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Glacier, glacier lake and permafrost distribution in the Brahmaputra river basin

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Glacier distribution, glacier changes, glacier lakes and their changes, and mountain permafrost occurrence are investigated and compared to climate scenarios in order to assess the influence of melting glaciers and degrading permafrost on the long-term runoff of the Upper Brahmaputra River. In this contribution we derive glacier inventories for three test areas in the Upper Brahmaputra River Basin based on semi-automatic classification of Landsat data of 2000 and supplementary ASTER data. The resulting glacier outlines are intersected with the glacier outlines of the Chinese Glacier Inventory from about the 1970s-1980s and compared to selected Corona satellite data from the 1960s. In total, an area loss of about 18% was observed over the period investigated. We estimate the according ice volume loss to be on the order of 20%. Using the Chinese Glacier Inventory and our inventory results we upscale the above glacier change to the entire Upper Brahmaputra River Basin.
Glacier lakes are mapped for the boundary region between Bhutan and Tibet using 1990 and 2000 Landsat imagery. Changes in lake area are compared to the observed glacier changes.
The permafrost distribution in the study region is estimated using regionally adapted versions of two empirical models, both originally developed to estimate the permafrost distribution on a regional scale in the Swiss Alps. One model (PERMAKART) applies a topo-climatic key, based on the relation between altitude above sea level, aspect, and permafrost probability. The second model (PERMAMAP) is based on a linear spatial relation between the bottom temperature of the winter snow cover (BTS), the mean annual air temperature (MAAT) and the potential direct solar radiation. Adaptation of the models is done through the inclusion of ground based meteorological data and validated using distribution patterns of rock glaciers. The latter are mapped from high resolution satellite data such as CORONA and Quickbird imagery.
Both, the observed glacier changes and the modelled permafrost distribution are compared to climate simulations in order to estimate the recent and near-future climate change impact on the glaciers and mountain permafrost in the Upper Brahmaputra River basin.