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# Quantifying the contribution of glacier melt to discharge for a data-sparse glacierized watershed in the Tianshan Mountains

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Glaciers are important freshwater storage systems in the Tianshan Mountians. Under the context of climate change, quantifying glacier melt contributions in high-mountainous basins is of importance for understanding the discharge composition and ensuring adequate management of water resources. In this study, the hydrological model HBV-D (Hydrologiska Byrans Vattenbalansavdelning-D) was modified and then used to simulate hydrological processes for a data-sparse glacierized watershed, the headwater catchment of Manas river basin (MRB) in the Tianshan Mountains. In comparison with the HBV-D model, the novel aspects for the modified HBV-D model included a spatial discretization method that can better describe terrain related variability and a glacier module based on an enhanced temperature-index approach. Reconstructed daily precipitation and temperature data based on meteorological station data and remote-sensing observation from 1967 to 2005 were used as model forcing data. The basin-scale simulations were evaluated using change ratio of glacier area derived from satellite data and observed daily streamflow at the basin outlet. The analysis showed the modified HBV-D model is superior to the original HBV-D model in simulating daily streamflow processes and can effectively reproduce the change rate of glacier area during the historical period. The mean annual contribution of ice melt to total discharge ranged between 17% and 41% and averaged 27%, although glacier area accounted for only 13% of the catchment drainage area in the MRB. Glacier runoff from June to September accounted for about 85.9 % of the average annual glacier runoff; and the largest monthly contribution of the glacier melt to river discharge in the MRB was up to 45% in August.