A SURVEY OF WATER QUALITY
OF PRUT RIVER IN 2022

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ABSTRACT

These days, information on water quality is essential for furture activities related to water: water as a source of drinkable liquid, water as industry supply for many technologies, but also water as a balance component of ecosystems. This is why, this paper presents several characteristics for the water sampled from Prut River and a discussion of the measured values. Based on the survey during the year 2022, the following conlcusions on water of river Prut could be drawn. Prut river has particular evolutions of its characteristics due to its geographical position and specific climate. The dependences of analyzed characteristics mainly on seasons reflect that human activities is not yet dominant in modifying these parameters. The role of Prut river as water border between Romania and Moldova should be taken into account when analyzing the data presented in this paper, as many human and agricultural activities around rivers are of low intensity as compared to internal water.

Keywords: Black Sea, airborne, wind speed, turbine, Romania, annual energy production (AEP).

1. ABOUT WATER SURVEY

The increasing economical activities need for water sources in the next decades this asks for detailed understanding the quality of available water resources and their vulnerability to climate change. Rivers and lakes near urban agglomerations are of interest to be available for industry and domestic use.

Because of its vital influence on human society, there are recognized standards methods to evaluate water quality by quantitative and qualitative parameters [1], [2], [3].

Georgescu P. L. et al. [4] presents a sudy on nutrient loads, hazardous substances and microbiological contamination for Danube river, based on a survey during the period 2011-2017 and discussing the water quality index and proposing a new forecast chart for water quality.

Molle F. and Wester P. [5] underlined that river basin and their evolution in time are important for society "to assess, capture, convey, store, share and use available water resources". Water survey is a component in dealing with particular 'shock events' (droughts, floods and contamination accidents) in order to support the environment sustainability. Institutional change, laws and guvernamental regulations also have a great influence on quality and availability of water resources. Maintaining water quality is a question of costs and risks, project at big scales to mitigate or to improve the water condition.

It is important to note that the characteristics of water in rivers can vary widely based on geographical location, climate, human activities and other factors. Monitoring and managing these characteristics are crucial for maintaining healthy river ecosystems and ensuring the availability of clean water resources [6].

A short description of Romania and Moldova river systems is given in the following lines in order to emphasis a strong bond between these two systems, also being in progress the collaboration between the two countries and the accession of Moldova to the European Union for future enlargement of the EU.

The Danube river is a major river that flows through Romania. It has diverse water characteristics due to its length and passage through various landscapes. The water temperature can range from colder in the mountainous areas to warmer in the lowlands. The big river is also influenced by sediment load from its tributaries and can carry significant amounts of nutrients, which can impact water quality downstream [7].

Transylvanian Rivers, such as Mureș, Someș, and Olt tend to have clearer water due to their origins in the Carpathian Mountains. The water is colder and generally less impacted by pollution as compared to lowland rivers [8], [9].

Eastern Rivers, flowing into the Danube, like Siret and Prut, can carry sediment and pollutants from agricultural runoff and industrial activities. The water quality of these rivers can be influenced by human

activities both within Romania and upstream in other countries, like Ukraine and Moldova.

In Moldova, the river system could be charestized as following.

The Prut River flows through Moldova before forming part of the border between Moldova and Romania. It can experience high sediment load during periods of heavy rainfall, leading to increased turbidity. Agricultural runoff and pollution can also impact the water quality of the Prut.

The Dniester is another important river in Moldova. Its water quality can be affected by pollutants from urban areas and industries along its banks. Agricultural runoff can introduce nutrients and sediment into the water.

Both Romania and Moldova face challenges related to water quality, including agricultural runoff, industrial pollution, and sedimentation. Efforts are being made to monitor and manage these issues to ensure the health of their river ecosystems and the availability of clean water resources for both human and ecological needs.

The aim of this study is to offer a survey of several characteristics of Prut river, in order to discuss their evolution during the year 2022. This information could be useful for further study on forecasting and on designing solutions to keep the water quality but also to support human activities in this region.

European Environment Agency (EEA) provides reports on the environmental issues and trends in Europe, including water quality, offering information on rivers and water bodies across the continent [10].

