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ANALYSIS OF PHYSICOCHEMICAL PARAMETERS AND TOTAL AMOUNTS OF MICROORGANISMS IN LAKE VLASINA

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Abstract: The comprehensive examination of Like Vlasina microorganism levels and physico-chemical parameters during summer and winter aimed to assess water quality. The temperature ranged from 2 ^{0}C to 24 ^{0}C, pH from 6.20 to 8.40. Key indicators, such as ammonia 0.109-0.387 mg dm^{-3}, nitrates 0.111-0.320 mg dm^{-3}, and nitrites 0.002-0.025 mg dm^{-3}, displayed distinct patterns. The count of mesophilic aerobic hemoorganotrophic microorganisms was lowest in winter 100 and peaked in summer 63500 no x 10^{-3} dm^{-3}
Nitrogen gradients increased with depth. Emphasizing the need for continuous monitoring to prioritize lake protection and address pollution, ensuring its sustained revitalization.

Keywords: microorganisms, temperature, pH, nitrogen gradients

Introduction

Vlasina Lake is located in southeastern Serbia on the territory of the municipality of Surdulica, 30 km from the South Morava valley to the west and from the Serbian-Bulgarian border to the south. It covers the greater part of the Vlasina Plateau. Located at 1,213 m above sea level and covering an area of 16 km^2. Vlasina Lake is the largest and highest artificial lake in Serbia.

Two cubic meters of first-quality water flow into the lake every minute. The water still contains dissolved organic matter, nitrogen compounds, phosphorus compounds, oxygen, etc. in different concentrations, depending on the season and temperature that dictates the movement of the cycle in the lake. It was formed in the place where in the past there was one of the largest mountain valleys of the Balkan Peninsula, better known as the Vlasina mud, i.e. where the Vlasina river stood out.

The lake, whose water color varies from gray-blue near the shore to dark blue in the middle of the lake, with green coastal areas, an indented coast, two

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islands and several elongated peninsulas with rocks, gives a special color to the Vlasina landscape. The Vlasina Lake and its surroundings have a sub-mountainous climate, with short dry, and fresh summers and cold winters. Water quality, great floristic, and faunal wealth are the basic values of this natural asset. In this work, the number of microorganisms present was analyzed, as well as the content of certain physical and chemical parameters to determine the water quality of this lake.

Materials and methods

The samples were always taken at the same places determined by landmarks on land, at different depths, with a prochromic bottle of volume 3 dm^{-3} with a mechanism for opening at the desired depth. They were immediately transported to the laboratory, filtered through a membrane filter with a pore size of 0.45 μm and then analyzed. Water sampling was done in winter (January 2022) and summer (August 2022).

The analyzed water quality parameters are: temperature, pH, oxygen saturation, concentration of nitrates, nitrites and ammonia. The temperature was measured in situ with a Dalmacija DT digital thermometer with an accuracy of 0.050 ^{0}C, the pH value was determined with a Wallace and Tiernan Col 2000 digital pH meter. The oxygen saturation was determined with the titrimetric method according to Winkler.

Concentrations of nitrate, total phosphorus and total organic matter were determined by spectrophotometric methods on a Cintra 404 UV-VIS spectrophotometer.

Analyzes of microorganisms were determined in the same period as the physical and chemical parameters. Microorganisms were determined using the Pour Plate technique on R.2 Agar. Incubation continues 168 hours at 20 °C. The seeded microorganisms were then counted under an electron microscope and expressed as the number of microorganisms per dm^3 of water.

Results and discussion

Table 1 shows the results of the analysis of the vertical distribution of the physical and chemical parameters of the Vlasin Lake water from 6 different sampling locations in January 2022 and August 2022. With increasing depth, temperature, pH and oxygen saturation decrease, while the concentration of

nitrogen gradients (ammonia, nitrate and nitrite) is increasing (graph 1).

