

ESTIMATION OF THE QUALITY OF WATER (CONCENTRATION OF NITRITE, NITRATE, PHOSPHATE, AMMONIAC, SULFATE AND CHLORIDE) IN THE LAKE CRNO JEZERO AT THE DURMITOR MT. FROM 2010 TO 2014

Tatjana Djekić¹, Dragana Vušković¹, Danica Srećković-Batočanin²

¹ *University of Niš – Faculty of Sciences, Višegradska 33, Niš, Serbia*

² *University of Belgrade-Faculty of Mining and Geology, Djušina 7, Belgrade, Serbia*

Abstract: The Lake Crno jezero is the largest and the most prominent lake on the Durmitor Mountain and is the second largest mountainous lake in Montenegro by surface area. By its natural and overall potentials Durmitor represents the pretty rare area in Montenegro that is practically lack of anthropogenic influence. The goal of this paper is to present and take into consideration the quality of lake water within the period 2010 to 2014. Comparative analysis of concentrations of nitrate, nitrite, phosphate, ammoniac, sulfate and chloride in the lake with proposed values by the Law on waters (Official gazette of Montenegro, no. 27/07) was performed, taking into consideration the existing regulative that has importance for better understanding of determined concentrations and their impact.

Key words: environmental protection, Crno jezero Lake, nitrate, nitrite, phosphate, ammoniac, sulfate, chloride

1. Introduction

The first scientific and systematized data on lakes at the Durmitor mountain gave Jovan Cvijić: “Where slopes of the massif meet the surface carved inside rocks and bordered with moraines occurs the deepest lake basin in the area of the Durmitor: lake Crno jezero with depth of 48m“(Cvijić J. 1924).

All lakes at the Durmitor Mountain are in general with chemically and bacteriological safe waters. Lakes display normal thermal stratification during summer and inverse during winter, when are snow covered (Stanković S. 1995).

The lake Crno jezero is the largest and the most famous lake at the Durmitor Mountain, and is the second mountainous lake by surface area in Montenegro. It is situated beneath the giant Međed, where the strong spring

Čelina appears in spring, when a snow starts to melt. The lake consists actually of two aquatic regions, Lake Malo and Lake Veliko jezero, which are separated by narrow land form known as “struga”. The length of lake (including both basins) is 1155 m, and the maximal width is 810 m. The lake has the surface area of 515 m². It is placed at the 1418 m a.s.l. The Lake Malo jezero is 49.1 meter deep, and the Lake Veliko jezero is 24.5 meters deep. Temperature of water in summer exceeds 22°C, thus being a very pleasant for swimming (Cerović B. 1979, <https://durmitor.wordpress.com/nacionalni-park/jezera/>).

Comparative analysis of concentrations of nitrate, nitrite, phosphate, ammoniac, sulfate and chloride in the lake Crno jezero at the Durmitor Mt., was performed utilizing data of the Institute for hydrometeorology and seismology of Montenegro.

2. Methods of study

The Institute for hydrometeorology and seismology of Montenegro (<http://www.meteo.co.me>), Department for the quality of water in Montenegro performs four series of measurement for the period June-October. This is a period of low water level, and the highest pollution as well as the highest use of water particularly for bath. All measurements and monitoring of the water quality take part in the Laboratory for the analyzing a water quality, which is accredited for sampling and testing according to the standard MEST EN ISO/IEC 17025:2011.

The appropriate analytical techniques: volumetric, electrochemical, gravimetric, spectrophotometric, flame photometry and membrane filtration methods are use for the assessment of physicochemical, microbiological and saprobiological parameters. Analytical procedure encloses two steps: field-work and the laboratory. This should incorporate a carefully notification and recording of meteorological and hydrodynamic parameters as well as organoleptic properties, a general appearance of water and the location of sampling point.

This paper takes into consideration results of studies performed in the Lake Crno jezero over raft from 2010-2014. Activities of the Section for monitoring and assessing water and air quality determine the Law of hydrometeorological activities ("Official gazette of Montenegro", no. 026/10 from 07.05.2010; 040/11 from 08.08.2011 and 030/12 from 08.06.2012);

Law on waters ("Official gazette of Montenegro", no.27/07); Act on organization and way of work of the state governance ("Official gazette of Montenegro", no. 5/12) as well as by another national rules. Activities of the Section are adjusted with the program of the World meteorological organization (WMO). Analysis of qualitative properties of water regarding the presence of mineral compounds of nitrogen (N), chlorine (Cl), sulfate (SO₄), and phosphorous (P) were performed in aim to determine a class of surface waters, their categories and quality in respect to recommended quality level, which has been defined by the Act on categorization of waters in Montenegro ("Official gazette of Montenegro", no. 2/07).

