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Chasing a complete understanding of a rapid moving rock slide: the La Saxe landslide

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Large deep seated slope deformations affect entire valley flanks and are characterized by slow to extremely slow present day displacement rates. Because of their extreme size, they are frequently characterized at their interior by secondary instabilities which can be classified as rockslides, that can originate large rock avalanches or can move at much faster rates with respect to the main mass. As a consequence local instabilities and reactivation of sectors of deep seated deformations should be carefully monitored and studied especially because they can affect strongly deformed and weakened rock masses. Because of these natural conditions and their preferential location in coincidence of slope steepening, these rockslides can undergo rapid evolution and activation putting the upmost urgency for monitoring, hazard and risk assessment.

We present the case study of the La Saxe rockslide (Courmayeur, Aosta valley, Italy), located within a deep seated deformation affecting most of the 10 km long left hand flank of the Ferret valley (between 1340 m and 2300 m a.s.l.) and which underwent a major phase of acceleration in the last decade. The rockslide affects the extreme south western tip of the deep seated deformation at the outlet of Ferret valley, with an estimated volume of about 8 x 106 m3 of clay schists and thinly bedded black carbonates, intensely folded and faulted. An intense investigation activity has been performed in the last 2 years to reach a more complete understanding of the phenomenon. Boreholes have been drilled, logged, and instrumented to constrain the landslide volume, the rate of displacement at depth, and the water pressure. Displacement monitoring has been undertaken at successive steps by setting up sequentially: a distance measurement network (6 optical targets), a GPS network for periodic measurements (12 stations), a ground-based interferometer (GB-InSAR, LisaLab, by Ellegi, with 10 min acquisition intervals), a geodetic network based on a total station and 25 optical targets measured at 2 h intervals, a GPS network (7 stations) for quasi-real time measurements, four differential multiparametric borehole systems (DMS columns up to 100 m long). A geotechnical network has been also implemented including open pipe piezometers, borehole wire extensometers and inclinometric casings. This enormous monitoring effort is motivated by the extreme risk associated to this phenomenon, which is hanging over a famous touristic resort, a world famous cable way, the Mont Blanc highway, and in close proximity to the Mont Blanc tunnel. Rockslide characterization, failure surface definition, and groundwater flow investigations allowed for a series of slope stability analyses to be completed, together with modelling of the expected invasion area. Relationships with snowmelt have been ascertained and an early warning system based on real time measurements redundancy and all weather capabilities has been set up. LisaLab GB-InSAR equipment continuously provide spatially distributed displacement data which have been analysed to identify different failure scenarios and sensitivity of the landslide to triggering and controlling factors. Geodetic measurements are integrated with GB-InSAR data for verification and in depth 3D displacement reconstructions.