

HYDROCHEMISTRY OF THE GHIDIGHICI ACCUMULATION LAKE (YEARS 2015-2020)

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The Ghidighici accumulation lake is part of the Dniester river basin and is built on the Bâc River, which flows into the Dniester – a main water artery of the Republic of Moldova. During the years 2015-2020, alkaline water masses were formed in the accumulation lake, with an average pH of 9.2 with a permanent content of carbonate ions. The pH values varied within the tight range between 8.7 and 10.2, which corresponds to alkaline or strongly alkaline waters and exceeds the permissible values for surface waters. Increased alkalinity of water can contribute to the formation of toxic conditions and the development of pathogenic microorganisms and bacteria.

The content of the main anions was linearly dependent on the water mineralization values. It showed a strong degree of correlation for HCO_3^- and SO_4^{2-} ions and an average degree of correlation for Cl^- ions. The seasonal dynamics of mineralization demonstrate the minimum average values in winter and its increase in spring. The total hardness of the waters did not undergo seasonal multiannual changes.

The hydrochemical parameters of mineralization and total hardness also varied in the multiannual context. For the values of mineralization the changes were the most pronounced. The maximum annual average mineralization was observed in 2015 (2477 mg/dm^3), after which there is a continuous decrease of these to 982 mg/dm^3 in 2019, which is 2.5 times less compared to the first year of monitoring. For the values of the total annual hardness, a similar trend is observed, but with a decrease not so essential and for the pH values no essential change was observed and these during the permanent observations indicated the alkaline character of the lake waters.

The dissolved oxygen content during the research period varied in the lake between 3.1 mg/dm^3 to 15.7 mg/dm^3 , the multiannual average being 9.3 mg/dm^3 . The degree of water saturation in oxygen varied between 36% (quality class IV – polluted waters, orange code) and 147% (quality class I – very pure waters, blue code), the average being 88%, which corresponds class II waters – pure waters, code green.

The waters of the accumulation lake during the research period contained substantial amounts of organic substances. The average content of biodegradable organic substances, which is determined by the parameter BOD_5 , was $4.7 \text{ mg O}_2/\text{dm}^3$, which by over 50% exceeds the allowable values for surface aquatic ecosystems and assigns water to class II. The content of biodegradable organic substances varied between $0.3 \text{ mgO}_2/\text{dm}^3$ (class I – very pure waters) and $12.7 \text{ mgO}_2/\text{dm}^3$ (class V – highly polluted waters, red code). Of all the processed water samples, over 50% contained biodegradable organic substances in concentrations exceeding their permissible limit concentration. In more than 40% of the samples the content of biodegradable organic substances more than 2 times exceeds the admissible values.

The analysis of the obtained data denotes an advanced pollution of the waters with biodegradable organic substances, which can be formed in the lake as a result of metabolic processes, but can also enter with sewage, drainage, untreated or poorly treated domestic water, from zootechnical units, etc. In other words, Lake Ghidighici has an increased impact of biodegradable organic matter, which contributes to the formation of states with dissolved oxygen deficiency in water and the possibility of rapid eutrophication of the lake.

In addition to the biodegradable organic substances, in the waters of the lake were detected enormous quantities of hardly degradable organic substances, the content of which is reproduced by the COD_{Cr} parameter. The content of these substances practically permanently exceeded the allowable values and presented a real danger for the lake ecosystem. During the research, the average value of bichromatic oxidability (COD_{Cr}), which characterizes the presence of hardly degradable organic substances, was $36.3 \text{ mgO}/\text{dm}^3$, which exceeds more than 2 times the permissible limit concentration. This parameter varied over the years in the wide range between $5.7 \text{ mgO}/\text{dm}^3$ and $108 \text{ mgO}/\text{dm}^3$, all being from the range of heavily polluted waters (class V – red code). The least impactful organic substances had the lowest degradation in 2015 ($20.3 \text{ mgO}/\text{dm}^3$), and the highest intervention of these substances was recorded in 2016 ($47.8 \text{ mgO}/\text{dm}^3$).

The ratio between permanganate and bichromatic oxidability during the study years was on average 0.40, which indicates that during the investigated period the tank was subjected to the impact of untransformed fresh organic substances (proteins, fats, etc.). The content of organic substances was subjected to seasonal dynamics. The maximum average value of the COD_{Cr} parameter was observed during the winter, and the decrease of the respective values was observed during the summer. Therefore, the waters of the accumulation lake have been subjected to increased anthropogenic impact. Various mineral forms of nitrogen and phosphorus were permanently present in the waters of the Ghidighici accumulation lake, the content of which varied depending on the season or the year of studies.

The total content of nitrogen mineral forms was 3.91 mg/dm^3 , of which the basic weight is nitrates, with an average content over the years of 3.4 mg/dm^3 . Nitrates make up 87% of all mineral forms of nitrogen. The share of nitrites is 1.4%, and of ammonium ions – 11.6%. For nitrite ions a very wide variety of values was detected – from their total absence, to 0.95 mg/dm^3 . The average ammonium ion content was 0.34 mg/dm^3 , which does not exceed the maximum allowable concentration. On average, the waters of the lake by the content of these ions can be attributed to class III – moderately polluted waters, yellow code. The data obtained indicate the presence of phosphates in very large quantities – up to 29 mg/dm^3 . This fact contributes to the rapid course of eutrophication processes of the lake, which can have undesirable consequences in the studied ecosystem, in the ecosystem of the Bâc River and the Dniester.

According to the average content of the mineral forms of nitrogen and phosphorus ($N_{\text{tot}} = 3.91 \text{ mg/dm}^3$; $P_{\text{tot}} = 0.63 \text{ mg/dm}^3$) Lake Ghidighici during 2015-2020 can be characterized as a strongly eutrophic aquatic object. In 2015 and in the summer of 2016, the content of mineral phosphorus exceeded the content of mineral nitrogen, which in these cases was the limitation in the development of aquatic plants. On average, the $N_{\text{tot}}/P_{\text{tot}}$ ratio was 6.2.

The maximum average concentration of phosphates was observed in summer, and the minimum – in autumn. Ammonium ions in larger quantities were detected in winter (class IV – polluted waters, code orange), when metabolic processes are slowed down, but the decomposition of dead organisms with the formation of these ions is performed, and the minimum content was detected during spring winter (class III – moderately polluted waters, yellow code), when all biochemical processes are carried out very quickly. The maximum average values, in terms of nitrite content, were detected in summer, and in autumn their content was minimal. Average nitrate concentrations did not vary significantly in different seasons.

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