

Sources of Precipitation and Hydrograph Components of the Sutri Dhaka Glacier, Western Himalaya

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Abstract : The Himalayan glaciers are the potential source of perennial water supply to Asia's major river systems like the Ganga, Brahmaputra and the Indus. In order to improve our understanding about the source of precipitation and hydrograph components in the interior Himalayan glaciers, it is important to decipher the sources of moisture and their contribution to the glaciers in this river system. In doing so, we conducted an extensive pilot study in a Sutri Dhaka glacier, western Himalaya during 2014-15. To determine the moisture sources, rain, surface snow, ice, and stream meltwater samples were collected and analyzed for stable oxygen ($\delta^{18}\text{O}$) and hydrogen (δD) isotopes. A two-component hydrograph separation was performed for the glacier stream using these isotopes assuming the contribution of rain, groundwater and spring water contribution is negligible based on field studies and available literature. To validate the results obtained from hydrograph separation using above method, snow and ice melt ablation were measured using a network of bamboo stakes and snow pits. The $\delta^{18}\text{O}$ and δD in rain samples range from -5.3% to -20.8% and -31.7% to -148.4% respectively. It is noteworthy to observe that the rain samples showed enriched values in the early season (July-August) and progressively get depleted at the end of the season (September). This could be due to the 'amount effect'. Similarly, old snow samples have shown enriched isotopic values compared to fresh snow. This could be because of the sublimation processes operating over the old surface snow. The $\delta^{18}\text{O}$ and δD values in glacier ice samples range from -11.6% to -15.7% and -31.7% to -148.4%, whereas in a Sutri Dhaka meltwater stream, it ranges from -12.7% to -16.2% and -82.9% to -112.7% respectively. The mean deuterium excess (d-excess) value in all collected samples exceeds more than 16% which suggests the predominant moisture source of precipitation is from the Western Disturbances. Our detailed estimates of the hydrograph separation of Sutri Dhaka meltwater using isotope hydrograph separation and glaciological field methods agree within their uncertainty; stream meltwater budget is dominated by glaciers ice melt over snowmelt. The present study provides insights into the sources of moisture, controlling mechanism of the isotopic characteristics of Sutri Dhaka glacier water and helps in understanding the snow and ice melt components in Chandra basin, Western Himalaya.

Keywords : D-excess, hydrograph separation, Sutri Dhaka, stable water isotope, western Himalaya

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