

Assessment of remote geohazards in high mountain areas of Tajikistan with special emphasis on GLOFs and the breach of natural dams

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Remote geohazard events in the mountains of Tajikistan have repeatedly caused disasters during the past decades. The rock avalanche of Hoit (1949) with about 30,000 fatalities and the GLOF in Dasht in 2002, with dozens of fatalities, are only two examples. Though, in general, the possibility that such events may occur is known, the stakeholders and the people in the villages are hardly aware of specific remote geohazards. The major objective of the research outlined here is to identify and to highlight potential source areas and pathways of remote geohazards events, in order to allow for well-designed mitigation procedures (compare the abstract "Capacity-building and mitigation strategies for remote geohazards" in this volume). The geohazard assessment is carried out in a four-step procedure:

- **Pre-assessment:** GIS and remote sensing techniques were employed for detecting potential source areas and pathways of remote geohazards. The relevant geomorphologic features in the study areas were mapped from medium-resolution datasets (SRTM digital elevation model, LANDSAT and ASTER images) in combination with topographic and geological maps as well as Google Earth. Specific areas of interest were deduced from the mapping results.
- **Helicopter survey:** the areas of interest identified during the Pre-assessment were viewed from the helicopter. The knowledge gained this way was used to select the areas for the field assessment.
- **Field assessment:** some areas of specific interest were visited in the field by international groups of 4 researchers during summer 2009. In particularly remote areas, they were dropped off from the helicopter. The areas of interest were analyzed and mapped in detail and the level of hazard emanating from the lakes or slopes was estimated.
- **Post-assessment.** Based on the field assessment, five areas of particular hazard were selected for further analysis. Scenarios of landslides, dam breaks and flood waves will be built and the possible impact farther down the valley will be assessed using computer models. Based on that, recommendations how to mitigate the hazard will be given to the relevant agencies and stakeholders as well as to the local population.

The final results of the project will be ready in spring 2010, the preliminary results are outlined below.

Particularly in the upper reaches of Rivakdara (Gunt Valley), a number of growing glacial lakes was identified. An outbreak of one of the glacial lakes could generate a flood wave weakening the composite dam of Rivakkul Lake, with catastrophic consequences for the population all the way downstream to the town of Khorog. Some more potentially hazardous glacial lakes drain directly and steeply into the villages of the Gunt Valley. Whilst most of these lakes are dammed by moraines - which may, however, contain some ice - some other lakes are dammed by glaciers or rock glaciers. The most significant example is located in Khavrazdara (Bartang Valley, Central Pamir), where the rock glacier dam appears stable at the moment, but further melting of the ice could lead to a sudden outbreak as soon as a certain threshold is reached.

In the highest portions of the Pamir, melting of the glaciers has not yet reached the stage as observed in the Southern Pamir. Glacial lakes just start to develop, but an accelerated evolution of glacial lakes in the area has to be expected in the future. In addition, surging glaciers in the area may lead to the quick development of new lakes. The Zarafshan and Turkestan Ranges in North-western Tajikistan have experienced comparable processes some thousands of years ago, as indicated by geomorphologic records. However, damming of lakes by rainfall-triggered landslides has been reported repeatedly.

Two major tectonic faults run through the territory of Tajikistan, allowing earthquake magnitudes of up to 7.5 and more. Whilst the dams of some lakes may be weakened by earthquakes, or flood waves may be generated by rock falls into the lakes (this may be the case with the Seven Lakes in the Fan Mountains), several lakes dammed by earthquake-triggered landslides do exist (Seven Lakes) or have broken out (Pasor-Ghudara Landslide). It is certain that new lakes will be dammed by earthquake-triggered landslides in the future, but the exact location of such events is hard to predict.