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Application of MODIS and adjusted Spot VGT dataset (1998-2017) on Nepalese river basins: on the interest to use seasonal adaptive thresholds for constraining snow melt simulation and enhance hydrological modelling results

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Measuring and modelling snow cover melting processes in Himalayan catchments are necessary to obtain reliable estimation of snow contribution in downstream runoff and its evolution in a context of climate change. This study focuses on the Duth Koshi river basin in Nepal (N 27° 40'/ E 86° 40'), located in a steep orographic region. More than 50% of elevations in the catchment are higher than 4000 m a.s.l., including glaciers and seasonal snow cover. Our study area covers 1500 km2, northern part of the catchment. The objective of this study is (i) to map by use of remote sensing dataset the snow cover area (8-day SCA), and (ii) to model the snow melting in all sub-basins of this catchment. The final goal is to enhance the performance of a degree-day hydrological model (HDSM), compared to the water discharge measured at the outlet of the watershed. Remote sensing: SCA time series were obtained from the 8-day MOD10A2 products from the MODIS-Terra sensor (2000-2017), completed with statistically adjusted Spot-VGT data from 1998 to 2000. Temporal 1998-2017 evolution indicates that the SCA over the Duth Koshi river basin slightly increases through the study period. This SCA database is then used as referenced data from which the thawing snow degree-day model is calibrated. This snowmelt model is initially based on three main parameters which are temperature threshold (Tms), a snowmelt degree-day factor (DDFs) and also a minimal snow height threshold (Hsmin). In purpose of obtaining snowmelt simulations which are more reliable to what is observed by the MODIS satellite, seasonal adaptive thresholds are applied to the snow melting module of HDSM. These seasonal thresholds are independenlty calibrated over the 8-day SCA dataset. The innovative step is to set a distinction between the winter season (November to May) and the monsoon season (June to October) in relation to the calibration of the snowmelt module. The use of a seasonal adaptive thresholds show generally better results for the sub-basins evaluated than when constant thresholds are used. Finally, those estimated SCA from the snowmelt module of HDSM are used to simulate runoffs at the outlet of the sub-basins which are compared with measured discharge, for the validation time period 2013-2016. The model shows satisfactory statistics (R2 = 0.8, Nash = 0.7), indicating that in this application case a degree-day model enhanced with seasonal thresholds applied on the snow melting module is suitable.