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Hydrological forecast based on the snow cover index, derived from basin-wide and elevation specific remote sensing snow cover data in mountainous basins

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Snow accumulation in mountains plays an important role in seasonal discharge in summer month in many parts of the world. Winter precipitation falling as snow in the cold period is stored in the mountains and released as meltwater during a warm period when demand is high, providing water to millions of people in downstream countries. This is of particular importance in semi-arid regions, where precipitation during the warm season is minimal. Therefore, it is important to monitor snow accumulation in the mountains for seasonal water availability assessments. However, direct observations in the mountains are usually rare due to limited accessibility and extreme weather conditions. Nowadays, remote sensing snow cover products deliver observations of the snow state with moderate spatial and high temporal resolution, which can be applied to monitor snow cover in mesoscale mountainous catchments.

In this study, we present a methodology to forecast seasonal and monthly water availability in mountainous areas. We use daily MODIS snow cover time series with 500 m spatial resolution to derive a snow cover index (SCI), a new index representing snow accumulation in the mountains representing the evolution of the snow accumulation. The SCI was then applied to forecast seasonal and monthly water availability based on linear models. The SCI was derived for a whole basin to forecast water availability in the vegetation period, whereas the elevation dependent SCI was applied to forecast water availability for upcoming months. The elevation dependent SCI was derived by disintegrating the snow cover area into defined elevation bands. This leads to the temporal assessment of snow cover state at different elevation zones contributing to total river discharge at different time scales. In a pilot study, the forecasting methodology was applied for 12 river basins in Central Asia. The results show that using SCI, on average 0.67 of the variance can be explained in forecasting seasonal water availability. As for the monthly forecast, the maximum explained variance of 0.70-0.80 was obtained for June, July, August and September months, indicating a strong dependence of water availability in these months on snow storage in the mountains, particularly in high elevation zones. For the months March, April, and May, the obtained explained variance is in the order of 0.6 indicating that not only snow contributes to river discharge in these months but also other components such as rain and groundwater. Using the presented methodology, linear forecast models based on remote sensing snow cover information can be derived. The forecasting methodology considering remote sensing snow cover data is of high applied importance in Central Asia and is currently being implemented into the forecasting workflows of local hydrometeorological services.