How to cite: Vigh, M., Horváth, Cs., Pandi, G. (2020) Water Quality of the Ţiganilor River Catchment in Cluj Napoca. *2020 "Air and Water – Components of the Environment" Conference Proceedings*, Cluj-Napoca, Romania, p. 247-256, DOI: 10.24193/AWC2020_23.

WATER QUALITY OF THE ŢIGANILOR RIVER CATCHMENT IN CLUJ NAPOCA

Melinda VIGH[1], Csaba HORVÁTH[2], Gavril PANDI[2],

DOI: 10.24193/AWC2020_23

ABSTRACT. The Ţiganilor River catchment covers both built areas and the green/natural areas of the Botanical Garden. As we will see, the location influences differentially the quantitative and qualitative hydric processes of the stream. Situated in a city with a particularly dynamic development, where the emphasis is on preserving a healthy natural and anthropic environment, this obliges the monitoring and evaluation of the aquatic bodies' qualitative parameters. We assessed this through two measurement campaigns, when parameters were determined in situ and in the laboratory. The physico-chemical parameters evaluation allowed the water classification in different quality classes. At the same time, there were sections where the water quality did not comply with the national regulations, and so they require further monitoring. Such situations where identified regarding the concentration of hydrogen ions, chlorine, nitrates, sulfates, sodium, magnesium and calcium.

Keywords. river catchment, sampling section, physico-chemical parameters, trends, extreme values, outliers.

1. INTRODUCTION

In recent decades, Cluj has become one of the most dynamic cities of Romania. The accelerated increase in the number of inhabitants is due primarily to the social absorption, but we must also mention the positive natural growth of the city. Only in the last five years Cluj residents number increased by 2%. Today Cluj has almost half a million people, along with Floresti, Apahida and Baciu. By estimates, its metropolitan area is expected to reach 500,000 inhabitants by 2030, and in 30 years it will have 800,000 inhabitants (Cristea, 2017).

The city of Cluj has strengthened its role to be one of the most important academic, cultural, industrial and business centers in Romania. This is where the leading universities, famous cultural hubs, prestigious national, international research and production centers are based. At the same time, the touristic function of the city has accelerated, by highlighting several local and neighboring tourist objectives, to which the airport development and the motorway proximity have also contributed substantially.

[1] Babes-Bolyai University, Faculty of Environmental Science and Engineering, Cluj, Romania vmelindap@yahoo.com
[2] Babes-Bolyai University, Faculty of Geography, Cluj, Romania hcsaba@gmail.com gavril.pandi@geografie.ubbcluj.ro

As a result, today the city ensures a high living standard, by managing its labor force, increasing the number of employees and reducing the unemployment rate. In the city's general development strategy, beside the stimulation of the economy and facilitating innovation, research and technology, tourism development occupies also an important place.

Taking all of this in consideration, the metropolitan area of Cluj fully deserves the status of the emerging second metropolis of Romania. Of course, this affects the psychological comfort zone of some of its inhabitants, but this is an inevitable connotation of any region's accelerated pace of development.

In this context, quantitative-qualitative assessment of natural and anthropogenic spatial units in the city is necessary, even mandatory.

2. CHARACTERISTICS OF THE RIVER CATCHMENT

The catchment of the Țiganilor River drains two strategic areas of the city: the residential Zorilor and Europa districts, with a strong and dynamic urban development, and the Botanical Garden, one of the main tourist objectives. The two zones are different from all points of view, which puts their mark on the characteristics of the runoff and the quality of the water. Downstream of the Garden, due to the underground channeling of the stream, the river catchment was practically abolished.

