Investigation of Mass Balance Processes on Glaciers in the Khumbu-Himal (Nepal) Based on Optical Satellite Data

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Climate change will pose a variety of challenges in the future, with global sea level rise among the most important ones. Out of all contributions to sea level rise, the contribution from glaciers is the one with the highest uncertainty. This is mainly because only very few and not necessarily representative glaciers are measured regularly. Among others, this limits the validation of extrapolation models.

On a regional scale, remote sensing data offer several possibilities for the mapping and monitoring of glaciers. Especially with the advent of very high resolution data, new possibilities can be exploited. The monitoring of glacier area, the calculation of the geodetic glacier mass balances and the tracking of changes in the seasonal snow and firn bodies of glaciers on a regional scale can not only help to enhance the spatial, but also the temporal coverage of observations.

In the presented study, we are using Pléiades tri-stereo data as well as Sentinel-2 data to analyse mass balance related processes on several debris-covered glaciers in the Khumbu-Himal region of Nepal. A focus is placed on the important but until now unquantified role of avalanche snow and the influence of rock debris cover on the glacier tongues and the ablation at exposed ice cliffs within the debris. High resolution digital terrain models will be extracted photogrammetrically from the Pléiades scenes, while the optical information will be used for pixel- and object-based surface classification in order to map surface features such as proglacial lakes, avalanche cones and ice-cliffs.

We aim at exploring the utility of very high resolution tri-stereo Pléiades imagery in quantifying these processes and determining their contribution to annual glacier mass balance as well as over the monsoon and non-monsoon season. Three DSMs of the highest possible accuracy and precision have been calculated for the study area, which encompasses 780km² of the main Himalayan divide. These can be used to calculate the geodetic mass balance of the investigated glaciers, but also to get information on differential melt in the debris covered parts of the glaciers.

In addition, Sentinel-2 images are used to classify the glacier surfaces into ice, snow and water (lakes). This will allow to monitor glacier surface properties, and enable a tracking of the changes of proglacial lakes, ice-cliffs and avalanche cones over time.