



## **Glacier Change and Glacial Lake Formation in Khumbu Himalaya using Digital Elevation Models and Satellite Data**

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Multi-temporal space imagery from 1962 (Corona KH-4), 1992 (Landsat TM), 2000 (Ikonos), 2002, 2003 and 2005 (ASTER) were utilised to investigate the glacier changes in Khumbu Himal. The downwasting rate was estimated using digital surface models (DSM) derived from Stereo Corona and ASTER. The DSMs in this terrain with high relief still contain some elevation errors. However, those are minor in the snow free areas with gentle slopes. Thus, the comparison of the surfaces of the debris-covered glacier tongues is feasible and showed the downwasting of the debris-covered glaciers. The highest downwasting rates with more than 20 metres ( $>0.5$  m/a) can be found at the transition zone between the active and the stagnant glacier parts of the debris covered glacier tongues. The downwasting is lower, but still clearly existing, in the active ice areas and at the snout with thick debris cover. All debris-covered glaciers show a similar behaviour. The investigated ice coverage in Khumbu Himal decreased about 5% between 1962 and 2005, whereas the highest retreat rates are found between 1992 and 2001. The debris-coverage increased concomitantly with the decrease of the total glacier area, whereas the clean ice area decreased more than 10%. The continuous recession and downwasting of the glaciers caused a rise of the total area of glacial lakes, and therefore led into an increasing danger of outburst floods (GLOF). Using the remote sensing data the glacial lakes were monitored and surface displacements were calculated. Based on the DSMs and the glacier surface velocities potential

sites of future lake formations could be identified.