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Specific analysis of the recent rockfall activity in the southeast face of the Piz Lischana (Engadin Valley, Graubünden, Switzerland)

Susanna Büsing (1), Antoine Guerin (1), Marc-Henri Derron (1), Michel Jaboyedoff (1), and Marcia Phillips (2)

(1) Risk Analysis Group, Institute of Earth Sciences, Faculty of Geosciences and Environment, University of Lausanne, Switzerland (susanna.buesing@gmail.com), (2) WSL-Institute for Snow and Avalanche Research SLF, Flüelastrasse 11, 7260 Davos Dorf, Switzerland.

The study of permafrost is now attracting more and more researchers because the warming observed in the Alps since the beginning of last century is causing changes in active layer depth and in the thermal state of this climate indicator. In mountain regions, permafrost degradation is becoming critical for the whole population since slopes and rock walls are being destabilized, thus increasing risk for infrastructure and inhabitants of mountain valleys. To anticipate the triggering of future events better, it is necessary to improve understanding on the relation between permafrost thaw and slope instabilities.

A rockfall of about 7000 m3 occurred in the upper part of the southeast face of the Piz Lischana (3105 m), in the Engadin Valley (Graubünden, Switzerland) around noon on 31 July 2011. Luckily, this event was filmed and ice could be observed on the failure plane after analysis of the images. In September 2014 and in the same area, another rockfall of 2340 m3 occurred along a prominent open fracture which was apparent since the failure of the rock mass in 2011. In order to characterize and analyze these two events, three 3D high density point clouds have been made using Structure from Motion (SfM) and LiDAR, one before and two after the September 2014 rockfall. For this purpose, 120 photos were taken during a helicopter flight in July 2014 to produce the first SfM point cloud, and more than 400 terrestrial photos were taken at the end of September to produce the second SfM point cloud. In July 2015 a third point cloud was created from three LiDAR scans, taken from two different positions.

The point clouds were georeferenced with a 2 m resolution digital elevation model and compared to each other in order to calculate the volume of the rockfalls. A detailed structural analysis of the two rockfalls was made and compared to the geological structures of the whole southeast face. The structural analysis also allowed to improve the understanding of the failure mechanisms of the past events and to better assess the probability of future rockfalls. Furthermore, valuable information about the velocity of the failure mechanisms could be extracted from the July 2011 video, using a Particle Image Velocimetry method (Matlab script developed by Thielicke and Stamhuis, 2014). These results, combined with analyses of potential triggering factors (permafrost, freeze-thaw cycles, thermomechanical processes, rainfall, radiation, glacier decompression and seismics) show that many of them contributed towards destabilization. It seems that the "special" structural situation led to the failure of Piz Lischana, but it also highlights the influence of permafrost.

This study also provided the opportunity to perform a comparison of both LiDAR – SfM. The point clouds have been analyzed regarding their general quality, the quality of their meshes, the quantity of instrumental noise, the point density of different discontinuities, the structural analysis and kinematic tests. Results show the SfM also allows detailed structural analysis and that a good choice of the parameters allows to approach the quality of the LiDAR data. However, several factors (focal length, variation of distance to object, image resolution) may increase the uncertainty of the photo alignment. This study confirms that the coupling of the two techniques is possible and provides reliable results. This shows that SfM is one of the possible cheap methods to monitor rock summits that are subject to permafrost thaw.