APPLICATION OF MODIFIED POSITIVE DEGREE DAY MODEL (MPDDM) FOR ESTIMATINGDISCHARGE FROM GLACIERIZEDHUNZA RIVER BASIN, KARAKORAM, PAKISTAN

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ABSTRACT

Pakistan, an agriculture-based country is highly dependent on the Indus irrigation system. The Indus River is the main source of water in Pakistan. The upper Indus basin includes the Gilgit, Hunza, Shigar, Shyok, Zanskar, Shingo, Astor, and Upper Indus sub-basins.A major proportion of flow in the Indus River is contributed by its snow and glacier-fed river catchments situated in the Karakoram Range. It is therefore essential to estimate the discharge from the catchment for water resources management. The present study conducted in the Hunza River basin (drainage area: 13,713 km^2) geographically, extends from 36.05°N, 74.04°E to 37.08°N, 75.77°E situated in the high-altitude central Karakoram region, with a mean catchment elevation of 4,631 m. Approximately 4,463 km^2 of catchment area is at an elevation above 5,000 m and almost the same area (33%) is glaciated. The total numbers of glaciers in basin are 1,500 approximately. The clean glacier area is 3,673km^2 and the debris cover area is 479km^2. This study analyses an opportunity to estimate the daily discharge, snow and ice melt contribution from the debris free area as well as ice melt under debris layers based on the positive degree-days calculated from daily mean temperature and precipitationfrom glacierizedHunza River Basin for 1995 - 2004 using Modified Positive Degree Day Model (MPDDM).This model is based on the relation that the melting of snow or ice during any particular period is proportional to the positive degree-days linked by the positive degree day factor involving a simplification of complex process that are more properly described by the energy balance of the glacier surface and overlaying atmospheric boundary layer. This approach is appropriate in region with scarce data as it requires less input data and uses simple equation to estimate melt. Daily temperature and precipitation data from the Naltar climate station of Water and Power Development Authority (WAPDA), Pakistanis used in the model as input. The model has been calibrated for 1995 – 1999 and validated for 2000 – 2004. It has revealed that the observed and simulate daily average discharge for the calibration yearsare275.13m^3/s and 267.29m^3/s and for validation years are 292.88m^3/s and 271.37m^3/s, respectively. In addition the model results a good agreement between observed and simulated discharge. The Nash-Sutcliffe Efficiency is 86.2% for calibration and 85.8% for validation years and the differences in volume are2.85% and 7.34%, respectively in the calibration and validation years. The snow and ice melt contribution for calibration and validation years are 39.38% and 38.65%, respectively. The obtained results enables us to conclude that the MPDD Model can be used to estimate the discharge of snow and glacier fed mountainous catchments like Hunza River basin and can also be used to study the impact of climate change in such basins and also useful for the future prediction of discharge to define hydro-power potential and other water resource management in the area which is the next step of this study.

KEYWORDS: Modified positive degree day model, Upper Indus Basin, water resource management, future discharge projection