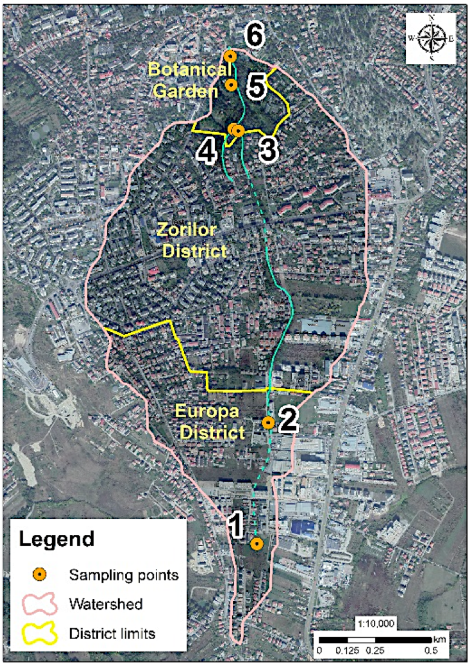

Fig. 1 ***Țiganilor catchment 1-spring, 2-Meteor str., 3-Botanical Garden, 4-tributary, 5-waterfall, 6-gauge***

The surface area of the river catchment measures 1.78 km^2, and the average altitude is 452 m. The average slope of the basin is 5.9% and in 90% has a Northern slope aspect. Due to the two areas with completely different characteristics, the land use is quite contradictory. In the districts, which occupy 94% of the catchment, buildings and streets cover important areas, where the infiltration coefficient is very small. In the Botanical Garden (only 6% of the river basin) the land is covered with woody vegetation and in a smaller proportion with grasses, which favors the infiltration process. Of course, these factors have completely different effects on the physical and chemical characteristics of the rivers' water.

The substrate is made of Sarmatian sands with varying thicknesses, reshaped due to the slopes slipping and sliding. These deposits include Feleac Concretion and were characterized by numerous occurrences of groundwater on the surface which disappeared due to the constructions. The clay areas are restricted to the upper part of the catchment. (Ujvari, 1961).

The Țiganilor stream originates from a small depression, behind a landslide wave, near Alecu Russo Street (Europa district). The groundwater reaches the surface and forms a small lake in the rainy periods, and disappears completely when it is drought. It flows to the limit of the Botanical Garden, sometimes on the surface between houses, and sometimes it is channeled, with an average slope of almost 6%. Depending on the character of the substrate and the surface geomorphological processes, the depth of the valley varies greatly. In the Garden the slope increases up to 9%, the stream deepens in the friable formations and the Feleac Concretion appears on the surface.

Here the stream receives a short-left tributary (only 0.28 km), which starts at the intersection of Cireșilor and Caisului streets. The rather strong flow indicates, however, the existence of a relatively large hydrographic sub-basin (0.53 km^2) with a significant underground supply. Also, from the left there is an outlet in the Țiganilor River arranged in the form of a waterfall. The water is completely drained, underground, and the spring should be somewhere near the Zorilor street, resulting in a length of 250-300 m. The stream exit from the territory of the Botanical Garden takes place through a tube with a variable diameter between 1200-2600 mm, which leads the water over a distance of 1057 m, up to the Morii Canal, in the Sindicatelor street.

3. DATA AND METHODS

The analyzed data come from six representative sampling points, from the main course and its tributaries. The first point is at the spring, which is in the Europa district, a depression with a small lake. The second sample was taken on Meteor Street, where the water of the stream flows through a concrete channel. The third sampling point is in the Botanical Garden, the water flowing again into the natural riverbed. Also, in the Botanical Garden there are two sampling points on the two tributaries on the left. The first one has a natural channel, and the second one has a regularized course and opens through a concrete channel in form of the waterfall. The last sampling point is before the exit of the Țiganilor River from the Botanical Garden, at the gauge placed by us on the stream.

Two sampling campaigns were carried out during the year 2019. One in March, after a rainy period, and the second in October, after a dry summer which prolonged until the autumn.

Two types of measurements were made at the six sampling points. In the field a portable Hanna WTW 320i multiparameter was used, which determined the hydrogen ion concentration, conductivity, salinity, dissolved substances and Redox potential. In the laboratory, the dissolved ions (F^-, Cl^-, Br^-, NO_2^-, NO_3^-, PO_4^{3-}, SO_4^{2-}, Li^+, Na^+, Ca^{2+}, Mg^{2+}, NH_4^+, K^+) were analyzed. Prior to chromatographic ion analysis, the water samples were filtered through 0.45 μS / cm porosity filters and diluted with ultrapure water (18 MΩ) to an electrical conductivity of 100 µS / cm, at the recommendation of the device manufacturer because, samples too loaded with substances lead to the rapid destruction of the ion column.

