Toward Constraining Mountain Stream Flow Constituents by Combining Citizen Scientist Acquired Geochemical Tracers with Sentinel-1 SAR Time Series in Pakistan

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ABSTRACT

Snow and ice melt are both critical components of streamflow in the transboundary Indus River Basin, which flows through the Hindu Kush, Western Himalaya, and Karakoram mountain ranges and serves as a primary water source for nearly 300 million people in Tibet, India, Afghanistan, and Pakistan. A lack of field measurement and data sharing limits specific understanding of the role of snow and glacier melt in Indus River flows, proliferating uncertainties for anticipating future water availability in a region vulnerable to climate change. Satellite-based synthetic aperture radar (SAR) instruments image day or night and also penetrate cloud cover. Due to the high permittivity of liquid water, C-band (5.5 cm wavelength) SAR imagery can be used to reliably detect meltwater present in the snowpack. This offers spatially explicit information about which areas of the snowpack can potentially contribute to streamflow, and also provides an alternative method for calculating snow cover area that is not subject to the same constraints prevalent in optical satellite imagery. Geochemical tracers offer a means to constrain streamflow constituent estimates (e.g. snowmelt, glacier melt, groundwater, precipitation), and have been used successfully in many temperate watersheds. Their application to glaciated alpine watersheds has been explored, though spatial and temporal isotopic variability in endmembers yields many open questions.

In this study, we analyze geochemical tracers from samples collected by local citizen scientists from 2018-2019 in the heavily glaciated Shimshal watershed in the Karakoram Mountains of Pakistan. We integrate geochemical data with European Space Agency Sentinel-1 SAR imagery in an effort to better constrain streamflow constituents in this remote basin that serves as a headwater to the Indus River in Pakistan. We compare our findings with modeled results from the region, explore the role and potential for citizen science to support climate-related studies, and identify important factors for future work.

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