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Constraining the DEM and the kinematics of an unstable slope in the Maurienne Valley (French Alps) from remote and ground optical techniques

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Clay-rich rocks are abundant in the Alps where they make a significant part of the sedimentary cover. When they are exposed, these rocks may form reliefs that are affected by rock falls. The failed material quickly transform into rock debris with a fine-grained matrix, which accumulates on slope and in gullies. Historical chronicles show that devastating debris flows can be triggered in the Alpine valleys in case of heavy rain falls. An unstable slope located in the Flysch zone (of Eocene age) has been chosen in the Maurienne valley (French Alps), which is 1 km wide at this location. The study area (0.3 km2) exhibits a rough topography with a slope varying between 20° at the bottom and 90° at the top, for a difference in elevation of about 500 m. The site has been affected by three rock falls (with a volume of about 30,000 m3) in the last fifteen years. The fallen material has filled two gullies. A debris flow occurred in one of this gully in January 2012 and covered a road on a thickness of 4 m. Seismic prospecting was carried out in this 400 long gully and at the cliff top. The results showed that the rock is strongly fractured and deconsolidated over a thickness of at least 10 m and could be affected by further collapses in the near future. A displacement measurement strategy, based on low-cost remote sensing techniques, has been developed in order to obtain spatially-distributed information on the kinematics of the slope and to better understand the double mechanism (fall-flow). Different remote sensing optical techniques using various platforms (satellite, helicopter, drone, and ground) have been first applied in order to obtain DEMs of the site at various scales. The resolution ranges from 1 cm (close range terrestrial optical photogrammetry) to 2 m (Pleiades images), with 50 cm for the helicopter. The DEMs accuracies were estimated from the results of a differential GPS survey. We discuss the optimum strategy to monitor both the flow and the cliff.