The results of the analyzed parameters were compared with the admissible values of the Ministerial Order 161/2006, in order to establish the ecological status of the Romanian national water bodies.

It should be mentioned that the dissolved ions of fluorine, bromine, lithium, nitrites, phosphates could not be identified due to the very low concentrations, and the ammonium ions only existed in some samples.

4. RESULTS

Hydrogen ion concentration (pH)

It has a general tendency of growth in both periods of analysis from the spring to the outflow. In March, a continuous growth is observed until entering the Garden, and in October a stronger inflection on the tributary. The average values are higher in spring (9.0) than in autumn (7.6). This is due to the contribution of inorganic substances reached in the river, during the rainy spring season.

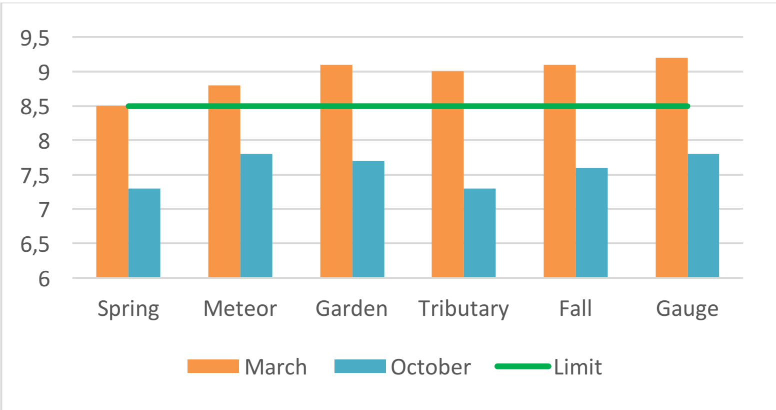

Fig. 2. ***Variation of the pH***

During March, at all sampling points, the pH value exceeded the threshold of 8.5 imposed in the national legislation for surface waters. Monitoring of this parameter is required in the following seasons as the presence of high pH values can induce negative effects on the aquatic ecosystems in the area.

Total Dissolved Solids

TDS values increase throughout the first sector, due to the newly developed urban district which is crossed. The maximums are almost identical in March on Meteor Street and at the entrance to the Garden (509 and 510 mg / l). The highest value in the autumn is recorded at Meteor street (436 mg / l). Through the Garden the concentration of dissolved solids decreases substantially. The two tributaries also show low values. The minimum (below 100 mg / l) is observed at the waterfall in both samplings. All EC values are higher in spring than in autumn.

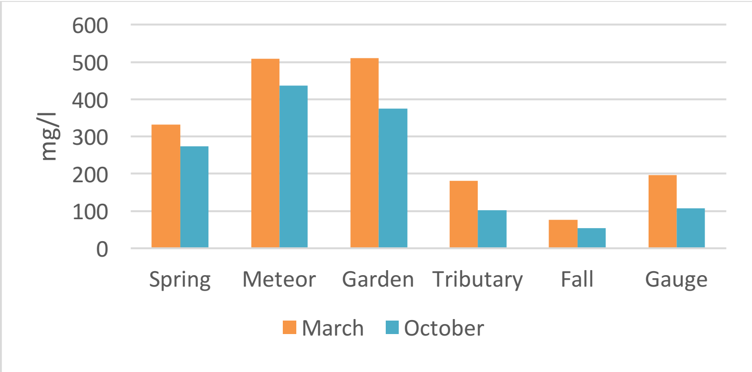

Fig. 3 ***Total dissolved solids values variation***

Conductivity

The variation of the conductivity has the same evolution as the TDS, because it is directly proportional to the quantity of dissolved salts. The maximum values are found at Meteor Street and at the entrance to the Botanical Garden, and the minimum values at the waterfall tributary. And here in March were higher values than in October. The high values for EC and TDS recorded in the first three monitoring points may indicate the presence of a high content of dissolved salts, especially inorganic salts.