Universities and research organizations conduct studies on water quality in specific regions. Institutions like the University of Bucharest, Alexandru Ioan Cuza University in Iasi (Romania), "Dunarea de Jos" of Galati and Moldova State University (Moldova) may have relevant research and data.

Drasovean R. et al. [8] present values for water samples from Siret, in 10 sites, during a time period between November 2016 and December 2017. There were reported the following indicators: nitrites, nitrates, chlorides, total phosphorus, sulphates, cadmium, lead, iron and zinc. Other physical and chemical parameters were also studied such as: density, dissolved oxygen, pH, salinity, total dissolved solids, turbidity etc. The assessed indicators exceeded the maximum admissible values especially between November 2016 and June 2017. Since September 2017, the assessed parameters have improved due to the measures taken by the Romanian authorities.

The aim of this paper is to present the evolution of a set of water characteristics for Prut River for the year 2022. This report could be useful for evaluating trends along more than one year.

2. METHODS

The water sampling station is located near the city of Cahul, an emerging city as concerning economic, academic and social life, the area where the pumps feeding the water purification basins for the city of Cahul. Figure 1 gives the position of the measuring station.
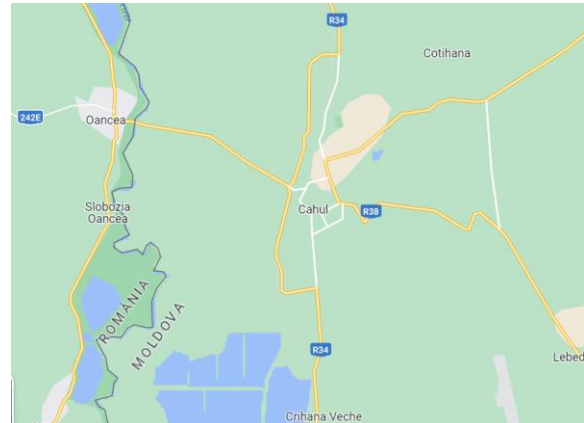

Fig. 1. Sampling point of the water

Figures 2 to 12 presents several characteristics of Prut water, during each month of the year (in the plots on the left side) and plots of values of the same characteristics during the entire year, pointing the average value for each month, in the right side. On the plots in the right side, blue lines are generated by average values of the year 2022, with a value for each month, calculated as average of the measured values during a month. The red line is for maximum values, measured each month, the green line is for the minimum values, also recorded each month and the black line (named "difference" in the plots) presents the difference between maximum and minimum values for each month. The band between red line and green line is of interest for assessing the variation of a parameter.

The following characteristics of sampled water were measured and recorded.

River water temperature varies with the seasons, geography and climate. It can impact the aquatic ecosystem, affecting the growth of aquatic plants and the behavior of aquatic organisms. From Fig. 2, one may notice two tendencies: cold water (November-March) and warm water (May-September), linked by slope of 15 °C during approximately 2 months. During the year 2022, the maximum values were recorded during July. Water temperature depends on the temperature of the atmosphere, depending on the season. For the analysed year, the water of Prut River did not have the water frozen.

