HÄMMERLI Lilian (2023) : The impacts of glacial meltwater on proglacial lakes : physical, chemical and biological properties

Abstract

Glacial meltwater is known to alter the light climate and thermal regime in proglacial lakes. In this project, we characterize how light attenuation and temperature pattern differ between clear and glacier-fed alpine lakes. In summer 2021, we conducted high-frequency monitoring and water sampling in two proglacial lakes. These two lakes are located next to each other and experience the same atmospheric condition but only one of them was directly influenced by the glacier. Light extinction coefficients (kd) in the glacier-fed lake were significantly higher compared to the clear lake (4.59±1.55m-1 vs. 0.42±0.1m-1). Light attenuation in the clear lake agreed with low suspended sediment concentrations allowing high chlorophyll a concentrations (330±160μg/L). In the glacial-fed lake, the high suspended sediment load (77.4±109.31mg/L) through glacial discharge reduced photosynthetically active radiation (PAR) in the water column, making it much more difficult for primary producers to exist (chlorophyll a concentrations 70±120μg/L). Nutrient inputs did not differ significantly between the lakes. The clear lake showed a marked diurnal pattern warming up during daytime and cooling down at nighttime, reaching highest temperatures at the end of August. The heat budget of the clear lake is very much driven by the vertical heat fluxes. The input of the glacial meltwater to the GF lake led to a non-typical daily mixing pattern with reverse stratification during the night and mixing during the day. Furthermore, mean water temperature was diminished by 3.2°C and higher daily surface water fluctuations (2.10±0.71°C) were measured. Computations of vertical heat fluxes and heat content change revealed that the advective flow contributed up to 22.8% of the heat loss in the glacier-fed lake. The glacial water affected the temperature regime in the glacier-fed lake by two effects: i) the advective flow represented an advective heat flux (heat loss) and ii) the glacial flour in the water column changed the color of the lake and thus the short-wave reflection. Due to data limitation, it remains unanswered how much each of these effects contribute to the heat budget. Next projects could answer this question in order to improve the modelling of mountain lakes. We conclude that glacial meltwater has major effects on proglacial lakes changing its light climate and thermal regime, which are the drivers of chemical and biological aspects in aquatic ecosystems. The results of this project expand the knowledge of the spatial differences regarding the impacts of glacial meltwater on proglacial lakes.