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Application of the physically based glacier model SURGES in the Lhasa River Catchment in Tibet

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In mountain areas glaciers are a considerable component of the water cycle. Water stored as glacier ice in alpine headwatersheds and released during melting periods is an important contribution for water supply management, hydropower generation and reservoir management. Meltwater production is related to the glaciated area, therefore the retreat of glaciers forced by climate change is one of the most significant impacts. The integrative research project Brahmatwinn (www.brahmatwinn.uni-jena.de) focuses on regional hydrological modeling and the determination of the impact of future climate change on the water balance in the twinning catchments of the Upper Danube and the Upper Brahmaputra River. In these mesoscale catchments the extension of most glaciers is below the spatial resolution of the model grid. To simulate the future changes in ice thickness and glaciated area under climate change scenarios at this resolution, a subscale approach is applied. Therefore the physically based model SURGES (SUbscale Regional Glacier Extension Simulation) has been developed and implemented into the decision support system DANUBIA in the framework of the Glowa-Danube project (www.glowa-danube.de). This model calculates the balance of energy and mass on the glacier surface depending on hourly meteorological input data, which are provided by the DANUBIA framework at each grid point in downscaling CLM data. The glacier is approximated by steps, which are based on a 50-m area-elevation distribution for each glacierized 1x1km2 grid unit and a related mean ice-thickness. The redistribution of ice due to ice flow is considered by a simple parameterization. Glacier inventories and local measurements provide the required input data. To apply SURGES in regions without inventory data and measurements, the required input data are generated by using generally available data and considerations of analogy. For the Lhasa River Catchment in Tibet the methodology to derive these input data is demonstrated. Elevation is taken from the SRTM elevation model, whereas the glacier boundary is deduced from satellite images. Plausible estimates of both ice thickness and movement are made by comparison with typical alpine glacier types taking into account the relationship between glaciated area, orography and glacier type. Finally, model validation as well as first results of the application of SURGES in the Lhasa River Catchment are presented.