Turbidity refers to the cloudiness or haziness of a fluid, caused by large numbers of individual particles. Turbidity is also defined as the opacity or lack of transparency of water, caused by very fine particles that cannot be identified with the naked eye. It depends on seasonal rains, melting snow in the mountains, the speed of the water. In rivers, turbidity can be caused by sediment, soil erosion and human activities. High turbidity can affect light penetration and impact the aquatic life [11]. There are standards methods for evaluating the turbidity [12]-[14].
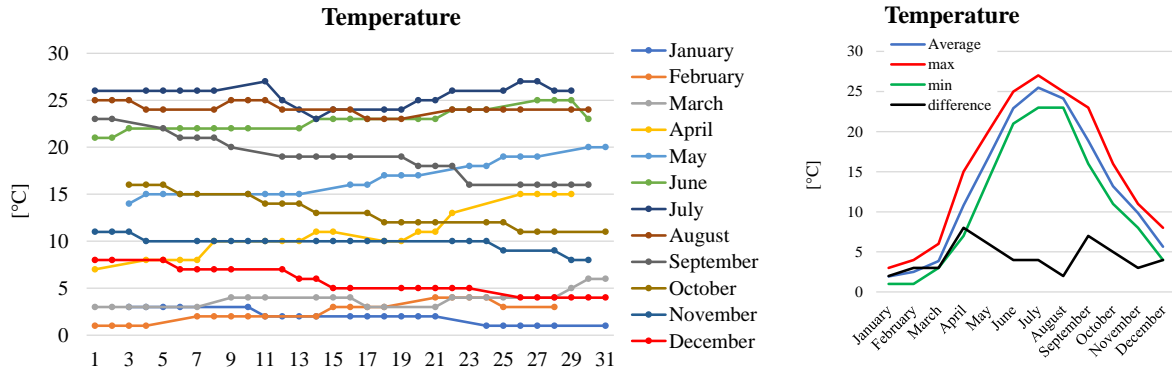
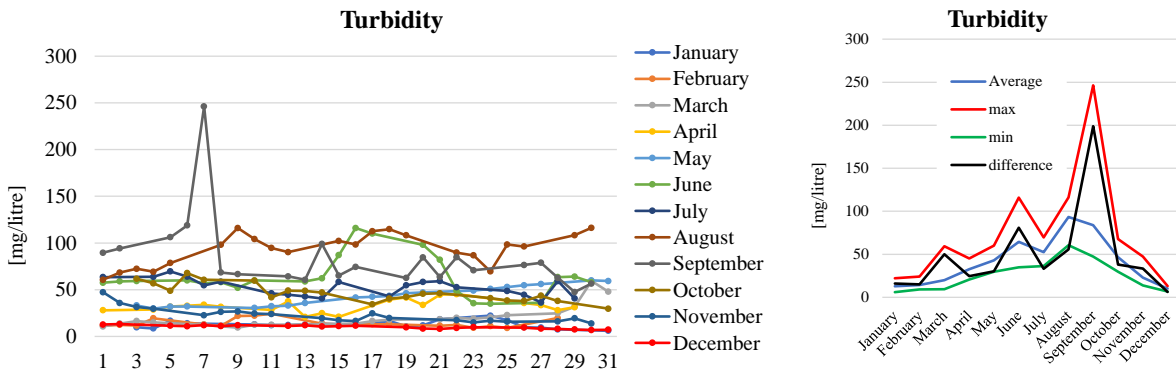Fig. 2. Temperature water of Prut river, during the year 2022

Fig. 3. Turbidity as a variation during each month of the year 2022 (left) and the average and extrem values in each month, during the same year (right)
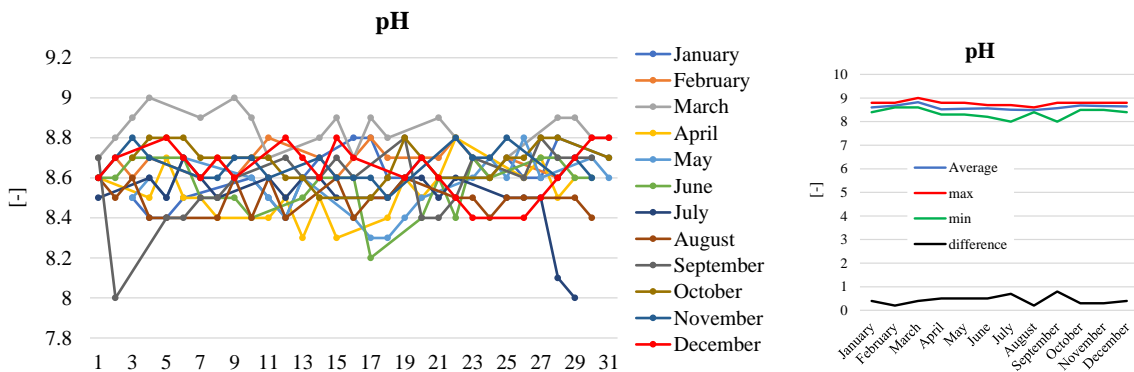

Fig. 4. Values of pH for the Prut water in 2022: evolution of this parameter for each month (left) the average and extrem values in each month, during the same year (right)

For Prut river (Fig. 3), the average values have only two bumps or peaks, in June and September, but maximum values are three local high values, that characterizing the month of September being the highest, reaching 250 mg/litre, as compared to the average value of 100 mg/litre.

