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Analysis of meteorological trigger conditions for torrential processes on a daily time scale

Martin Braun and Roland Kaitna
Institute of Mountain Risk Engineering, University of Natural Resources and Life Sciences, Vienna, Austria

Floods, intensive bedload transport, debris floods, and debris flows represent a severe hazard in torrent catchments in Alpine regions. These processes are expected to be mostly triggered by intensive, localized thunderstorm events or long lasting low-pressure systems. For forecasting debris flow hazards and estimation of potential changes due to climate change, identification of meteorological trigger conditions is of interest. In this study we investigate meteorological trigger conditions of torrential events recorded in Austria. The analysis is based on daily rainfall and temperature data. In total 7617 events and 1032 data-sets from meteorological stations, distributed over a region of approximately 80,000 km^2, and dating back until the year 1874, are available for analysis. Nearest stations to event as well as a weighted distance approach were combined with a Bayesian analysis to determine typical trigger conditions in different alpine settings. While according to Bayesian analysis the majority of debris flows is likely to be triggered by short rainfall events with an intensity of 60-70 mm/day, the signal for debris floods is less clear. Thresholds for debris floods tend to show higher rainfall intensities of 70-100 mm/day as prerequisites, but also a significant amount was caused by longer rainfall durations up to two days. Furthermore, the total event rainfall plays a higher role compared to debris flows. Intensive bedload transport shows a more complex relationship with a typical triggering event rainfall between 150 and 200 mm and rainfall intensities exceeding 100 mm/day. Flood events are mainly caused by a complex combination of influencing factors with different combinations of triggering event rainfall, high rainfall intensities and rainfall duration. The results of our study contribute to an improved understanding of torrential activity in the Alps and examine the influence of rainfall conditions on different types of torrential events.