

Glacier-induced Hazards in the Trans-Himalaya of Ladakh (NW-India)

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Glaciers are important water resources for irrigated crop cultivation in the semi-arid Trans-Himalaya of Ladakh (NW-India). Due to global warming, many glaciers of South Asia have retreated over the last century and further ice loss will threaten local livelihoods in the long run. In the short term, an increase of flood events caused by melting glaciers and permafrost is expected for the Himalayan region. Beside large catastrophic events, small outburst floods are 'more' regularly reported for various parts of the region. This also holds true for the Trans-Himalayan region of Ladakh, where small glaciers exist at high altitudes. Caused by glacier retreat, a number of proglacial lakes have been formed, most of them dammed by ice filled moraines. The potential risk of these lakes is shown by recent reports on glacial lake outburst flood in the villages Nidder in October 2010 and Gya in August 2014. The 2014 flood destroyed several agricultural terraces, a new concrete bridge and two houses. Own remote sensing analyses shows the increase of a moraine dammed proglacial lake in the upper catchment area, which grew from about 0.03 to 0.08 km² between 1969 and 2014. Because of the relatively stable altitude of the lake level, one can assume that the flood was caused by a piping process, initiated by melted ice bodies in the moraine. Already in the 1990s a small GLOF was observed in the village, which destroyed some fields. As in 2014, the lake was not completely spilled and a short-term decrease of the lake area is detectable in remote sensing data. Thus, further GLOF-events can be expected for the future. Beside physical risk factors, population growth and new infrastructure development along the streams and valleys increases potential damages of floods. Therefore, investigations are required to estimate the risks of these small glacial lakes and the potential flood effected area for the case study of Gya as well as for the whole region of Ladakh. Remote sensing data are used to detect glacial lakes and their dynamics, and to derive historical GLOF-events. These results will be contextualized with oral history and local interviews about historical flood events. Due to the small size of these glacial lakes and the fact that many of them are almost always frozen, a monitoring system based on high resolution images and field surveys is required to detect potential lake outburst hazards.