For the Prut river, from April to July, turbidity values are increasing and from September to October, also this characteristic increases due to seasonal rains. In winter, the water is clear, but from spring and the rains, the water becomes more turbid, also because the tributaries of the Prut river bring clay and mud from the areas where they have been passed. At the beginning of autumn, before the rains, the turbidity has high level because of low waters and because the rains start.

This analysis of several parameters of Prut water near Cahul city is of interest due to the closeness of the sampling point and also because this river, as Siret one, is discharged in the Danube river in a same region, near Galati [8], [15].

The pH level of river water indicates its acidity or alkalinity, on a scale of from 0 to 14. The value 7.0 is for neutral water. The optimum pH for river water is considered around 7.4 [3], [16], [17]. It can be influenced by natural factors, like rocks and soil types, as well as by human activities, such as agriculture and industrial discharges and sewage. Aquatic organisms are adapted to specific pH ranges, so changes can impact their health. pH is a measure of the activity of hydrogen ions in solution. Measuring the pH value is also very important for efficient water treatment and control processes (flocculation, chlorine disinfection).

Figure 4 present the data for the year 2022, for Prut river. The maximum values were recorded for March, meaning a relationship to spring water (with high volumes and subtances brought with rain waters). The pH values for Prut river are varying in a narrow range, aprox. 8 units to 9 units. Aquatic creatures (with few exceptions) prefer a pH range of 6.5-9.0 and analyzing the plots in Figure 4, the anual values of Ph of Prut river in 2022 is supporting water life.

The alkalinity of water is related to the pH level, alkaline water is considered to be water with a pH above 7, tap water, flat water, are not considered alkaline. For water samples from Prut river, minimum values (around 2.5 mg/litre) was measured in July-August, maximum values being recorded in January, February and even March, the average value being around 4 mg/litre. Band between maximum and minimum values for the same month does not overpass 0.5 mg/litre (Fig. 5).

In temperate regions, chlorides only grow in spring, this phenomenon is due to melting snow and seasonal rains [18].

Chlorides are found in natural water salts of sodium, calcium, and magnesium. Cl− is widely distributed in natural water and is present in almost all surface waters, but the content varies in a large range, from 10 to 20 mg/L in river water to 19,000 mg/L in seawater. The source of Cl− in waters can be divided into natural sources and anthropogenic sources [19].

The two main natural sources are as follows. The water flows through the soil and rock layers containing chloride, which leads to dissolute salt deposits and sediments containing chloride in water stream. Rivers near the sea are affected by the tide, leading to an increase in the chloride presence in water. When 1% seawater is added to a water source, the chloride content increases to 190 mg/L.
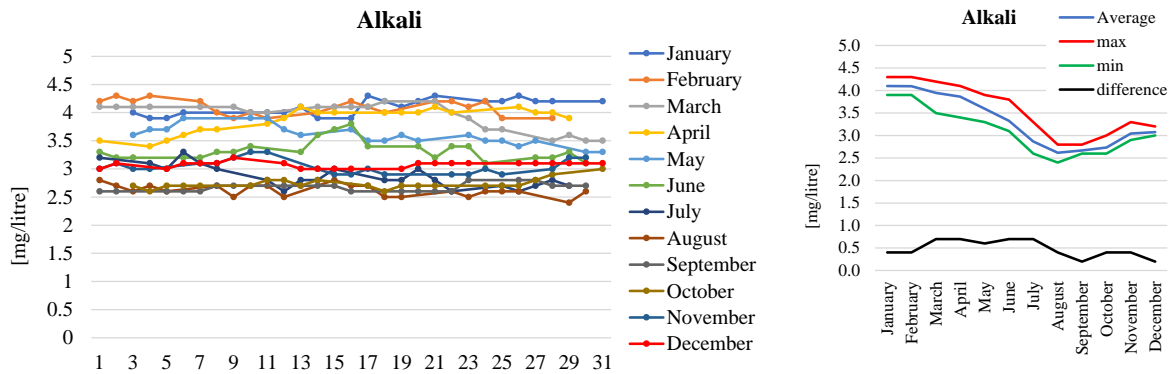

