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Characterization and monitoring of the Séchilienne rock slope using 3D imaging methods (Isère, France)

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The Séchilienne landslide located in the Romanche Valley (Isère, France) is a well instrumented mass movements of about 650 m high and 250 m wide, with a potential volume of about 3 million m3 in the most active part (Duranthon and Effendiantz, 2004 ; Kasperski et al., 2010). The slope, which is mainly composed of micaschist, is characterized by the presence of a NE-SW sub-vertical fracturing system involved in the destabilization of the area. The rock slope has been continuously moving since the eighties decade, with a growing acceleration during the period 2009-2013 followed by a progressive stabilization during the last years. The monitoring of the active part of the rock slide is currently carried out by an instrumentation system in order to prevent a large failure.

In this work, we used different 3D techniques in order to monitor the whole rock slide displacements in three dimensions, as follows: (a) First of all, we used a Terrestrial Laser Scanning to obtain high resolution point clouds (8 cm point spacing) of the rock slope geometry. Nine different fieldwork campaigns were performed during the last six years, as follows: Aug. 2009, Jul. 2010, Nov. 2011, Nov. 2012, Jun. and Nov. 2013, Jul. and Oct. 2014, May 2015, which provided a set of 3D representations of the rock slope topography over time; (b) In addition, we used three Helicopter-based Laser Scanning campaigns carried out in Jan. 2011, Feb. 2012 and Mar. 2014 acquired by the Cerema (Chanut et al., 2014); (c) Finally, more than 600 photos were taken in Apr. 2015 in order to build a photogrammetric model of the area using Structure-from-Motion (SfM) workflow in Agisoft PhotoScan software. All types of data were complementary for the study of the movement and allowed us having a good spatial vision of the evolution of the most active part of the slope.

A detailed structural analysis was performed from both LiDAR and SfM point clouds using Coltop3D (Jaboyedoff et al., 2007). Eight joint sets were detected, allowing us to estimate the susceptibility of the slope to three main failure mechanisms: planar sliding, wedge sliding and flexural toppling. Moreover, we carried out the 3D tracking of several homogenous rock compartments using the roto-translation matrix technique (Oppikofer et al., 2009) in order to quantify separately the translational and rotational components of displacements. Large-scale movements (from several dm to more than 10 m) were observed in the active area with a coupling between subsidence and toppling oriented towards the valley. Lateral structures that cut the rear active part also seem to be affected by a clockwise rotation around the topple axis.

The acquisition of dense and accurate terrain information using LiDAR and SfM for studying the Séchilienne landslide has been useful for quantifying the 3D displacements and clarifying the failure mechanisms involved in the complex dynamic of the active part of the slope.

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