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Optimizing data acquisition and processing of UAV surveys in high mountain environments: Lessons learned from the study of talus slope geomorphology in large study areas

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In high alpine environments, talus slopes are often inaccessible or unsafe due to their steep slopes (30°-37°), a high surface roughness, frequent rock falls or other hazardous geomorphic processes. Conventional approaches (Total Stations, Terrestrial Laser Scanners or differential Global Navigation Satellite Systems) to study its topography have proven to be challenging and difficult to apply over large areas. Therefore, Unmanned Aerial Vehicles (UAVs) have been used in the past few years to acquire high-resolution data on talus slope topography. It has proven to be a cost-efficient system that can produce highly accurate datasets, with resolutions that are not achieved by satellite-derived products. Since the flexibility of UAVs, it is possible to achieve high temporal resolutions as well, often needed when recording topographic changes that are the result of highly dynamic geomorphic processes. Since UAV-surveying covering large areas in steep mountainous terrain remains very challenging, we developed a workflow to optimize data acquisition and processing. We present the study of a 1.3 km2 talus slope (Col du Sanetsch, 2100-2750 m a.s.l.), surveyed in two consecutive summers (2017-2018) in the Western Swiss Alps. The UAV is a custom-made and low-cost Hexacopter DJI F550 with a Pixhawk flight controller. It was equipped with a Panasonic Lumix DMC-GM5 photograph camera with a F3.5–5.6 lens and producing 16 MP images. The focal length was fixed to 20 mm, a shutter speed of minimum 1/500 and ISO set on 400. To achieve a longitudinal overlap of 70% and a side overlap of 65–75%, the camera shutter speed was set at 6 s interval. Surveying at a constant altitude of 90 m above the ground surface, the Ground Sample Density (GSD) was 3.5 cm/pixel and we needed 3 days and 25 flights to capture the study area completely. Differential GNSS (Global Navigation Satellite System) measurements using Post-Processing Kinematics (PPK) and Real-Time Kinematics (RTK) were performed to reference the model to a real-world system. Processing the 1400 images per survey was done in Agisoft PhotoScan Pro to produce dense point clouds. Change detection was done through 3D point cloud processing (M3C2) in CloudCompare and a Difference of DEMs (DoD) was made with the use of own software. Preliminary results are presented here and important lessons are drawn for future research.