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Glacial Lakes as Indicators of Environmental Change: Insights from the Kaffiøyra Plain (Svalbard, Arctic)

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Abstract

The Arctic is one of the most sensitive ecosystems on Earth, where changes in aquatic environments are closely tied to dynamic climatic processes intensified by growing global anthropogenic pressure (AMAP 2021). The Kaffiøyra Plain, located in the western part of Spitsbergen (Svalbard), is characterized by the presence of numerous glacial lakes, which constitute an important element of the local landscape and, at the same time, an excellent indicator of environmental change (Liu et al. 2024; Rizzo et al. 2025). The aim of this study was to assess the physicochemical and microbiological parameters of glacial lake waters. The data obtained were used to identify potential sources of anthropogenic pollution in the Arctic environment and to observe climate-related processes.

A total of 22 water samples were collected from glacial lakes located in the catchment areas of the Aavatsmark, Irena, Eliza, and Dahl glaciers. The physicochemical investigations included field measurements of electrolytic conductivity, pH, temperature, salinity, and dissolved oxygen concentrations using in situ methods, as well as laboratory analyses of chemical oxygen demand (COD) and concentrations of selected nitrogen and phosphorus forms (nitrites, nitrates, ammonia, total nitrogen, total phosphorus) using cuvette tests. The microbiological analyses included the determination of the total bacterial count, average cell volume, and prokaryotic biomass using epifluorescence microscopy. In addition, the samples were subjected to taxonomic diversity analysis using next-generation sequencing (NGS, Illumina) of the hypervariable V3–V4 region of the 16S rRNA gene, with data processing performed in the CLC Genomics Workbench environment.

The research conducted is part of broader efforts to monitor water quality in the Arctic and contributes to a better understanding of the functioning of glacial lakes under intensifying climate change. The obtained data highlight the importance of protecting vulnerable polar ecosystems, which are particularly exposed to rapid glacier melting and the associated hydrological transformations (Sobota et al. 2016; Sułowicz et al. 2020). At the same time, they

indicate the need for further research on microbial biodiversity, which constitutes a key component of the stability and resilience of Arctic aquatic ecosystems.

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