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Assessment of Snow cover and Prevalent Hydro Climatic trends over Upper Indus Basin using Hydrological Modelling

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The surface water hydrology of Upper Indus Basin (UIB) governs with the melt water runoff which guarantees the essential water supply to the major reservoirs in Pakistan. This water provides necessary support for agriculture, domestic consumption, and hydropower generation; all critical for a stable economy in Pakistan. The primary objective of present study was to calculate snowmelt runoff at Gilgit River, additionally includes to categorize trends, variability investigation and valuation of changes in Stream flows, Precipitation and Temperature (Qmean, Pmean and Tmean) at 35 river discharge gauges and 15 climatic stations over UIB. Snowmelt runoff model (SRM) incorporated with MODIS remote-sensing snow cover products was selected to simulate the daily discharges and to calculate the contribution of snow and glacier melt impact on the discharge in the Gilgit River basin during (2000-2012). We employed Mann-Kendall (MK), non-parametric test for ensuring existence of trend and Sen's method to estimate slope in annual and seasonal time series. Temporal and spatial variability is examined in detail for four time spaces (1st) 1961- 2013, (2nd) 1971- 2013, (3rd) 1981- 2013 and (4th) 1991- 2013 to address the inconsistency in accessible observed record The ultimate findings of this study revealed that the SRM can be used successfully in the snow- and glacier-fed sub-catchments of Gilgit River Basin. We found Gilgit River Basin enduring a stable or marginally increasing trend of summer (April-September) snow cover. The river discharge from the Gilgit basin is a combination of snow and glacier melt with rainfall-runoff but snow and glacier melt are dominant at Gilgit River. The observed decreases in Tmean appear stronger and more significant at Astore, Cherat, Chilas, Chitral, Dir, Drosh, Gilgit, Gupis,Kakul, Kohat, Risalpur, Skardu and Saidu Sharif during summer in the first series, while fourth series seemed warm resulting 5 stations revealing significant increasing trends. We noted Pmean unveiled stronger evidence of dryness by having 10 stations exhibiting negative significant trends in July at Astore, Bunji, Cherat, Chilas, Chitral, Dir, Drosh, Gilgit, Gupis, Kakul and Saidu Sharif during fourth series. Similarly, we observed stable significant decreases in Qmean and summer flows (21 guages) mainly at the glacial fed regions of Indus, Jehlum and Kabul river basin during (1961-2013) including Bunji, Kharmonng at Indus while Astore at Doyian, Chitral at Chitral, Nowshera at Kabul river and entire Jehlum Basin. We found summer flows steadily decreased during fourth series and observed highest number of stations exhibiting significant decreasing trends during the month of September. This study concludes that decreasing hydro climatic trends dominated the UIB, both temporally and spatially.
Keywords: Upper Indus Basin; SRM; Temperature; River flows; Precipitation; Snow cover; Trend analysis