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Attributing the changes in seasonal runoff to dominated water sources in a snow and glacier melt-dominated catchment

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Attributing the changes in seasonal runoff to dominated water sources in a snow and glacier melt-dominated catchment

Trend analysis indicates significant changes in the magnitude and timing of seasonal runoff from 1960 to 2010 in the Ala_archa catchment in Central Asia, which is dominated by snow and glacier meltwater. This study modeled the dominated water sources, including snowmelt water, glacier melt water and rainfall water, for daily discharge events in this basin. Hydrological parameters were estimated in a stepwise method. First, parameters were divided into the melting group and non-melting group based on sensitive analysis. The parameters belonged to the melting group effect the estimation of snow and glacier melting, while it is the opposite for the parameters belonged to the non-melting group. Second, the melting parameters were calibrated on the observed annual glacier mass balance data. Third, the non-melting parameters were calibrated on the observed daily discharge series using the calibrated melting parameters. Fourth, the melting parameters were recalibrated on both the observed glacier mass balance data and the daily discharge series. The calibration steps were repeated until the relative difference of all the melting parameter values between two calibration procedures were lower than 5%. The dominated water sources for each discharge event were identified by the fraction of water inputs in the whole basin during a 7-day period preceded the discharge event. The fraction of various water inputs were calculated in 300m-elevation bands. In cases the fraction of snowmelt water is higher than 0.6, the corresponding discharge events were identified as snowmelt dominated events, and it is the same for the rainfall and glacier melt dominated events. Results show that the increasing in winter runoff is caused by the increased rainfall, the increased spring runoff is driven by the increasing of snowmelt, while the increased glacier meltwater dominated the increasing in the summer and autumn runoff. The early forward in the timing of spring and summer runoff is driven by the earlier occurrence of snowfall events and glacier melting.