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Estimation of different flow components in a high-altitude glaciated catchment (Dudh Koshi, Nepalese Himalaya) using a distributed glacio-hydrological model

Louise Mimeau, Michel Esteves, Patrick Wagnon, Fanny Brun, Thomas Condom, Hans-Werner Jacobi, and Isabella Zin

IGE, Univ. Grenoble Alpes, CNRS, IRD, Grenoble INP, Grenoble, France (louise.mimeau@univ-grenoble-alpes.fr)

In a context of climate change and of water demand growth, understanding the origin of water flows in the Upper Himalayas is a key issue to estimate the future water resource availability and to plan the future uses of water in downstream regions.
One of the main issues in high elevated and glaciated catchments hydrology is the insufficient representation of the cryospheric processes that control the dynamics of ice and snow covered surfaces in distributed hydrological models. Model shortcomings and the lack of meteorological data associated to extreme topography can lead to large uncertainties that need to be quantified.
Here we focus on an Upper Dudh Koshi sub-catchment in Nepal with an area of 150 km^2 of which 26% was glaciated in 2015. The hydrological regime of this catchment is essentially driven by precipitation and glacier melt during the monsoon season from June to September. This study aims at estimating the contribution of rainfall, glacial and snow melt to the Khumbu River runoff, as well as their seasonal variability during the period [2012-2015].
The physically based glacio-hydrological model DHSVM-GDM (Distributed Hydrology Soil Vegetation Model - Glacier Dynamics Model) was forced with in-situ meteorological data to run simulations for a period of three years. To simulate snow and glacier processes, DHSVM-GDM uses an energy balance model with one ice and two snow layers. For the needs of the study, some parametrizations were adapted in order to take into account cryospheric processes that are not or only partially described in the standard version of DHSVM-GDM, such as snow aging and liquid water transfer through glaciers. The snow albedo representation has been modified to have a more accurate description of the snow pack dynamics. Daily MODIS satellite images were used to validate the simulation of snow albedo and snow cover area. Mass balances from local measurement on the Pokhalde and Changri Nup glaciers, as well as regional geodetic mass balances provided for the validation of the simulated mass balance of glaciers.
Simulations based on several future climate scenarios with increasing air temperature and changing precipitation patterns will be presented, in order to evaluate the impact of climate change on the runoff contributions.