



A qualitative evaluation of the glacial lake outburst flood (GLOF) risk management at Imja lake, Everest region, Nepal

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Glacial lake outburst floods (GLOF) are one of the most hazardous processes in glaciated high mountain areas. In the Everest region the Dig Tsho GLOF in 1985 destroyed numerous houses, bridges, farmland, a hydro power station and trails. Currently, the potential GLOF of Imja lake (88 million m³) poses severe risks to numerous villages downstream of Imja and Dudh Koshi rivers. Tourist numbers in this region are rising and currently in the order of 60,000 per year (2018).

The aim of the study was to analyze the status of GLOF risk management in the Everest region and how resilience of threatened people can be increased. Applied methods include literature study, field observation and a qualitative survey in 2018.

To reduce the GLOF risk, the Imja lake was artificially lowered by three meter and an early warning system (EWS) was installed in 2016. Selected members of threatened villages were trained in emergency drills. Warning signs inform locals and tourists about the GLOF risk which include multi-hazard maps showing not only the potential flood heights but further geomorphic hazards like rock falls, debris flows and slides. Additionally to this process oriented information, the locations of evacuation centres are also presented in these maps.

Due to the extreme magnitude and low frequency of the GLOF hazard at Imja lake high uncertainties are involved in assessing potential onset and impacts of such a GLOF. Therefore, risk communication between stakeholders, scientists and local population is very challenging. Often local people were left in anxiety by researchers, experiencing that no GLOF occurred for years. Guides and porters were not part of risk communication so far.

Even though lots of important measures have been implemented to reduce the GLOF hazard and risk from Imja lake, our qualitative evaluation indicated that there is still room for improvements: Regular testing of the full EWS should be implemented. Existing multi-hazard maps used in GLOF risk management are confusing experts, tourists and locals and should therefore be revised. While the locations of GLOF evacuation centres are included in these multi-hazard maps, some centres are located in high geomorphic hazard areas. Furthermore, these multi-hazard maps do not show the full extent of potentially inundated areas and do not include the erosion of fluvial terraces. In case of the 1985 GLOF such erosion led to catastrophic destructions. A major drawback is that the planning of evacuation centres considers local inhabitants only. Scenarios of GLOF occurrence in tourist season are missing and should be developed and integrated in GLOF risk management. Considering the extreme magnitude, it would be desirable to get an alternative to the current EWS. A stable cellular network would be a cheap possibility, so that villages close to the lake could issue additional warnings down the valley as backup.