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4D understanding of failures in soft sedimentary rocks using repetitive terrestrial stereo-photogrammetry: the case of the Rosselin deep-seated slope instability, Valais, Switzerland.

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The objective of this study is (i) to highlight the potential of low-cost stereo-photogrammetry to monitor the 4D deformation of rock instabilities and (ii) to add to the 4D understanding of failure development in soft sedimentary rocks.
The Rosselin instability is located in a landslides prone area in the municipality of Riddes, canton of Valais, Switzerland. This deep-seated slope instability has developed in Triassic dolomitic carbonates overlaid by highly fractured Cretaceous conglomerates and schists. Its estimated volume is of 300'000 m3. A catastrophic scenario can cause the obstruction of a river located 400 m beneath. The sudden failure of the landslide dam would then threaten the municipality of Riddes of major floods and debris flows.
On May 14, 2013, precursor signs of activity (minor rockfalls, developments of tension cracks) in a part of the Rosselin instability were observed after a relatively wet period. Therefore, in complement to risk mitigation planning a monitoring strategy was set up. In addition to the installation of extensometers, repetitive terrestrial stereo-photogrammetry surveys were acquired at a distance of 100 m of the instability in order to build a four-dimensional understanding of the failure. Seventeen high-resolution photogrammetric acquisitions were realized between the 15th and the 17th of May the day the main failure occurred.
The comparison of the states before and after the event of May 17 allowed to compute a mobilized volume of 30'000 m3 (1/10 of the total volume of the Rosselin instability). 3D displacements are derived from the photogrammetric acquisition and obtained with a cross-correlation technique. The kinematics analysis allowed the highlighting of (i) strong deformations during the pre-failure stage within the mass probably induced by progressive brittle fracture damages and of (ii) a control of pre-existing regional discontinuities in the failure stage leading to a general wedge sliding. It also shows that in the runout stage the highly dislocated mass almost instantaneously behaves as a flow as it gathers speed. The field observations, the geometry of the failure and the computed mobilized volumes were then used as input for runout modelling of further possible failure scenario using a depth-integrated approximation of the flow dynamics equations.

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