Detection and stability analysis of rock slopes in differents spatials scales.

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The "les Pics" area, located in the Rhône valley (canton of Wallis, south-western Switzerland), is a complex unstable system, composed by a deep-seated gravitational sliding (DSGS), minors landslide inside the deformed mass and characterized by recurrent rockfall activity.
A 30,000 m^3 rockfall occurred in 2004, partly obstructing a secondary road crossing the slope. During historical events, some blocs even reached the Rhône valley. The mechanisms of the DSGS and the rockfalls, as well as their possible relationships have been investigated.

Morpho-structural, computer and geophysical analysis (Self-Potential profiles (SP), GPR, field measurements and DTM-based computing) show that the DSGS is linked to a major fault that affects the whole slope. The mean orientation of the major fault (085/70) is nearly parallel to the Rhône valley. Geomorphologic observations indicate that at present, the DSGS has a very low displacement rate. Water infiltrations in the upper part are confirmed by the SP measurements. The infiltrations are localized in depressions formed by minor faults that are sub-parallel to the major one.
A numerical model, concerning the slope evolution during the glacial retreat, was performed with 2D geomechanical simulation based on finite difference method (Agliardi et al., 2001). The volume of instabilities and the position of the failure surface were estimated utilizing the Slope Local Base Level (SLBL) method.
The results of the two simulations are in according to field observations. Geomechanical simulation, based on finite difference method, show the formation of minor landslides inside the deformed mass and ancient collapses of the lower part. Reactivation of pre-existing vertical discontinuities and formation of tension cracks in the upper part were recognized.
The volume of the DSGS is estimated in 100 mio of m^3 and the volume of the two inside landslides are estimated in 25 mio of m^3.
The triggering cause of the phenomenon must be related, in according to the numerical simulation, to the removal of glacial confinement about 15’00-17’000 years ago. This caused an important unloading of the slope causing the formations of failure surface and reactivation of ancient discontinuities.

The study of shallow rockfall activity was devised in two parts. In the first part a semi-automatic detection of diffuse hazard, based on “Matterock” methodology (Rouiller et al., 1998) was performed.
In a second time visible instability are analyzed by field investigations. For 30,000 m^3 rockfall occurred in 2004 a complete back analysis was performed to identify mechanical characteristics of the rock mass. The propagation and the blocs trajectories of the 2004 rockfall event was also modelled using 3D Rotomap® program to obtain rebound and friction coefficients.

Semi-automatic detection show that the strong activity is mainly due to planar sliding in the bedding plane orientation (016/20). In the upper part of the study area, wedges made up of two tectonics joints, generally oriented 220/75 and 126/65 can also induce rockfall activity. Toppling failure mechanisms can also be found in particular associate with planar failure. (016/20)

For the 2004 event a complex failure system coupling wedge and toppling mechanisms are identified.

Due to the main orientation of the slope, the main instability factor seems to be freeze and thaw cycle coupled with important precipitations. The last months of winter and the first month of autumn present the most important rockfall activity.

Geomorphologic observations and terrestrial LIDAR monitoring indicate that at present the shallow activity (rockfall, mud flow, debris flow) are increasing. In particular we observe a reactivation of ancient instabilities.

The results of the various investigations were integrated in a GIS to build a geodatabase of regional instabilities.

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