Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11904

Nutrient (C, N, P) export from debris-covered and debris-free glaciers, Chandra basin, Western Himalaya

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A warming climate may significantly affect the freshwater ecosystems and downstream settlement of the Himalayan glacierized region by changing streamflow and water quality. Glaciers export C, N, and P to adjacent streams. Knowledge of organic carbon and nutrient transport both within glaciers and into glacier outflows will provide better estimates of the magnitude of solute export to surrounding areas. In this work we provide an understanding of the nutrient dynamics and its export from two adjacent glaciers in Chandra basin, Western Himalaya - one a debris-covered and other a debris-free glacier. Surface snow and meltwater samples were collected from both the glaciers along a transect from the accumulation zone to the snout, during August to September 2019. Time-series sampling of meltwater streams was also conducted just below the snout from both the glaciers. The debris-covered glacier had a higher concentration of dissolved organic carbon (DOC) and total phosphorus (TP). This is likely due to greater interaction between water and rocks/sediment resulting in a larger supply of phosphorus and organic material. Solute fluxes were higher in the debris-free than the debris-covered glacier, due to high specific discharge rates of 7.3 ± 1.1 and 1.4 ± 0.2 m^3s^{-1}, respectively. DOC and TP export were 481 ± 83 and 362 ± 97 kg day^{-1} respectively, in the debris-free glacier. DOC export was 3-times and TP export was 7-times lower in the debris-covered glacier. The particulate phase dominated phosphorus export (> 95% of total phosphorus flux) in both types of glaciers. Export rates for total dissolved nitrogen were 180 ± 36 kg N day^{-1} in the debris-free and 25 ± 2 kg N day^{-1} in the debris-covered glacier. We show that these glaciers transport large quantities of C, P and N to the surrounding regions. As solute fluxes increase with discharge, these glaciers may become increasingly important under warming climate scenarios.