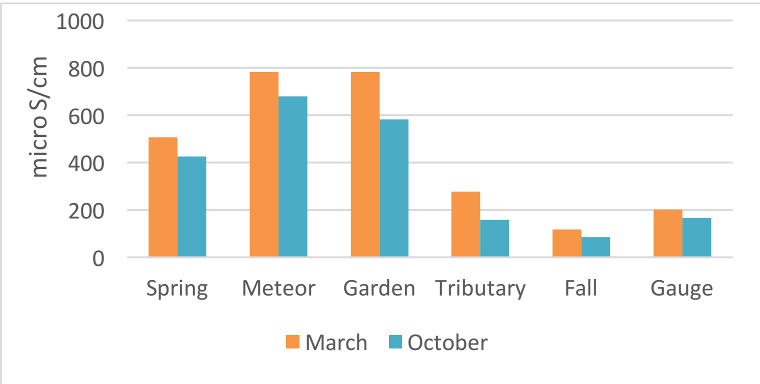

Fig. 4. ***Conductibility values variation***

Redox potential

In March the values have a nearly continuous decreasing evolution, from -86 mV to -140 mV, the only difference appears at the waterfall. In October, there is an irregular variation, with high values at the source (-22 mV) and tributary (-8 mV), after which it decreases until leaving the Garden. The largest difference between the two measurements is at the tributary (-8 mV in March, -130 mV in October). We can observe the inverse proportional correlation between the pH values and the redox potential. This is normal, because the alkaline pH leads to the inhibition of the oxide - reduction capacity, especially due to the dominance of the hydroxide ions.

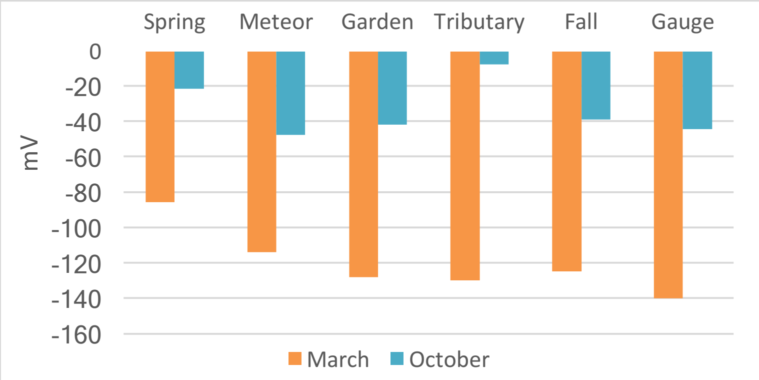

Fig. 5. ***Redox potential values variation***

Salinity

This parameter has higher values upstream of the Botanical Garden. The maximums (0.3‰) are reached in the Meteor section, a value that extends to the Garden in March. At the tributary and waterfall, the values are both zero. In March, there is a slight increase in the gauges' section (0.1‰), and in October the value is zero. The amount of salt in the water sample is very small so it cannot be detected by the multiparameter used, a device with much greater accuracy would be needed. The low values of the conductivity and of the chlorine, calcium, magnesium, sodium and sulphate ions emphasize that in the respective samples the percentage of salts is reduced.

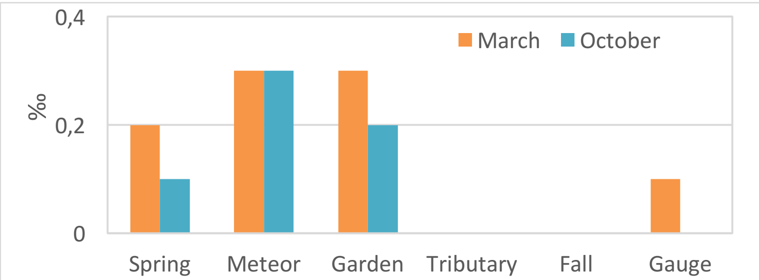

Fig. 6. ***Variation of salinity***

Chlorine

The chlorine concentration increases from the spring to the Botanical Garden, where the maximums are recorded (66 mg / l and 76 mg / l respectively). At the waterfall, the values are the lowest (11 mg / l, respectively 7 mg / l). At the outflow of the Garden there is an increase, up to about the values from the spring. The chlorine content recorded in the Meteor sampling points and the Botanical Garden is relatively high, these water samples falling into the moderate ecological quality class (Order 161/2006). After the confluence of the tributaries, due to the dilution process, the chlorine content decreased, falling into the 1st (very good ecological state) and 2nd (good ecological state) quality class.