Fig. 5. Alkali content in Prut water in 2022: evolution of this parameter for each month (left) the average and extrem values in each month, during the same year (right)
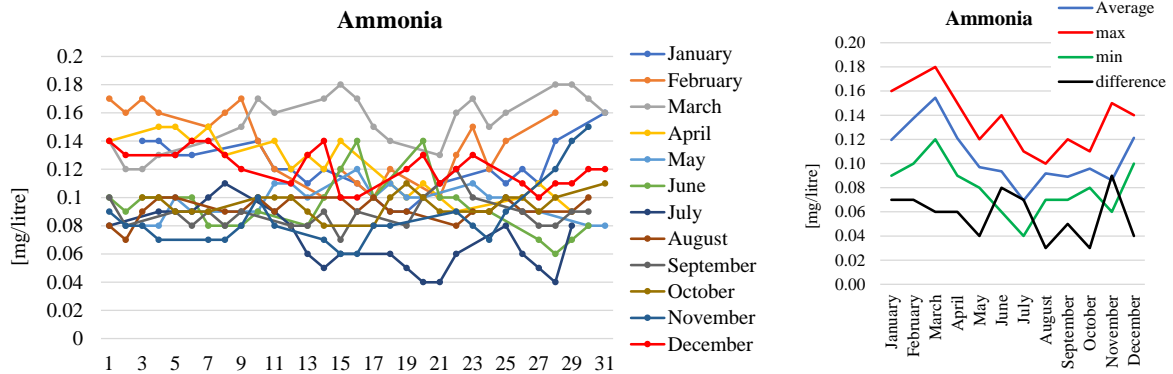

Fig. 6. Ammonia concentration during year 2022, monthly (left), annually (average calculated for each month)
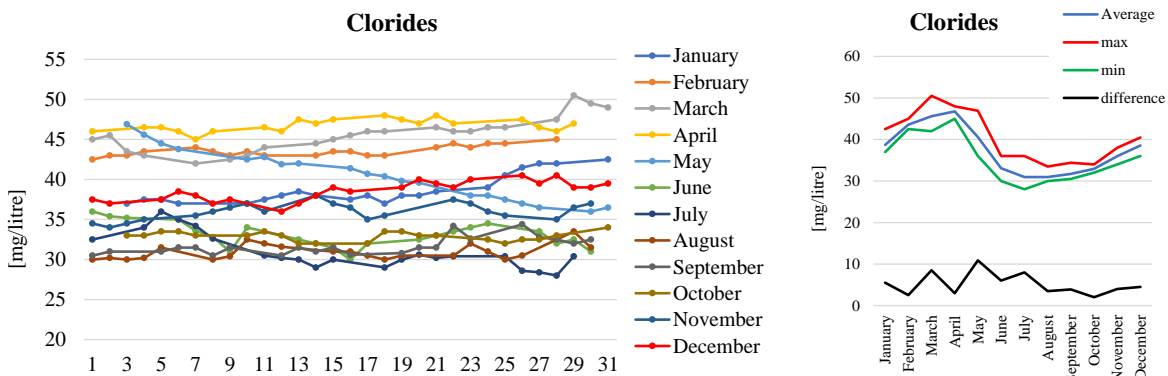

Fig. 7. Evolution of clorides in each month (left) and the annual evolution (right)

Anthropogenic sources mainly come from industrial wastewater discharges. The main sources of industrial activities are chemical, petrochemical, pharmaceutical, paper, cement, soap, textile, paint, pigment, food, machinery manufacturing, and leather industries. This type of chloride contained in wastewater discharged from production activities is the main source of chloride pollution in surface waters. In areas of human activity, industrial wastewater and domestic sewage are important sources of chloride in water bodies. The chloride content in general urban river water is much higher than that in distant suburban river water [17], [18].

For Prut river, the chloride values are 28-50 mg/litre, higher values being during February-May and lower values in summer (Fig. 7).

The color of the water varies according to the environmental and seasonal conditions. When observing relatively small amounts of water, it appears colourless, dissolved suspended elements or impurities in the water may give it a different colour. The colouring depends on the turbidity, the higher the turbidity, the higher the colouring. For the Prut river, data on color are given in Fig. 8.

