



## **A procedure for analyzing lake outburst hazard and its application to the South-Western Pamir, Tajikistan**

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In the last 40 years, several new lakes have formed in the South-Western Pamir of Tajikistan (Central Asia), and existing lakes have grown. The most dynamic environment in terms of lake evolution are the retreating and decomposing glacier tongues and their direct forefields. Other lakes are dammed by landslide deposits or older moraines. In 2002, sudden drainage of a glacial lake in the area has triggered a catastrophic debris flow, destroying the village of Dasht.

Building on existing approaches, a stringent rating scheme was devised, allowing for a quick regional-scale identification of potentially hazardous lakes and possible impact areas. This approach relies on GIS, remote sensing and empirical modelling. A scoring system including dam type and geometry, lake drainage, lake size and lake size evolution, susceptibility to mass movements into the lakes, and seismic hazard was employed to determine the Lake outburst hazard. Out of the 428 lakes mapped in the area, 6 were rated Very hazardous and 34 Hazardous. The possible impact area was estimated using a combination of empirical-statistical approaches for debris flows and floods. As a result, a rating of the Impact hazard (Negligible to Extremely high) was assigned to each raster cell of the study area. The hazard classifications were used for the identification of lakes requiring in-depth investigation.

The analysis scheme has proven as a valuable tool for a rapid and reproducible identification of potentially hazardous lakes and possible impact areas. It does not require specialized input data, but largely relies on internationally available medium-resolution satellite imagery and DEMs. This enables an application in remote or poorly developed areas with limited availability of local information. The disregard of such data, however, also limits the scope of the method: it is clearly confined to the identification of areas requiring closer attention. The regional-scale analysis has to presume the unknown parameters as utmost unfavourable in order to come up with worst-case assumptions. This avoids to miss potentially hazardous lakes and situations during the site selection for detailed studies.

The Dasht 2002 event, the most destructive GLOF in the documented history of the South-Western Pamir, originated from a lake rated as Very susceptible, but only Medium hazardous in the regional-scale analysis. A closer on-site inspection did not reveal a substantial difference to other glacial lakes with such a rating, except for the short lifetime of the lake (one year). This finding underlines the need to detect glacial lakes immediately after their emergence and to take adequate measures.

Also modelling of the travel distance of the Dasht event showed the difficulties of putting GLOF events into prescribed schemes: it was impossible to reconstruct the travel distance of the flow by employing empirical rules based on previous events. This, in conjunction with the thoughts presented above, shows the importance of broad-scale risk mitigation strategies in potentially affected areas, including awareness-raising and preparedness-building within the local population, in combination with a regular monitoring of the glacial environment.