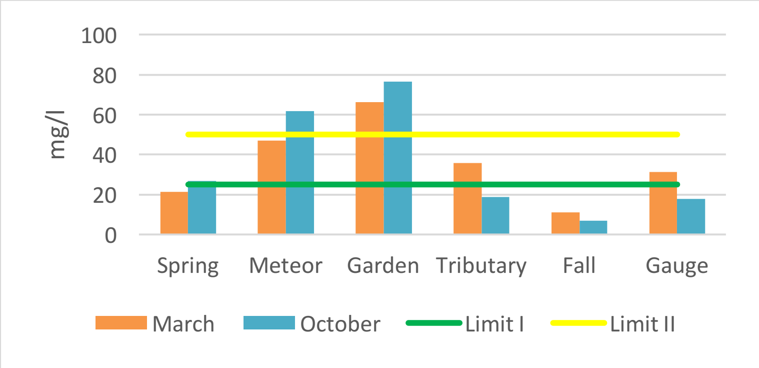

Fig. 7. ***Chlorine variation***

Nitrate

It oscillates in both measurement campaigns, but with a general tendency of growth. The lowest values are at the source, below 1 mg / l. At the waterfall, there is a negative inflection, both in spring and autumn. The maximum values are recorded at the exit of the Garden in spring (15 mg / l), respectively at the entrance in the Garden in the autumn (11 mg / l). The high concentration of nitrates at three of the six sampling points, at both samples, places these water bodies in the 4th water class (bad ecological state). At Meteor Street and the waterfall, in March, the water concentration of nitrates is between 3-6 mg / l, so in 3rd quality class (moderate ecological state). Considering the seasonal fluctuations identified in the present study, it is necessary to monitor the nitrates during the following seasons.

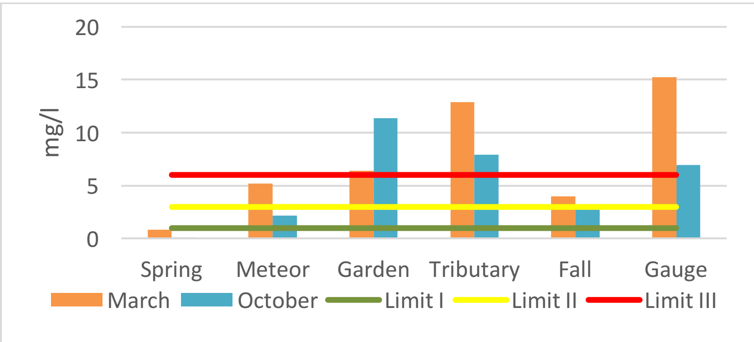

Fig. 8. ***Nitrate variation***

Sulfate

The evolution of the two samples is almost parallel within the Botanical Garden, with minimum values (9 mg / l) at the waterfall. Upstream, a stability around 80 mg / l is observed in March, in October there is a very pronounced peak (107 mg / l) at the Meteor section. In general, the sulphate content of the first three sampling points is classified in the 2nd quality class (between 60 and 120 mg / l).

For the rest of the sampling points it is lower, corresponding to the 1st class waters (very good ecological condition).