The highest temperature value measured on the surface of the water in summer was 25 ^{0}C, and the lowest in winter was 30 ^{0}C. The pH values range between 6.20-7.81 for the winter period and between 6.89-8.40 for the summer period, with higher values (more pronounced basic environment) at all stations in the summer period. As a complex expression of the concentration ratio of cations and anions, inorganic and organic ions, aerobic and anaerobic environmental conditions, the pH value of lake water regularly decreases with depth and this characterizes any moment of the test. That vertical gradient is weakest in winter , and reaches its maximum in summer, when it fits into the general stagnation. Nitrate concentration ranged between 0.111 - 0.312 mg dm^{-3}. for the winter period and between 0.109 - 0.320 mg dm^{-3} for the summer period. Nitrite concentration ranged between 0.002 - 0.019 mg dm^{-3} for the winter period and between 0.009 - 0.025 mg dm^{-3} for the summer period. Nitrites are one of the nodal points in the ecological circulation of nitrogen as intermediate products of mineralization on the one hand and denitrification on the other. As very unstable, oxidizable compounds, they can indicate intensive mineralization, i.e. rotting, and hypoxia. For this reason, it is difficult to get into the dynamics, but it is certain that their almost constant presence in a relatively high concentration in the lake is based on intensive processes of detritus decomposition and semi-anaerobic. Ammonia concentration ranged between 0.109 - 0.224 mg dm^{-3} for the winter period and between 0.162 - 1.387 mg dm^{-3} for the summer period. Ammonia nitrogen is present in the entire volume of the lake. The content of microorganisms varied a lot in both test periods (it varied more in the summer period). Its number ranged from 100 to 63500 br x 10^{-3} dm^{-3}.

Table 1. Vertical distribution of some water parameters of Vlasina Lake taken from 6 different sampling sites in January 2022

Mesta uzorkovanja vode	Dubina (m)	Temperatura (°C)	pH	Saturacija kiseonikom	Amonijak (mg dm^{-3})	Nitrati (mg dm^{-3})	Nitriti (mg dm^{-3})	Ukupni mikroorganizmi (brx10^{-3} dm^{-3})
I	0	3	7,81	81,0	0,185	0,135	0,01	1150
	1	3	7,81	73,6	0,187	0,142	0,012	1150
	3	3,5	7,61	72,8	0,192	0,142	0,016	1180
	6	4	7,50	71,8	0,208	0,155	0,016	1260
	12	5	7,19	66,8	0,224	0,194	0,019	1450
II	0	3	7,79	78,7	0,128	0,122	0,007	1120
	1	3	7,70	75,4	0,131	0,136	0,008	1120
	3	3,5	7,57	62,4	0,147	0,141	0,008	1160
	6	4	7,26	67,1	0,177	0,157	0,008	1200
	12	5	7,11	60,7	0,195	0,174	0,008	1350
III	0	3	7,76	81,6	0,136	0,116	0,008	1100
	1	3	7,67	80,4	0,143	0,121	0,008	1100
	3	3,5	7,61	80,4	0,146	0,147	0,008	1150
	6	4	7,42	76,6	0,168	0,154	0,008	1200
	12	5	7,12	62,6	0,189	0,196	0,015	1450
IV	0	3	7,51	81,2	0,124	0,112	0,002	100
	1	3	7,30	76,4	0,126	0,126	0,008	100
	3	3,5	7,21	71,5	0,148	0,141	0,008	110
	6	4	7,11	67,1	0,153	0,157	0,008	130
	12	5	6,89	60,7	0,174	0,184	0,008	290
	20	5	6,82	58,9	0,181	0,261	0,008	1550
V	0	3	7,43	88,4	0,111	0,122	0,002	100
	1	3	7,33	85,0	0,121	0,126	0,010	100
	3	3,5	7,09	78,6	0,143	0,142	0,012	110
	6	4	6,97	65,7	0,156	0,179	0,008	130

	12	5	6,81	61,9	0,166	0,214	0,008	270
	20	5	6,72	52,3	0,179	0,247	0,009	1550
VI	0	3	7,39	71,8	0,109	0,111	0,01	130
	1	3	7,19	70,4	0,112	0,115	0,013	130
	3	3,5	7,03	68,8	0,126	0,149	0,007	130
	6	4	6,97	62,8	0,146	0,171	0,008	130
	12	5	6,79	58,4	0,149	0,216	0,008	130
	20	5	6,62	51,8	0,178	0,251	0,008	140
	30	5	6,20	49,5	0,201	0,312	0,008	280

