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Estimation of Snow and Ice Melt Contributions to Discharge from the Glacierized Hunza River Basin, Karakoram, Pakistan

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Abstract : This paper presents the results of a semi-distributed modified positive degree-day model (MPDDM) for estimating snow and ice melt contributions to discharge from the glacierized Hunza River basin, Pakistan. The model uses daily temperature data, daily precipitation data, and positive degree day factors for snow and ice melt. The model is calibrated for the period 1995-2001 and validated for 2002-2013, and demonstrates close agreements between observed and simulated discharge with Nash–Sutcliffe Efficiencies of 0.90 and 0.88, respectively. Furthermore, the Weather Research and Forecasting model projected temperature, and precipitation data from 2016-2050 are used for representative concentration pathways RCP4.5 and RCP8.5, and bias correction was done using a statistical approach for future discharge estimation. No drastic changes in future discharge are predicted for the emissions scenarios. The aggregate snow-ice melt contribution is 39% of total discharge in the period 1993-2013. Snow-ice melt contribution ranges from 35% to 63% during the high flow period (May to October), which constitutes 89% of annual discharge; in the low flow period (November to April) it ranges from 0.02% to 17%, which constitutes 11 % of the annual discharge. The snow-ice melt contribution to total discharge will increase gradually in the future and reach up to 45% in 2041-2050. From a sensitivity analysis, it is found that the combination of a 2°C temperature rise and 20% increase in precipitation shows a 10% increase in discharge. The study allows us to evaluate the impact of climate change in such basins and is also useful for the future prediction of discharge to define hydropower potential, inform other water resource management in the area, to understand future changes in snow-ice melt contribution to discharge, and offer a possible evaluation of future water quantity and availability.

Keywords : climate variability, future discharge projection, positive degree day, regional climate model, water resource management
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