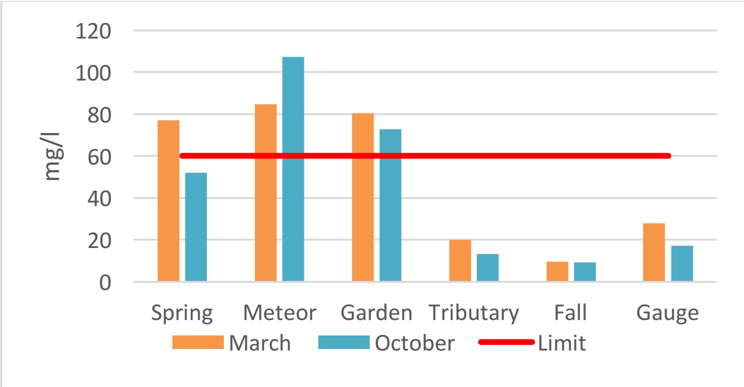

Fig. 9. ***Sulfate values variation***

Sodium

The trends variation is almost the same in both measurement campaigns. The values increase from the spring to the entrance to the Botanical Garden, where the maximums are recorded (49 mg / l in March, 47 mg / l in October). Minimum values are at the waterfall (6 mg / l in March, 4 mg / l in October), after which there is a slight increase. From the point of view of the sodium content, the water samples taken from the first three points fall into 2nd quality class. As a result of dilution with the two tributaries, the sodium content decreases, falling into the 1st quality class (very good ecological condition).

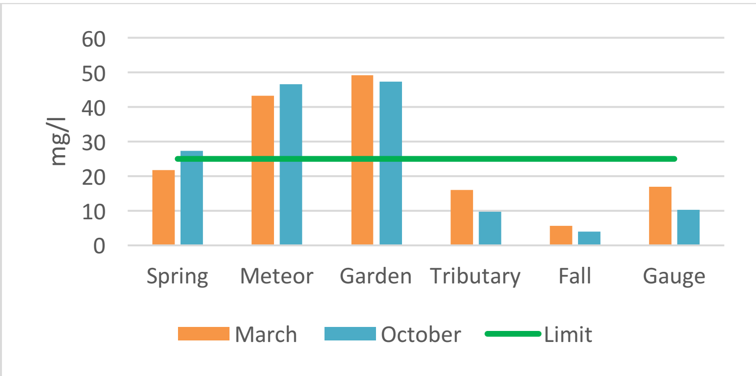

Fig. 10. ***Sodium values variation***

Potassium

The potassium content fluctuated differentially in the two sampling moments. Significantly higher values were recorded in the first two river sectors in October. We note the maximum value recorded in October at the sampling point in the Botanical Garden (7.68 mg / l). On the two tributaries and at the gauge the values where close in both samplings because of the dilution process. The high concentration recorded at the Botanical Garden sampling point may be correlated with the application of fertilizers in the area (mainly houses with gardens), it is interesting and it needs further analysis why the nitrate values didn't show increases.

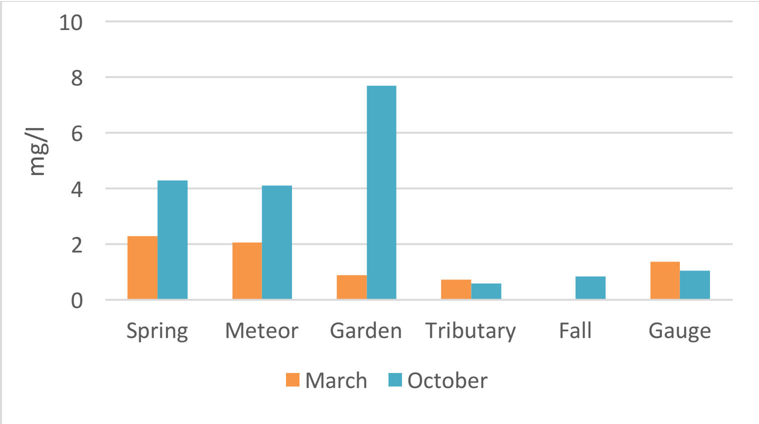

Fig. 11. ***Potassium values variation***

Magnesium

It resembles the variation of the sulphates, with an almost parallel trend in the Botanical Garden, and in the upper basin a relative stability in March and a maximum in October in the Meteor section (17 mg / l). The minimum values are at the two tributaries and at the outflow of the Garden. The water samples taken from the Meteor street point, on both dates, and the entrance in the Garden, in March, fall into the 2nd quality class. The rest of the water samples correspond to quality 1st class, which represents a very good ecological condition.