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Table 2. Vertical distribution of some water parameters of Vlasina Lake taken from 6 different sampling sites in August 2022

Mesta uzorkovanja vode	Dubina (m)	Temperature (°C)	pH	Saturacija kiseonikom (%)	Amonijak ($mgdm^{-3}$)	Nitrati ($mg\ dm^{-3}$)	Nitriti ($mg\ dm^{-3}$)	Ukupni mikroorganizmi ($brx10^{-3}\ dm^{-3}$)
I	0	25	8,40	98,0	0,228	0,167	0,013	2010
	1	23	8,21	75,6	0,236	0,198	0,015	3560
	3	23	8,11	62,8	0,298	0,213	0,018	4300
	6	22	8,10	59,8	0,321	0,263	0,018	5230
	12	11	7,79	55,8	0,375	0,294	0,019	33750
II	0	25	8,39	97,7	0,225	0,158	0,009	1980
	1	23	8,37	77,4	0,227	0,196	0,01	2940
	3	23	8,17	57,9	0,248	0,218	0,01	3970
	6	22	8,06	52,3	0,288	0,247	0,01	5090
	12	11	7,53	40,7	0,374	0,287	0,01	31220
III	0	25	8,36	86,9	0,178	0,151	0,011	2020
	1	23	8,27	78,4	0,231	0,156	0,011	3120
	3	23	8,01	71,8	0,257	0,179	0,011	3960
	6	21	7,74	64,2	0,278	0,203	0,011	5120
	12	11	7,42	50,9	0,359	0,258	0,019	32390
IV	0	25	8,11	97,9	0,178	0,121	0,009	3640
	1	23	8,10	87,9	0,234	0,123	0,013	3750
	3	23	8,09	73,8	0,276	0,142	0,013	2870
	6	22	8,00	51,5	0,251	0,185	0,013	2240
	12	11	7,59	43,7	0,359	0,244	0,013	31550
	20	9,5	7,22	40,9	0,396	0,291	0,015	1100
	0	25	8,09	98	0,174	0,111	0,015	3170
	1	23	8,03	88,9	0,211	0,109	0,015	3340
	3	23	8,00	71,9	0,235	0,136	0,019	2990

V	6	20	7,66	65,8	0,299	0,172	0,022	1940
	12	11	7,29	52,5	0,342	0,241	0,022	29670
	20	9,5	7,01	40,7	0,387	0,290	0,025	1090
VI	0	24,5	8,01	96,9	0,162	0,102	0,015	490
	1	23	8,01	89,5	0,191	0,111	0,019	1100
	3	23	7,92	81,7	0,216	0,119	0,021	4300
	6	20	7,81	75,8	0,258	0,168	0,022	6700
	12	11	7,39	69,9	0,288	0,244	0,022	63500
	20	9,5	7,02	61,8	0,318	0,291	0,022	5340

