Landslide dam susceptibility in the Austrian Alps inferred from modelled landslides, potential valley damming and lake formation

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In mountain landscapes, landslides often block river courses. Although landslides are well-known threats, the risks imposed by landslide dams are sometimes neglected. The impeding of a river can lead to the submergence of parts of the upstream valley and a failure of the dam can flood downstream terrain in a catastrophic event.

Our aim is two-fold: we are interested in creating a landslide dam susceptibility map relying on modelled landslides and resulting damming of valleys and formation of lakes, and in studying the relation between the occurrence of landslide dams and lithology.

Landslide susceptibility maps are a common tool for natural hazard mitigation, but landslide dam susceptibility maps are rarely produced. Several simple indices (Blockage Index, Backstow Index) have been developed to predict the obstruction capacity and stability of landslides on a river from landslide and catchment characteristics (landslide volume, catchment area, dam height etc.). However, those methods were applied on observed landslides, and did not consider landslide susceptibility. Here, we created a first modelling-based landslide dam susceptibility map and compared it to the results provided by the indices.

Although the relation between lithology and landsliding has been thoroughly studied, no connection with dam formation has been highlighted so far. Lithology has an impact on various characteristics of the landslide, including its volume, and also influences valley geometry. We investigated if some alpine lithological units are more prone to landslide dam formation than others.

In our modelling approach we used a 10 m DEM of the Austrian Alps and stochastically triggered landslides based on slope thresholds. We then simulated the runout of the landslides using a fluid flow solver. For each landslide deposit we computed the maximum dammed volume by filling the landslide-dammed DEM, and compared those volumes to the lithology. We also tested the different theoretical geomorphological indices to predict the impounding of the river and compared them to the actual results provided by our method.