Geophysical Research Abstracts
Vol. 16, EGU2014-6621, 2014
EGU General Assembly 2014

GIS-based topographic reconstruction and geotechnical modelling of the Köfels Rockslide (Austria)

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Investigating fossil landslides may help to predict possible future events. The larger than 3 km2 Köfels rockslide, located in the Ötztal Valley (Tyrol, Austria) represents one of the largest landslides in metamorphic rock masses in the Alps. It occurred in the early Holocene approx. 8700 years BP and has been subject of numerous studies. So far no reconstruction of the pre-failure topography and volume determination based on high resolution airborne laser scanning digital elevation models (DEM) and up-to-date GIS methods was done. In addition, only a few numerical studies using numerical modelling techniques focusing on the failure as well as deformation process and the rock mass strength properties were performed.

The present work will attempt to close this gap. The Köfels rockslide is reanalyzed with regard to its actual and initial topography as well as the involved failure and deposition volumes based on a recent DEM. The complex topographic situation of the study site requires four different models of the terrain in order to calculate the volume of the failure and deposition mass. Therefore the following topographies are reconstructed: (i) the pre-failure topography representing the situation before the event, (ii) the topography of the failure surface without the deposition mass in the valley, (iii) the topography after the event but before valley incision and deposition of the alluvium north and south of the rock slide deposit, and (iv) the up-to-date DEM, which represents the present topographic situations in the area. The volumes of the failure and deposition masses of the Köfels rock slide are estimated by comparing the four terrain models. Besides geomorphological considerations based on the DEM, published data from boreholes and an investigation adit are used to reconstruct the pre-failure valley topography.

For the geotechnical analysis the 2-D discrete element code UDEC by Itasca is applied to a geological cross section of the Köfels rock slide. In particular, the shear strength properties of the basal shear zone are determined by means of back-calculation methods. In addition, different scenarios focusing on the initial failure process are performed. The impact of groundwater flow, the change of stress state due to glacial unloading and the effect of dynamical loading, induced by an earthquake, on slope failure is simulated. The results are employed to explore combinations of conditioning and triggering factors suitable for leading to the onset of such an extreme event.