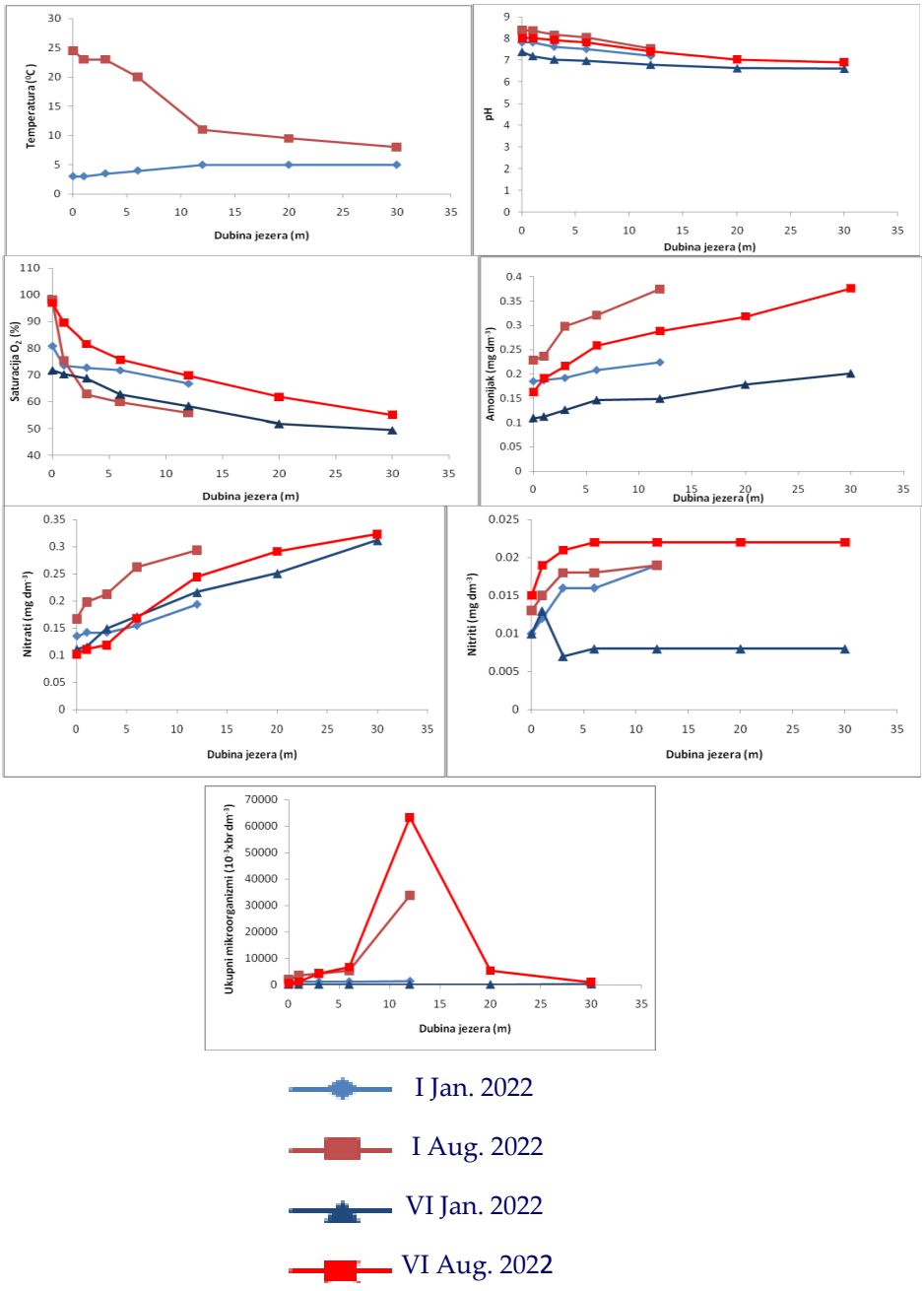

Chart 1: Changes in the physical and chemical parameters of lake water and total microorganisms by depth for two sampling periods, January 2022 and July 2022

Note: Graph 1 shows the values for two stations (I and VI) due to the transparency of the results and their characteristics (these stations differ most in the measured values of the parameters).

Conclusion

The movement of physical and chemical parameters depends on the movement of the water temperature in the lake. It dictates the movement of the cycle in the lake. When the temperatures are uniform, these parameters are also more uniform. (in winter, the values of these parameters change less because the temperatures are more uniform).

Changes in pH following temperature changes. The content of nitrogen gradients (nitrite, nitrate, and ammonia) increases with the increase in the water depth in the lake. Nitrates are consumed in the epilimnion during the summer. Nitrites occur as intermediate products of mineralization on one side and denitrification on the other. These compounds and the present particles mostly settle at the bottom of the lake. The degree of saturation of lake water with oxygen is the result of a complicated relationship between its consumption and renewal. In summer, oxygen is intensively produced in the process of photosynthesis on the surface and is consumed in the hypolimnion. Renewal is done during circulation, but incomplete (deeper layers).

The content of microorganisms is difficult to determine because it changes and is disturbed after each rainfall, its seasonal constancy and vertical distribution cannot be observed. This indicates that the lake ecosystem is very unstable.

The presented data confirm the high quality of the water of the Vlasina Lake, although it is necessary to constantly monitor all physical and chemical parameters as well as the content of the present microorganisms that could threaten the ecosystem of the lake in order to take the most priority measures in the protection of the lakes themselves.

Picture 1.: Vlasina Lake

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