

Exploration of a periodic GLOF in Halji, West Nepal using modeling and remote sensing

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Glacier lake outburst floods (GLOF) represent a serious threat to high mountain communities worldwide. Understanding their mechanisms and the driving forces that influence their timing and amplitude especially in the light of a changing climate is essential in order to plan meaningful mitigation measures. In this case study we focus on a periodic GLOF which occurs in Limi Valley, West Nepal since 2006. The GLOFs threaten inhabitants and an ancient monastery in Halji Village. Based on an interpretation of satellite imagery it appears that the source of the flood is a supra-glacial lake at the altitude of 5350 m a.s.l. on a glacier approximately 6 km from the village. The lake discharges through a sub-glacial drainage system to the SE diverting from an older drainage path towards the NE. The formation of the lake can be related to a retreat of the glacier due to an increase in temperature in the last decade which is shown by meteorological data from the High Asia Reanalysis (HAR). The retreat of the glacier was confirmed by an analysis of Ice, Cloud, and land Elevation Satellite (ICESat) data for the period 2003-2009 and of a time series of satellite images. The amount of melt water that potentially could feed into the GLOF is simulated by a physically based energy and mass balance model, coupled with a multilayer snow model to account for subsurface processes like refreezing and subsurface melt within the snow pack, solely forced by HAR data. Based on the modeled contemporary state of the glacier, projections of future melt water quantities are obtained assuming various scenarios for temperature and precipitation variability. Additionally, the amount of discharged water is estimated using the raster-based hydraulic model FloodArea. The timing and amplitude of the 2011 flood event is reconstructed from photos and accounts of an eyewitness. The results are used to assess present and future flood risk, which allows for a planning of effective mitigation measures and adaption strategies for Halji village.

Keywords: GLOF, remote sensing, High Asia Reanalysis (HAR), glacier mass balance model, hydraulic model, supra-glacier lake, Limi Valley,