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Distribution and characteristics of large slope instabilities in Rhone Valley (Switzerland)

Andrea Pedrazzini, Michel Jaboyedoff, Alexander Loye, and Battista Matasci
IGAR, Faculty of Geosciences, Lausanne, Switzerland (andrea.pedrazzini@unil.ch)

Large slope instabilities are very frequent in glacial valleys, especially after the glacial retreat. The development and the spatial distribution of the instabilities could be controlled by distinct main important factor or a combination of different causes. The factors leading to slope destabilization cloud be roughly divided in two distinct categories: Internal factors, (e.g rock mass proprieties, joint sets geometry and mechanical characteristics, permeability) and External factors (e.g. external stresses, groundwater pore pressure, glacial unloading and erosion). External factors influence and drive the evolutions of the internal factor leading to a progressive degradation of the rock mass characteristics.
In the study, inventory and the characterisation of large slope instabilities, affecting the upper portion of the Rhone Valley (south-western Switzerland) were carried out to identify the different factors controlling their distribution.
The study area represent a surface of about 5'250 km2, characterized by the large NE-SW U-shaped Rhône valley and by his large N-S tributary catchments. Geology and tectonic setting as well morphometrics characteristics (e.g. relief, elevation, and gradient) are very changing all along the study area leading the development of different slope dynamics after the glacial retreat.
Detection of potential unstable areas and main geomorphometric features was carried out combining different remote sensing data as high resolution digital elevation model (2 m cell size), aerial orthophotos and Google Earth images. Bibliography and historical researches were also performed to obtain information about the evolution of the detected instabilities. Field survey was realized for interesting study cases and to verify remote sensing observations.
Mapping and differentiation of large slope instabilities was conducted according to their size, geometry and morphological style. Based on these parameters and on previous proposed classifications (Hutchinson, 1988) instabilities were divided in five different categories as DSGSD, mixed landslide-DSGSD, rockslide and rock avalanches, roto-translational landslides and undifferentiated erosion areas.
Several morphological and structural criteria were also investigated for each landslide area including geometrical descriptor, degree of deformation, potential structural constraints, relative or absolute chronology relation and present-day movements.
Mapping and bibliography researches allow identifying up to 255 slope instabilities inhomogenously distributed along the Rhône valley and his tributary catchments. The total area of detected instabilities represents 10% of the entire study area.
Statistical and spatial analyses have been performed in order to point out the main factors influencing the distribution of the large slope instability in the Rhône catchment. Considering all the detected instabilities spatial analysis indicates the presence of 4 main areas with an important concentration of large slope instabilities. A strong spatial relationship between the uplift gradient and the density of large slope stability was also outlined. Where the gradient is higher important differential movements occur, inducing the development of large slope instabilities. The lithology and the structural settings seem also influencing the distribution of large slope instabilities. In particular, the lithologies as well as the orientation of the main foliation influence the type and the size of the instability that could be developed. For example, roto-translational landslides are mostly developed in the sedimentary cover of the Helvetic Nappes where alternations between hard and soft rocks are important. DSGD are more frequent in foliated metamorphic rocks where important sub-vertical tectonics features are present.