Rock glacier impact on high-alpine freshwater chemistry

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Borehole soundings have revealed a warming of mountain permafrost of up to 1°C during recent decades. There is evidence that the increase in air temperature has favored the solute release from active rock glaciers, and pronounced changes in water quality of headwaters in the Alps have been described. Here, we report on solute concentrations of selected streams and springs in the vicinity of an active rock glacier in the Central European Alps (Lazaun, Italy). Stream water sampling started in 2007, and samples were analysed for major ions and heavy metals. We compare surface freshwaters of different origin and chemical characteristics, i.e. outflows of active and fossil rock glaciers, a spring emerging from a moraine and an ice glacier fed stream. Substance concentrations were highest in springs impacted by active rock glaciers, and dissolved ions increased up to a factor of 3 through the summer season. This pattern reflects a seasonally varying contribution to runoff by the melting winter snow pack, summer precipitation, baseflow and ice melt. Intense geochemical bedrock weathering of freshly exposed mineral surfaces, which are due to the downhill movement of the active rock glacier, is considered as a major reason for the high ion and metal concentrations in late summer runoff. In addition, solutes contained in the ice matrix of the rock glacier are released due to enhanced melting of rock glacier ice. On the contrary, minimum substance concentrations without any seasonal variability were found in the moraine spring.