the COD values.

Tables 5 and 6 show the results of iron and COD in correlation with the values of diatom quality indices (BDI and SI) for the sampling points of the Bega river.

Table 5. Correlation of iron in water with BDI values in Bega River

Sampling point	BDI	Iron quality class*
B 1	3.91- moderate toxic pollution	I-very good (<0.10 mgFe/L)
B 2	3.82- moderate toxic pollution	I- very good (<0.10 mgFe/L)
B 3	2.66- strong pollution	II- good (0.337 mgFe/L)
B 4	2.69- strong pollution	I- very good (0.204 mgFe/L)
B 5	2.51- strong pollution	II- good (0.382 mgFe/L)
B 6	2.73- strong pollution	III- moderate (0.744 mgFe/L)

*Romanian Order no. 161/2006 [22]

Sampling points B1 and B2 are classified as having a moderate toxic pollution determined on the basis of the biological diatoms index. The rest of the sampling points are characterized by a strong pollution with a maximum of pollution at point B6. The same trend is maintained in the case of the quality class determined based on the total iron parameter. There we have a pollution maximum at point B6, this being in the IIIrd quality class with a determined concentration of total iron in the water of 0.744 mg/L.

Table 6. Correlation of COD in water with SI values in Bega River

Sampling point	SI	COD quality class*
B 1	1.74- low pollution	II- good (17.1 mgO2/L)
B 2	2.25- high pollution	III- moderate (28.6 mgO2/L)
B 3	2.32- high pollution	III- moderate (32.4 mgO2/L)
B 4	2.30- high pollution	II- good (22.8 mgO2/L)
B 5	1.97- moderate pollution	II- good (23.3 mgO2/L)
B 6	2.40- high pollution	III- moderate (27.4 mgO2/L)

*Romanian Order no. 161/2006 [22]

Interpreting the SI values, it was found that the only sampling point that has a low pollution is B1. The rest of the sampling points having highly polluted water with the exception of point B5, which has moderate water pollution. The water quality based on the COD indicator fluctuates from good to moderate depending on the sampling area.

The classification of water into quality classes according to Romanian Legislation based on the COD indicates a satisfactory correlation between them and the pollution quantified with the help of the Saprobity Index. The points with high pollution on the left side have a quality correspondent on the right side.

CONCLUSIONS

From a physical-chemical point of view, the water quality of the Bega and Timis rivers does not present an alarming pollution. There are small punctual exceedances of the quality limits, but overall, the water of these rivers is good to very good quality.

Diatoms communities can undergo specific changes due to various causes, among which we mention: periods of drought or heavy rains, massive accidental discharges characterized by toxic substances in high concentrations that lead to the rapid death of sensitive species and the multiplication of tolerant species at an accelerated rate or also the water temperature plays an important role in the study of diatoms, many species being thermotolerant.

Diatoms have the ability to be bioindicators because they can record changes in the environment much faster than the concentrations determined on momentary samples of the physical-chemical indicators. For example, the presence of bioindicator diatoms species recorded the fluctuations of metal concentrations or other chemical indicators for a longer time than at the time of sampling. That is why a strict correlation cannot be appreciated. Because a concentration of heavy metals or organic pollution at a given time, does not say anything about the quality of the water that flows permanently.

As a general conclusion, we can state that diatoms, as a tool for quantifying surface water pollution, can be used successfully. They can provide at least satisfactory results.

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