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The structurally-controlled rockslide of Barmasse (Valais, Switzerland): structural geology, ground-based monitoring and displacement vs. rainfall modeling.

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In this communication, we show a case study on the Barmasse rockslide (Val de Bagnes, Valais, Switzerland), which is an active structurally-controlled instability that threaten roads and inhabitants. The entire slope is included within the Middle Penninic unit. According to regional tectonic stresses, the micaschists that compose the instability have been intensively deformed and metamorphised leading to an important foliation and fracturing. Structural settings have been extracted from 3D points-clouds of the crown area. These datasets were acquired with a terrestrial LiDAR (TLS) and processed with Coltop-3D software.

The landslide can be defined as a complex instability, with a continuous movement on a basal surface. This deformation also generates a frequent rockfall activity in the upper part of the slope. The landslide was monitoring using different remote sensing techniques (TLS, GNSS and GB-InSAR):
a) regarding TLS measurements, we monitored long term 3D displacements comparing two different TLS points clouds acquired in 2009 and 2011, showing more than 3 m displacements in two years in the upper part of the slope (crown area);
b) differential GNSS measures were obtained at the toe of the slide, validating TLS measurements in those areas were vegetation hampered remote sensing measurement;
c) finally the landslide was also monitored by a GB-InSAR in order to investigate short term displacements. The experiment was carried out during summer 2011, recording displacement rates exceeding 7 mm in 12 h in the main scarp, and confirmed the high amplitude of daily displacements.

We are also continuously recording landslide displacements at a daily rate over the most active part of the slope using one crackmeter. The kinematics of the landslide is characterized by a continuous displacement (3rd creep state) which is clearly controlled by external forces (rainfall episodes): on the one side, landslide velocity sharply increases it value after rainfall episodes; on the other side, landslide velocity is progressively reduced during dry periods, tending to a horizontal asymptote of null displacement. In order to model landslide kinematics, we obtained a response function that reproduces the landslide displacements based on a convolution of daily precipitation during a certain time window (50 days in this case study). Two different response functions following exponential and power laws were tested. The variables of these functions were optimized in Matlab in order to minimize the error between the real and the modeled displacements. The hydrological model shows close resemblance to reality during the calibration period (2007-2008) and is able to forecast landslide displacements during subsequent years.

Using both kinematic settings and hydrological approach enables to forecast future displacements according to weather conditions and to establish threshold values a possible early warning system of the Barmasse rockslide.