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Time-variant risk assessment of a hazard cascade at the example of a rockslide dam - a case study in the Upper Val Venosta / Vinschgau Valley, Italy

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Earthquakes and heavy precipitation events represent the main triggering factors of mass movements such as landslides, rockslides or debris flows. The overall hazard potential is increased significantly if the mass movement subsequently interacts with an adjacent river course by creating a fully or partially blockage of the channel. These temporary dams can cause disastrous secondary hazards by backwater inundation or outburst floods. Therefore, the formation and failure of rockslide dams can be regarded and assessed as a cascade of hazards. Through the cascading effects, rockslide dams can affect areas at great distances up –or downstream of the site where the actual mass movement occurred. Moreover, the time span between the generation and the failure of a rockslide dam can vary from few minutes to several days or even decades. This type of cascading hazard is therefore subject to high temporal and spatial variability. Due to the difficulties assessing the probabilities of each part of the hazard cascade, there is a substantial uncertainty involved in the assessment of the overall hazard.

Risk assessments, however, often do not account for this complexity when assessing the exposed elements. Especially the exposure of people, highly mobile in space and time, is often not taken into consideration. In this study, we propose a novel approach that combines both the dynamic components of the hazard and the exposure.

The study area extends over the two municipalities of Stilfs/Stelvio and Prad am Stilsferjoch/Prato allo Stelvio in the Autonomous Province of Bozen/Bolzano (South Tyrol) in Northern Italy. Both municipalities are major tourist destinations in the region featuring two ski resorts, a national park and the well-known 'Stilfser Joch/Passo dello Stelvio' mountain pass. This implies a high daily and seasonal fluctuation of people, including commuters and tourists.

The upper part of the slope above the village of Trafoi is at risk of a sudden failure of a large rock slide mass. Previous works modelled various slope failure scenarios and predicted rockslide run-out depositions of up to 75 m height in the channel of the Trafoi River. In this work, firstly the hazard induced by a potential rockslide dam was quantified. The backwater inundation was assessed by a GIS-based method and the downstream flood event was modelled with a combined 1D-2D hydrodynamic model. Secondly, the number of exposed people was estimated by a grid-based population model capable to simulate daily or seasonal movement patterns of people.

Results show that peak discharge out of the breaching rockslide dam can reach up to 2550 m^3s^{-1}. Population modelling reveal that around 6640 people would be exposed to this hazard in winter time and 7250 in summer time. About one third of the persons would be tourists and one fourth were local commuters.