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UAV-based Natural Hazard Management in High-Alpine Terrain - Case Studies from Austria

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Unmanned Aerial Vehicles (UAV) have become a standard tool for geodata collection, as they allow conducting on-demand mapping missions in a flexible, cost-effective manner at an unprecedented level of detail. Easy-to-use, high-performance image matching software make it possible to process the collected aerial images to orthophotos and 3D-terrain models. Such up-to-date geodata have proven to be an important asset in natural hazard management: Processes like debris flows, avalanches, landslides, fluvial erosion and rock-fall can be detected and quantified; damages can be documented and evaluated. In the Alps, these processes mostly originate in remote areas, which are difficult and hazardous to access, thus presenting a challenging task for RPAS data collection. In particular, the problems include finding suitable landing and piloting-places, dealing with bad or no GPS-signals and the installation of ground control points (GCP) for georeferencing. At the BFW, RPAS have been used since 2012 to aid natural hazard management of various processes, of which three case studies are presented below.
The first case study deals with the results from an attempt to employ UAV-based multi-spectral remote sensing to monitor the state of natural hazard protection forests. Images in the visible and near-infrared (NIR) band were collected using modified low-cost cameras, combined with different optical filters. Several UAV-flights were performed in the 72 ha large study site in 2014, which lies in the Wattental, Tyrol (Austria) between 1700 and 2050 m a.s.l., where the main tree species are stone pine and mountain pine. The matched aerial images were analysed using different UAV-specific vitality indices, evaluating both single- and dual-camera UAV-missions.
To calculate the mass balance of a debris flow in the Tyrolean Halltal (Austria), an RPAS flight was conducted in autumn 2012. The extreme alpine environment was challenging for both the mission and the evaluation of the aerial images: In the upper part of the steep channel there was no GPS-signal available, because of the high surrounding rock faces, the landing area consisted of coarse gravel. Therefore, only a manual flight with a high risk of damage was possible. With the calculated RPAS-based digital surface model, created from the 600 aerial images, a chronologically resolved back-calculation of the last big debris-flow event could be performed.
In a third case study, aerial images from RPAS were used for a similar investigation in Virgen, Eastern Tyrol (Austria). A debris flow in the Firschnitzbach catchment caused severe damages to the village of Virgen in August 2012. An RPAS-flight was performed, in order to refine the estimated displaced debris mass for assessment purposes. The upper catchment of the Firschnitzbach is situated above the timberline and covers an area of 6.5 ha at a height difference of 1000 m. Therefore, three separate flights were necessary to achieve a sufficient image overlap. The central part of the Firschnitzbach consists of a steep and partly dense forested canyon / gorge, so there was no flight possible for this section up to now. The evaluation of the surface model from the images showed, that only half of the estimated debris mass came from the upper part of the catchment.