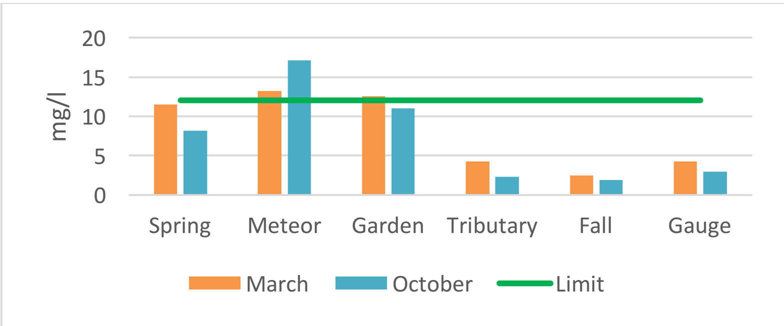

Fig. 12. ***Magnesium values variation***

Calcium

The trends of variation are similar in the two measurements campaigns. The highest values are recorded in the Meteor street section (127 mg / l, respectively 143 mg / l). In the lower part of the watercourse, as well as the tributaries, the values are small. The minimum values are registered at the waterfall (9 mg / l in March, 18 mg / l in October). From the point of view of calcium content, the waters taken from the spring area fall into the 2nd quality class (good ecological condition), and those from the Meteor and Garden sections correspond to 3rd quality class, representing a moderate ecological state. After dilution with the tributary waters, the calcium content decreases, and so the water samples fall into the 1st quality class.

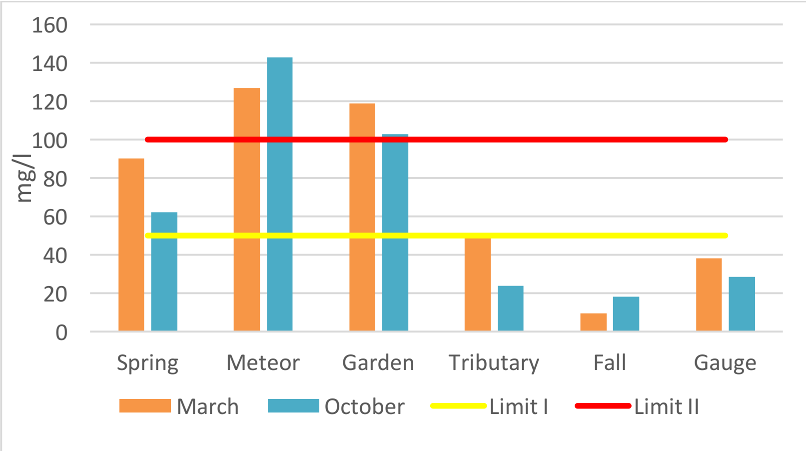

Fig. 13. ***Calcium values variation***

4. CONCLUSIONS

The analysis of the water bodies quality in the Ţiganilor River indicates a good overall ecological state. In case of most physico-chemical parameters, the water falls into very good and good quality classes. There are problems with nitrate concentration, where some water bodies belong to the 4th quality class.

The location of the hydrographic basin in the urban built up area of the city and the existence of the Botanical Garden in the lower part requires a continuous water quality monitoring in the Ţiganilor River catchment, and also where the quality is not good, improvement measures must be taken.

REFERENCES

1. Cristea M. (2017): *Cluj 500K*, cluj.info
2. Ministerul Mediului şi Gospodăririi Apelor, Ordinul 161/2006, *Normativ privind clasificarea calităţii apelor de suprafaţă în vederea stabilirii stării ecologice a corpurilor de apă*
3. Ujvari I. (1961): *Observaţiuni hidrologice în Grădina botanică din Cluj*, Studia UBB, Geologia-Geographia, Cluj
4. INESA (2010): *PUG-Raport de mediu pentru planul urbanistic general al Municipiului Cluj Napoca*
5. Jamie Bartram & Richard Ballance (1996) *Water quality monitoring : a practical guide to the design and implementation of freshwater quality studies and monitoring programs*, Published on behalf of United Nations Environment Programme and the World Health Organization
6. Pop S.O. (2014): Municipiul Cluj – Napoca – Monografia, dinamica si estetica peisajului urban, Rezumat teza de doctorat, Cluj