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Analysis of displacements and fissure structures on a slow-moving landslide through very high-resolution orthophoto mosaicing

Sabrina Rothmund (1), Manfred Joswig (1), Uwe Niethammer (1), and Jean-Philippe Malet (2)

(1) Institute for Geophysics, Universität Stuttgart, Stuttgart, Germany (sabrina.rothmund@geophys.uni-stuttgart.de), (2) School and Observatory of Earth Sciences, Institute of Earth Physics, CNRS & University of Strasbourg, Strasbourg, France

Very high-resolution multi-temporal images with a ground resolution of a few centimeters allowed to detect and analyze displacements and fissure patterns of the Super-Sauze landslide (Southern French Alps).
Images taken by an unmanned aerial vehicle (UAV) during a flight campaign in October 2008 have been used to produce a very high-resolution orthophoto-mosaic of the landslide. In this study, a set of 59 of a total of 1486 images was selected and photogrammetrically processed using different non-parametric rectification approaches (projective transformation, piecewise affine transformation and polynomial transformations of the second and third order). The generated orthophoto-mosaic covers the entire landslide area of 0.09 km^2 with a ground resolution of 3 to 8 cm.
The comparison of this UAV-based orthophoto-mosaic with an orthophotograph from May 2007 (ground resolution of 20 cm) allowed the characterization of the horizontal displacements of the landslide. Displacement vectors were estimated by visually inspecting the images to identify distinct features (rocks, boulders and vegetation patches) in the two orthophotographs. This approach was chosen because of the high dynamics of the landslide and the disadvantageous long period between the repeated image acquisitions. Displacements between 7.1 and 55.4 m in varying directions have been detected and areas of different dynamics could be distinguished for the period between May 2007 and October 2008.
Various structures, in particular fissures of different distributions and orientations, could be resolved in the UAV-based orthophoto-mosaic. The similarity of the observed fissures with glacial crevasses is striking and suggests a similar genesis. The identified longitudinal, transverse and cross-shaped fissures are linked to abrupt changes of in-situ crest orientation in the shallow subsurface. The observed shear fissures occur at the lateral boundary of emerging in-situ crests. The fissure genesis could be traced to the bedrock topography and supports previous investigations that buried in-situ crests and gullies directly affect the behavior and dynamic of the landslide.