Glacier Changes in the Himalaya / Transhimalaya using Various Remote Sensing Data

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We utilize a variety of remote sensing imagery to analyze and compare glacier changes for western Nyanchentanghla Mountains in Tibet [1], Mt. Everest area/Nepal [2], and Garhwal Himalaya/India [3]. We generated the glacier inventories in a semi automated way by extracting recent (2000 -2009) outlines using a band ratio technique based on Landsat TM/ETM+ or Terra ASTER and splitting the glaciers into their respective drainage basins using a flowshed algorithm based on a DEM. The outlines were visually checked and manually improved for gross errors. Earlier sources for space imagery include Corona KH-4 and KH-4B (years 1962-1972), Hexagon KH-9 (year 1976), and Landsat MSS (years 1972-1976) imagery. The estimated accuracy of the mapping is ~3% and depends mainly on snow conditions and geolocation errors. Multi-temporal DEMs were generated for the Mt. Everest area based on stereo Corona, ASTER, and Cartosat-1 in order to address glacier volume changes.

In all study areas the vast majority of the glaciers retreated. The overall area loss of the investigated glaciers is higher in continental range in Tibet (~7.7%, 1976-2009; ~0.23%/a) and less in the Everest area/Nepal (~5%, 1962-2005; ~0.12%/a) and in Garhwal Himalaya/India (~5%, 1968 – 2006; ~0.13%/a). These values are lower than in other parts of the world but still significant. However, it has to be taken into account that many glaciers in Garhwal Himalaya and the Mt. Everest area are covered with supra-glacial debris. The area loss for the clean ice glaciers in these regions is almost twice as high (~10%). In addition, the changes of the debris-cover glacier can mainly be recognised through downwasting. We found surface lowering of up to 1m/a for the glaciers at Mt. Everest. A warming trend can be observed in every study area. So far, we are not able to attribute glacier changes to specific climate elements due to insufficiency of available climatic data.

References

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