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A comparison of multicopter and fixed-wing unmanned aerial systems (UAS) applied to mapping debris flows in small alpine catchments

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The use of unmanned aerial systems (UAS) for documenting natural hazard events (e.g. debris flows) is becoming increasingly popular, as UAS allow on-demand, flexible and cost-efficient data acquisition. In this paper, we present the results of a comparison of multicopter and fixed-wing UAS. They were employed in the summer of 2015 to map two small alpine catchments located in Western Austria, where debris flows had occurred recently: The first event took place in the Seigesbach (Tyrol), the second occurred in the Plojergraben (Salzburg). For the Seigesbach mission, a fixed-wing UAS (Multiplex Mentor), equipped with a Sony NEX5 (50 mm prime lens, 14 MP sensor resolution) was employed to acquire approximately 4,000 images. In the Plojergraben an AustroDrones X18 octocopter was used, carrying a Sony ILCE-7R (35 mm prime lens, 36 MP sensor resolution) to record 1,700 images. Both sites had a size of approximately 2km^2. 20 ground control points (GCP) were distributed within both catchments, and their location was measured (Trimble GeoXT, expected accuracy 0.15 m). Using standard structure-from-motion photogrammetry software (AgiSoft PhotoScan Pro, v. 1.1.6), orthophotos (5 cm ground sampling distance - GSD) and digital surface models (DSM) (20 cm GSD) were calculated. Volume differences caused by the debris flow (i.e. deposition heights and erosion depths) computed by subtracting post-event from pre-event DSMs. Even though the terrain conditions in the two catchments were comparable, the challenges during the field campaign and the evaluation of the aerial images were very different.
The main difference between the two campaigns was the number of flights required to cover the catchment: only four were needed by the fixed-wing UAS, while the multicopter required eleven in the Plojergraben. The fixed-wing UAS is specially designed for missions in hardly accessible regions, requiring only two people to carry the whole equipment, while in this case a car was needed for the multicopter deployment. This plays an important role especially for the monitoring of events, where the access roads were destroyed or non-existent. On the other hand, the fixed-wing UAS requires more space for starting and landing. Both campaigns were performed over a full day therefore the lighting conditions changed from flight to flight, affecting the quality of the recorded images. Although the Sony ILCE-7R offers much higher images quality and higher sensor resolution, the results of image processing of Seigesbach and Plojergraben are comparable in terms of processing time, GSD and accuracy for this application. One important difference between the campaigns is for example, that in the Plojergraben, the torrent is partly hidden by bank-side trees and many trees are lying in the riverbed, which causes large errors in calculated volumes. From our experience, external conditions like lighting, visibility and accessibility are determining factors for getting high-quality results in alpine environments, and good results are possible with low-cost equipment. Notwithstanding the operational constraints, the choice of the platform therefore is of secondary importance for debris flow volume mapping.