3. Obtained results

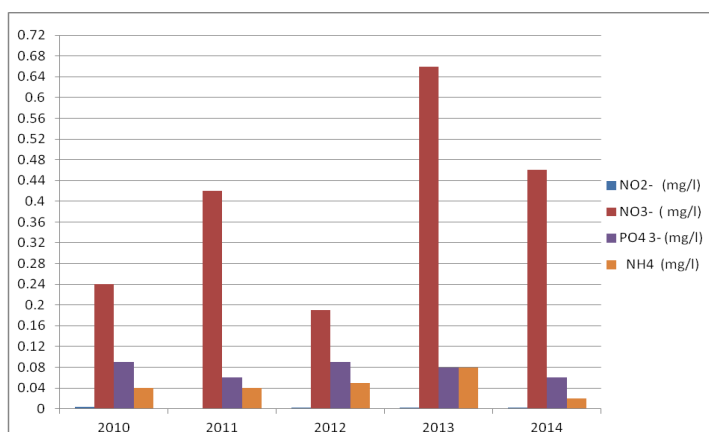
The maximal allowed quantities (MAQ) according to the Act on categorization of waters in Montenegro (Off. Gaz. of MNE, no. 2/07) determine a various classes. For the class "A" is it a 10 mg/l of nitrate, nitrite from 0.00 to 0.002 mg/l, phosphate 0.01 mg/l, ammoniac 0.00 mg/l, and for chloride is 10 mg/l. For the class A1, the MAQ of nitrate is 20mg/l, nitrite 0.003 mg/l, phosphate 0.02 mg/l, chloride 20 mg/l, sulfate 20 mg/l. For the class A2 recommended concentrations of nitrate is 25 mg/l, nitrite 0.005 mg/l, phosphate 0,05 mg/l, chloride 40 mg/l, and sulfate 50mg/l. In the class A3 is nitrate 50 mg/l, nitrite 0.02 mg/l, phosphate 0.10 mg/l, chloride 200 mg/l, and sulfate 200 mg/l. Obtained results were taken in consideration in agreement with the existed laws and sub laws acts: Act on categorization of waters in Montenegro (Off. Gaz. of MNE, no. 2/07), the Law of hydrometeorological activities (Off. Gaz. of MNE, no. 26/10), the Law on waters (Off. Gaz. of MNE, no.27/07), and Act on organization and way of work of the state governance (Off. Gaz. of MNE, no. 5/12). It was estimated for the observed period that the Lake Crno jezero considers to A1 class in water quality, although with a discrepancy. Identified concentrations of nitrite, nitrate, phosphate and ammoniac are given in the Table 1, while for chloride and sulfate results are in the Table 2.

It could be concluded that according to the obtained results for concentrations of nitrate and nitrite (table 1) and to the Act on categorization of waters in Montenegro (Off. Gaz. of MNE, no. 2/07) the lake Crno jezero corresponds to classes A and A1. The highest concentration of nitrate was recorded in 2010, while the lowest concentration was in 2012. The latter is

almost four times less than the maximal value. Maximal amount of nitrite was recorded in 2013, whereas the lowest value, actually lack of it, fits to 2011.

Table 1. Concentrations of nitrite, nitrate, phosphate and ammoniac in mg/l from 2010 to 2014 measured from raft on the Lake Crno jezero

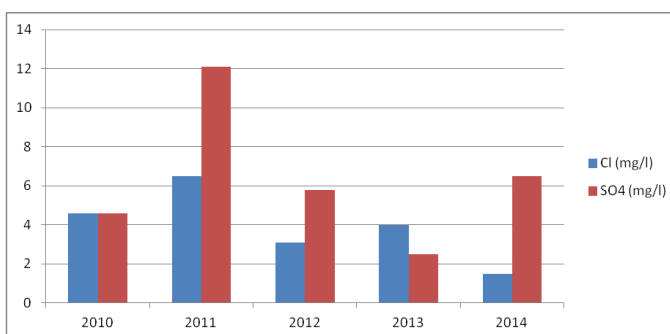
	2010.	2011.	2012.	2013.	2014.
NO ₂ ⁻ (mg/l)	0.003	0.000	0.002	0.002	0.002
NO ₃ ⁻ (mg/l)	0.24	0.42	0.19	0.66	0.46
PO ₄ ³⁻ (mg/l)	0.09	0.06	0.09	0.08	0.06
NH ₄ (mg/l)	0.04	0.04	0.05	0.08	0.02



Graphic 1. Graphical presentation of results from the table 1.

Table 2. Concentrations of chloride and sulfate in mg/l from 2010 to 2014 measured from raft on the Lake Crno jezero

	2010.	2011.	2012.	2013.	2014.
Cl (mg/l)	4.6	6.5	3.1	4.0	1.5
SO ₄ (mg/l)	4.6	12.1	5.8	2.5	6.5



Graphic 2. Graphical presentation of results from the table 2.

Maximal amount of nitrite was in 2013, and the lowest in 2011 when nitrites were practically absent. Mentioned discrepancy is related for concentrations of phosphate and ammoniac that correspond water samples to a class A3. The reason for it is most probably sampling from shallow depths, which is commonly populated by grasses. The highest concentration of phosphate was recorded in 2010 and in 2012, while the lowest values were in 2011 and 2014. Maximal amount of ammoniac was measured in 2013, and the lowest, yet four times smaller in the next 2014. The data given in the table 2 reflects that the amounts of sulfate and chloride are within the recommended range MAQ during the period of observation. According to the "Act on categorization of waters in Montenegro" (Off. Gaz. of MNE, no. 2/07) these quantities classify water to the class A. Maximal values for both was recorded in 2011. Minimal quantity of chloride was recorded in 2014, whereas for sulfate it was the year 2013 (almost five times smaller than the maximal measured concentrations in given period).

Water from the Lake Crno jezero may be used for breeding of precious fish species (salmonids). This possibility classifies water to S class, which fulfills all requirements regarding quality of the class A1. In term of bathing is water of class K1 meaning really excellent for it.

4. Conclusion

According to the above noted facts water from the Lake Crno jezero corresponds to A1SK1 classes. Concentrations of nitrite, nitrate, phosphate, ammoniac, sulfate and chloride measured from raft, are variable throughout a year but remain within the MAQ range, which is proposed by the Act on categorization of waters in Montenegro" (Off. Gaz. of MNE, no. 2/07). Variable concentrations could be explained by sampling a shallow-depth waters, which are often grasses populated. Additionally, the influence of a natural process, such as the presence of evergreen trees and their physiologic products, along with the anthropogenic influence caused by numerous visitors, fishermen and swimmers should not be excluded.

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- <http://www.meteo.co.me>