Geophysical Research Abstracts
Vol. 15, EGU2013-4546-4, 2013
EGU General Assembly 2013
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Identification and characterization of rock slope instabilities in Val Canaria (TI, Switzerland) based on field and DEM analyses

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In Alpine areas rockslides and rock avalanches represent common gravitational hazards that potentially constitute a danger for people and infrastructures. The aim of this study is to characterize and understand the different factors influencing the distribution of large slope instabilities affecting the Val Canaria (southern Switzerland). In particular the importance of the tectonic and lithological settings as well as the impact of the groundwater circulations are investigated in detail.

Val Canaria is a SW-NE trending lateral valley that displays potential large rock slope failure. Located just above one of the main N-S communication way (Highway, Railway) through the Alps, the development of large instabilities in the Val Canaria might have dramatic consequences for the main valley downstream. The dominant geological structure of the study area is the presence of a major tectonic boundary separating two basement nappes, constituted by gneissic lithologies, i.e. the Gotthard massif and the Lucomagno nappe that are located in the northern and southern part of the valley respectively. The basement units are separated by meta-sediments of Piora syncline composed by gypsum, dolomitic breccia and fractured calc-mica schists.

Along with detailed geological mapping, the use of remote sensing techniques (Aerial and Terrestrial Laser Scanning) allows us to propose a multi-disciplinary approach that combines geological mapping and interpretation with periodic monitoring of the most active rockslide areas.
A large array of TLS point cloud datasets (first acquisition in 2006) constitute a notable input, for monitoring purposes, and also for structural, rock mass characterization and failure mechanism interpretations.
The analyses highlighted that both valley flanks are affected by deep-seated gravitational slope deformation covering a total area of about 8 km2 (corresponding to 40% of the catchment area). The most active area corresponds to the lower part of the valley, where gypsum outcrops. Dissolution of gypsum at the bottom of the slope leads to the creation of large slope instabilities since deep seated creeping evidences are observed in both flanks of the valley. However, an important distinction between the slope instabilities characterizing the two valley flanks can be observed. The NW flank of the valley is influenced by the presence of high strength orthogneiss with a main foliation dipping into the slope with the consequent formation of gravitational compressional features, such as counter-scarps and trenches in the upper part of the slope. The presence of altered gypsum and persistent faults on SE flank represents the main geological factor leading to the development of slope instabilities. In this area the instability typologies are manly large collapse/dissolution and deep landsliding. In addition, periodic TLS acquisitions performed in the lower portion of the slope highlight continuous centimetric-scale displacements and an important rock fall activity. Several karst channels affecting the gypsum outcrops have been also identified. This suggests the primary influence of groundwater circulation.
A 3D geological model based on several geological cross sections is performed to understand the importance of lithological boundaries as well as the orientation of structures (faults, fold, stratification) to investigate in detail the groundwater circulation.