Water contains organic and inorganic substances. Oxidability is conditioned by the amount of organic substances found in the water and, thus, it is an indicator of the level of organic sunstances in water, expressed in miligrams of oxygen in a litre of water and it refrects the water pollution . The quality of drinking water is maximum 5 mg O_2/litre, and as the temperature increases, so does the oxidability. For Prut river, this characteristic increases during spring rains (Fig. 9).

Naturally occurring ammonia is strictly monitored in the water source. Although ammonia is generally harmless in low concentrations, high concentrations of ammonia can cause damage and health risks. Therefore, ammonia levels must be properly monitored and maintained. For the river Prut, this characteristic is given in Fig. 6, for the year 2022. It is obvious that in summer there is a low level of amonil and higher values are recorded, between 0.12-0.14 mg/litre.

Suspended particles differ from one season to another, depending on the snow melt from the month dissolves or is entrained to the river, and therefore, the nitrate content increases in winter.
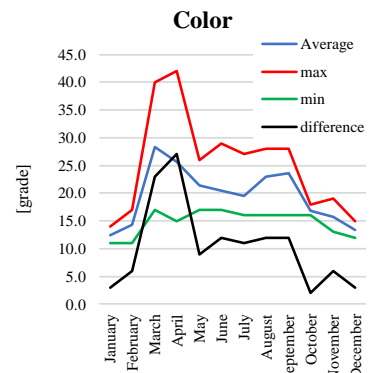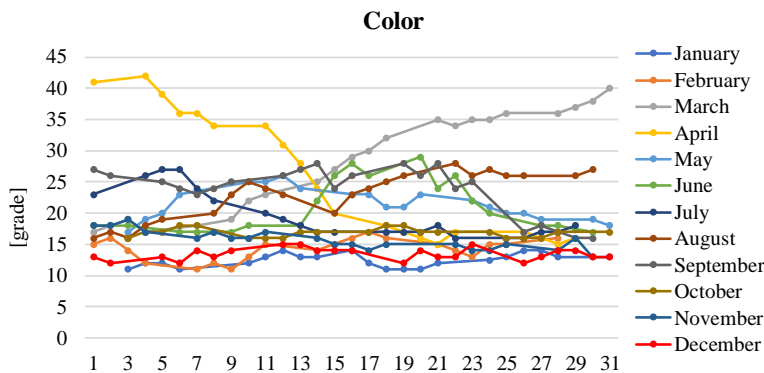

Fig. 8. Water color evolution during year 2022, monthly (left), annually (average calculated for each month)
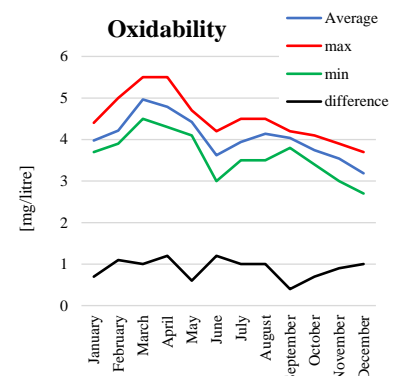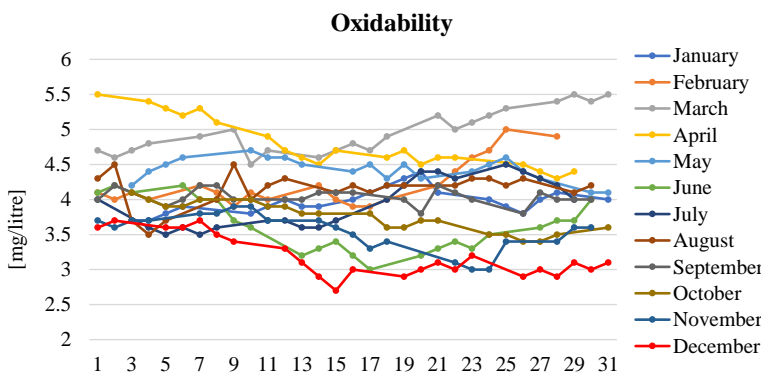

