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Comparison of DSMs acquired by terrestrial laser scanning, UAV-based aerial images and ground-based optical images at the Super-Sauze landslide

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In recent years, the high-resolution and multi-temporal 3D mapping of the Earth's surface using terrestrial laser scanning (TLS), ground-based optical images and especially low-cost UAV-based aerial images (Unmanned Aerial Vehicle) has grown in importance. This development resulted from the progressive technical improvement of the imaging systems and the freely available multi-view stereo (MVS) software packages. These different methods of data acquisition for the generation of accurate, high-resolution digital surface models (DSMs) were applied as part of an eight-week field campaign at the Super-Sauze landslide (South French Alps). An area of approximately 10,000 m^2 with long-term average displacement rates greater than 0.01 m/day has been investigated. The TLS-based point clouds were acquired at different viewpoints with an average point spacing between 10 to 40 mm and at different dates. On these days, more than 50 optical images were taken on points along a predefined line on the side part of the landslide by a low-cost digital compact camera. Additionally, aerial images were taken by a radio-controlled mini quad-rotor UAV equipped with another low-cost digital compact camera. The flight altitude ranged between 20 m and 250 m and produced a corresponding ground resolution between 0.6 cm and 7 cm. DGPS measurements were carried out as well in order to geo-reference and validate the point cloud data.
To generate unscaled photogrammetric 3D point clouds from a disordered and tilted image set, we use the widespread open-source software package Bundler and PMVS2 (University of Washington). These multi-temporal DSMs are required on the one hand to determine the three-dimensional surface deformations and on the other hand it will be required for differential correction for orthophoto production.
Drawing on the example of the acquired data at the Super-Sauze landslide, we demonstrate the potential but also the limitations of the photogrammetric point clouds. To determine the quality of the photogrammetric point cloud, these point clouds are compared with the TLS-based DSMs.
The comparison shows that photogrammetric points accuracies are in the range of cm to dm, therefore don't reach the quality of the high-resolution TLS-based DSMs. Further, the validation of the photogrammetric point clouds reveals that some of them have internal curvature effects. The advantage of the photogrammetric 3D data acquisition is the use of low-cost equipment and less time-consuming data collection in the field. While the accuracy of the photogrammetric point clouds is not as high as TLS-based DSMs, the advantages of the former method are seen when applied in areas where dm-range is sufficient.