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Capturing the crisis of an active rock glacier with UAV survey

Christophe Lambiel, Sébastien Rüttimann, Régis Meyrat, and Sebastian Vivero
Institut des Dynamiques de la Surface Terrestre, Université de Lausanne, Lausanne, Switzerland (christophe.lambiel@unil.ch)

Several rock glaciers have been recognized as being destabilized during recent years in the European Alps, and especially in the Western Swiss Alps, through field observations, aerial image photogrammetry or InSAR analyses. However, some landforms may have been missed due to hidden location, small size or not well-defined boundaries. This is the case of the La Roussette rock glacier in the Arolla valley (Valais Alps). This rock glacier occupies a small cirque at 3100 m a.s.l. in southeast exposure and overhangs the top of a talus cone. Due to its hidden location, the existence of this landform was unknown until last year. It was indeed first observed in April 2016 on the occasion of a ski touring. Large crevasses in the snow cover were present and the snow mantle on the talus cone was largely covered by blocks fallen from the rock glacier snout. These observations indicated extremely rapid movements and the occurrence of a major crisis in the rock glacier development.

Due to the topographic location and the frequent rock falls from the front, the access to the rock glacier is almost impossible in summer. To investigate the processes occurring on the landform we performed thus 3 drone flights during summer 2016 using a Sensefly eBee RTK. The advantages of this machine are that no ground control points for georeferencing the digital elevation model (DEM) are needed and that the flight plan can roughly follow the topography. It is thus particularly useful for studying landform evolution in steep slopes. The flights were carried out the 10th June, the 12th August and the 14th September 2016. Image processing was carried out with Pix4D to produce DEMs and Orthomosaics for each flight. A resolution of $\sim$4 cm was reached. In addition, an automatic camera was installed to capture the movements at the front several times per day.

The drone surveys allowed the observation of the back of the rock glacier, which was almost impossible from any terrestrial location. The orthomosaics clearly show the slide of the rock glacier body on a shear plan and the very rapid movement that occurred during the summer. Total movement of the rock glacier was 45 m between the 10th June and the 12th August. Meantime, the front advance was “only” 22 m. This means that strong compression occurred, what can explain why the rock glacier did not collapse on the talus cone despite extremely rapid movements on a very steep slope. Between the 12th August and the 14th September the velocities remained high (3D displacement of 13 m), yet decreasing progressively. The high activity of the first part of the summer and the successive deceleration was also observed thanks to the time-lapse images.

It is very probable that the peak of the crisis has been reached during summer 2016. This will be verified with further drone survey during summer 2017. In addition to the capture of a sudden rock glacier crisis by a remote sensing method, this study also shows how useful are UAVs for studying remote, inaccessible and dangerous landforms.