Fig. 9. Evolution of water oxidability during year 2022, monthly (left), annually (average calculated for each month)
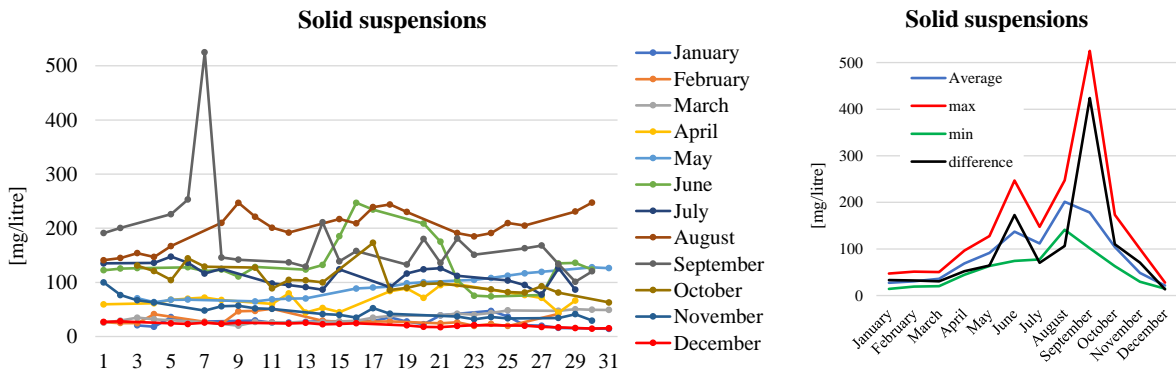
Fig. 10. Evolution of solid suspensions during year 2022, monthly (left), annually (average calculated for each month)
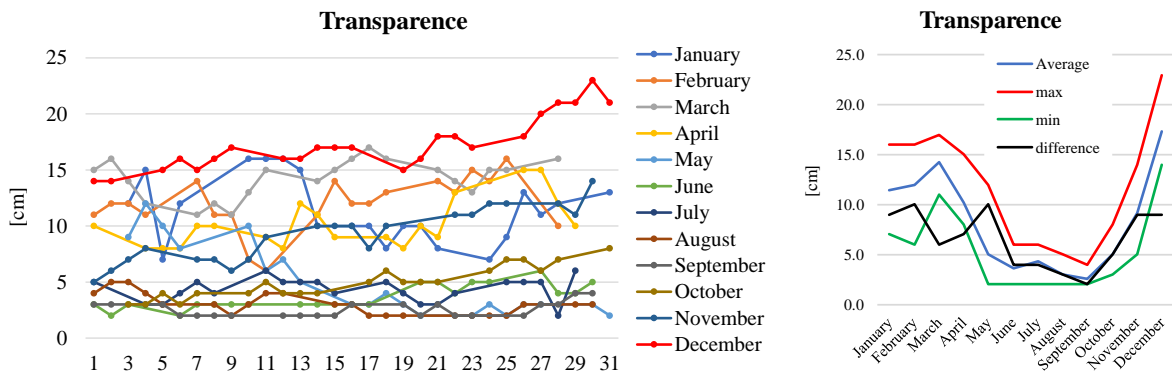

Fig. 11. Evolution of transparence during year 2022, monthly (left), annually (average calculated for each month)

Any solid material that can be transported by water, wind or ice could form sediments [6]. They include soil particles (silt, sand and clay) that are deposited on the bottom of a river bed. These particles are classified by size from the smallest (clay is less than 1…2 μm in diameter) to the largest (coarse sand is up to 1.5-3 mm) [7]. Silt is positioned in between, ranging from 5 μm to 50 μm. For the year 2022, the montly characterization of solid suspensions in Prut river is given in Fig. 10 left and the average value during the entire year 2022 is given in the same figure, but right position. In winter this value is low, but it increases in May-June and in the first month of autumn (September and October).

