APPLICATION OF TEMPERATURE INDEX MODEL FOR ESTIMATING DAILY DISCHARGE FROM THE SHIGAR RIVER BASIN, CENTRAL KARAKORUM, PAKISTAN

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ABSTRACT

The high mountains of Hindu Kush, Himalaya and Karakoram (HKH) contain large masses of flowing ice and snow. These ice masses and snow are the primary source of water for the entire region of HKH so it is very important to have knowledge for the sustainable use of these available fresh water resources. In this study, modified temperature index model has been used to simulate total discharge and contribution of snow and ice in discharge from the Shigar River basin in central Karakoram, Pakistan. Shigar basin covers an area of 6921.429 km2; and 2774 km2 (48 %) of the entire basin is glaciated among which 25.5 % of the glaciated part is covered by debris layer and remaining 74.5 % is covered by clean ice and permanent snow. Great variation in altitude exists in the basin which starts from Shigar Bridge, 2204 m a.s.l, and maximum elevation reached by K2 8611 m a.s.l. To simulate discharge, we first divided whole basin into 26 altitude belts, meanwhile zonal area of debris covered ice, clean ice and the rock and vegetation has been calculated. Daily temperature and precipitation from Skardu meteorological station has been used as input variable after correlating the data with the Shigar station data (r=0.875). Model has been calibrated for the period 1988 to 1991 and 1992 to 1997 are used for validation. Local temperature lapse rate of 0.0075 °C/m is used in this study. Critical temperature has been used to separate form of precipitation in rain and snow. Precipitation increases by 0.223 % up to 3000 m a.s.l and decreases by 0.627% up to 5500 m a.s.l and again increasing trend has been found. In situ measured ice ablation values and remotely sensed debris covered and clean ice data is gathered, available observed discharge and met data has been analyzed. We used seasonal degree day factors for low and higher elevations. Observed and simulated discharge for the period of calibration and validation was 224.6 (m^3/s), 222.85 (m^3/s) and 232.28 (m^3/s), 232.88 (m^3/s) respectively. The Nash Sutcliffe efficiency for the simulated and observed discharge for the year of calibration and validation is 0.815, 0.765 with volume difference of 0.78 % and 0.26% for calibration and validation period respectively. Contribution of snow and ice in total discharge was 37.91 % for the period of calibration and 37.46 % for validation period. The results obtained from the modified temperature index model showed that this model is good enough to estimate daily discharge from glacierized river basins and it can be used in hydrological studies of glacierized river basins.

KEYWORDS: Positive degree day, simulated discharge, Daily temperature and precipitation, Debris covered ice, clean ice, Altitude belts