Analysing the impacts of extreme precipitation events on geomorphic systems in torrential catchments; a comparative study from Upper Styria, Austria

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Empirical observations and climate models simulations indicate an increase of intensity and frequency of extreme precipitation events triggering torrent hazards over the last 100 years. This trend is predicted to continue in the future, likely resulting in a rise of the frequency of hazardous torrential processes. That might lead to an increase of sediment-laden torrential flooding events, which are one of the most frequent geo-hazards in Austria.

Heavy rainfall, the availability of sediment, and the connectivity of sediment deposits are crucial factors for the occurrence and severity of hazardous hydro-geomorphic processes. To protect lives and infrastructure an effective design of protection measures depends on the analysis of past extreme events. Repeated topographic surveys, such as laser scanning campaigns, are used to assess hillslope-channel relationships and quantify geomorphic work of different geomorphic processes in torrent systems. The analysis of pre- and post-event high-resolution topographic data is important for the understanding of sediment dynamics and changes in channel morphology. The aim of this study is to investigate the response and the amount of mobilised sediment from three different torrential catchments to extreme precipitation- and runoff events.

The three study areas are located in the Niedere Tauern (Central Alps, Austria). The Schöttlbach catchment is dominated by mica-schist and the proportion of quaternary sediment is around 20%. The Lorenzerbach and Schwarzenbach catchments are characterized by different gneiss, phyllite as well as schists and a quaternary sediment share of approximately 50%. In the last decade all three catchments were struck by heavy rainfall that triggered torrential events causing considerable damage to human settlements and infrastructure.

The point clouds of the Lorenzerbach and Schwarzenbach catchment as well as the pre-event dataset of the Schöttlbach catchment were collected with an airborne laser scanning system. For the post-event point cloud of the Schöttlbach, a UAV-borne laser scanning system was used. All datasets differ in quality due to flight altitude, scan angle, point density and footprint diameter. In the course of this project a workflow is developed to analyse uncertainties and improve the comparability of datasets from different surveys. This is also necessary for a reliable Geomorphic
change detection (GDC) analysis as well as the investigation of sediment dynamics and the estimation of erosion and deposition volumes.

Finally the outcomes of the GCD analysis are compared with the results of event-documentations done by the Austrian Service for Torrent and Avalanche Control. The approach of Zedlacher (1986) is used to estimate sediment loads for 150-year flood events. However, preliminary results indicate that this approach underestimates sediment output during extreme events for all three catchments. Based on the analysis of terrain models and other available information, we aim to ‘update’ the empirical Zedlacher approach to improve sediment load estimation, with the overarching question whether intensified precipitation events under climate change conditions will cause a shift of the torrential systems towards higher sediment yields.