Nitrates are found in different forms in land and aquatic ecosystems. These include ammonia (NH_3),

nitrates ($-NO_3$), and nitrites ($-NO_2$). Nitrates are essential plant nutrients, but in excess they can cause significant water quality issues. Together with phosphorus components, nitrates in excess can increase eutrophication, causing increases in aquatic plant growth and changes in the types of plants and animals that live in the water. This, in turn, affects dissolved oxygen, temperature and other water characteristics. Nitrates in excess can cause hypoxia (low levels of dissolved oxygen) and can become toxic to warm-blooded animals at higher concentrations than 10 mg/L). The natural level of ammonia or nitrate in surface water is typically low (less than 1 mg/litre); in the effluent of wastewater treatment plants, it can range up to 30 mg/litre [20].
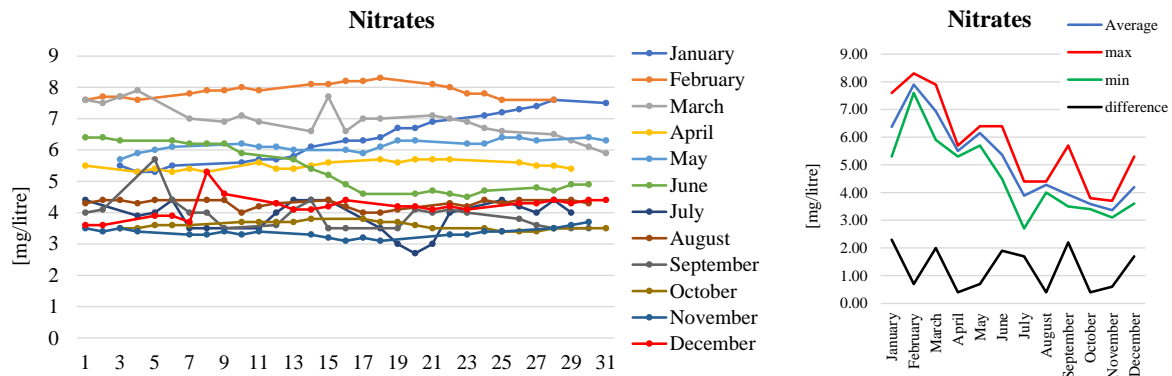

Fig. 12. Nitrates concentration during year 2022, monthly (left), annually (average calculated for each month)
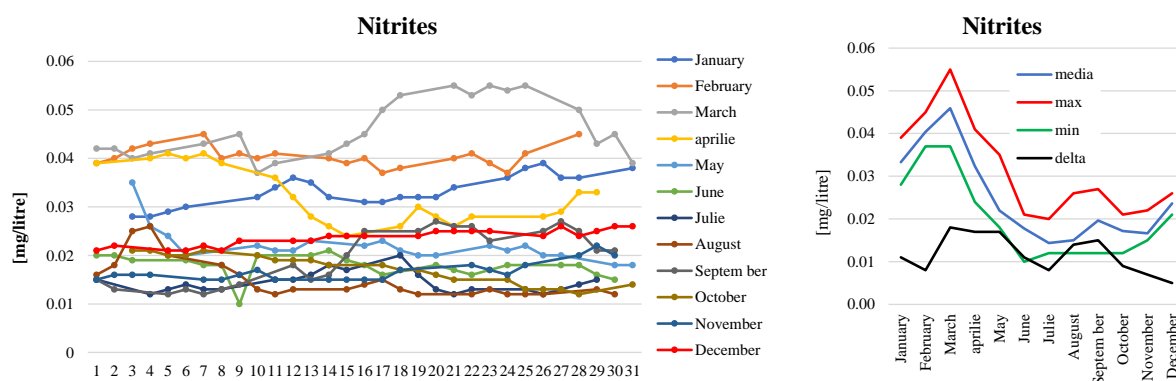
Fig. 13. Nitrites concentration during year 2022, monthly (left),
annually (average calculated for each month)

3. CONCLUSIONS

Water parameters could be grouped into two classes
- parameters that are not depending on the year seasons,
- parameters that are depending on the year seasons

Each river has its particularities in the evolution of the analyzed set of characteristics.

Based on the survey during the year 2022, the following conlcusions on water of river Prut could be drawn:

Prut river has particular evolutions of its characteristics due to its geographical position and specific climate.

The dependences of analyzed characteristics mainly on seasons reflect that human activities is not yet dominant in modifying these parameters.

Also, its role as water border between Romania and Moldova should be taken into account when analyzing the data presented in this paper, as many human and agricultural activities around rivers are of low intensity as compared to internal water.

ACKNOWLEDGEMENT

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