

## **Automatic detection of glacial lakes, their recent changes and associated hazard potentials in the Eastern Alps based on remote sensing.**

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The past and ongoing strong glacier retreat implies formation and rapid changes of glacial lakes and their environment. Debris flows and flood waves from glacial lake outbursts pose significant threats to people and infrastructure in the Alps and other high mountain regions. Especially outside Europe glacial lakes are often located in poorly accessible regions. For hazard assessment it is thus important to have methods for fast lake detection in remote regions.

The objective of this study is to develop methods and techniques for lake detection and hazard assessment over large areas based on remote sensing data and digital elevation models (DEM). A GIS-tool for lake detection based on multispectral satellite data is presented and an analysis of glacial lake changes between 1985 and 2003 in the Eastern Alps is performed. Also, an approach for first hazard assessments is developed.

For lake detection the Normalized Difference Water Index (NDWI) is applied (Huggel et al., 2002). This index uses the spectral reflectance differences of water, similar to the well-known Normalized Difference Vegetation Index (NDVI). The NDWI, a correction by a focal function and a cast shadow mask is calculated automatically with a GIS-Tool. The result of this fully automatic procedure is verified in a selected area in the Upper Engadin.

For assessing the effects and runout of potential outburst floods from these lakes, flow trajectory modelling based on Huggel et al. (2003) is applied. First trials showed feasible results but revealed also problems and limitations of the method. In all cases manual corrections were needed. The DEM accuracy and the spatial and spectral resolution of the satellite images turned out to be the most limiting factors. A further limitation is the fact that rockfall as a potential trigger for lake outbursts cannot be assessed only with elevation data and satellite images. Nevertheless, it can be a useful tool for gaining a first overview of the situation over larger areas.

The comparison of conditions in 1985 and 2003 showed that the area of some glacial lakes as well as the number of lakes in glaciated areas increased. Also, the situation of some glacial lakes changed because of glacier retreat. The flow modelling has shown that some of the lakes can be problematic and should be analysed more detailed and possibly needing regular observation.

The strength of this model is the fast overview of the situation over large areas. The model is designed to facilitate subsequent more detailed investigations and field observations. It can be applied all over the world given the availability of multispectral satellite data and elevation information, a service which, indeed, today's technology makes possible.

## REFERENCES

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