Geophysical Research Abstracts
Vol. 20, EGU2018-18211, 2018
EGU General Assembly 2018
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Temporal variability of debris flow triggering thresholds (Mühlsturzgraben, National Park Berchtesgaden)

Margherita J. Stumvoll (1), Joachim Götz (2), and Johannes Buckel (3)

(1) University of Vienna, Department of Geography and Regional Research, Vienna, Austria (margherita.stumvoll@univie.ac.at), (2) University of Graz, Department of Geography and Regional Sciences, Graz, Austria (joachim.goetz@uni-graz.at), (3) Techn. University of Braunschweig, Institute for Geophysics and Extraterrestrial Physics, Braunschweig, Germany (johannes.buckel@sbg.ac.at)

Debris flows in mountain environments are controlled by a combination of preparatory (predisposition and disposition) as well as triggering factors highly variable in space and time. Extrinsic or intrinsic thresholds for debris flow initiation are alternating as well and depend on the current status and stability of the corresponding system. Related knowledge on the variability of debris flow triggering thresholds is fragmentary but of particular interest if human settlements or infrastructure is affected.

The small (0.5 km^2) but steep Mühlsturzgraben catchment in the National Park Berchtesgaden (Δh = 1250 m) experienced frequent high-runoff events with the activity of debris flows due to the main preparatory factors of the specific lithologic setting and high rainfall intensities at the northern fringe of the Alps. The catchment drains into the Klausbach valley, a popular tourist destination easily accessible by public transport, and is composed of two lithologic units. The lower Ramsau dolomite is highly susceptible to frost weathering and provides large amounts of debris via small-scale rockfall which gets frequently flushed out (across a road) into the main valley during intense rainstorms and/or snowmelt. In contrast, the overlaying massive Dachstein limestone tends to release larger scale rock and blockfall. If such events hit snow avalanche deposits, even larger debris flows can be triggered spontaneously through liquefaction (last time in Sep 1999).

Former studies suggested a local precipitation threshold of 2 mm/10 min to induce debris flows in the study area. To test the variability of this threshold over time and to investigate recent surface dynamics a monitoring campaign was launched in Aug 2015 using multi-temporal (airborne and terrestrial) LiDAR data and different approaches of topographic change modelling. Several climate stations within and in close proximity to the study area provide local weather data to analyse rainfall intensity. However, since Aug 2015 no debris flow events occurred, although 10 heavy precipitation events (maximum 10-minutes rainfall: 5.2 mm) exceeded the suggested threshold. This relatively short time series already demonstrates the temporal variability of precipitation thresholds for triggering debris flows: After disturbing rockfall events in 1999, the study area responded with heavy debris flow activity, resulting in a reduced sediment availability and, in further consequence, in enhanced triggering precipitation intensities.

Future investigations are needed to validate current thresholds or threshold ranges. Therefore TLS and climatic time series data will be continued and supplemented by structure-from-motion approaches in order to cover the entire study area. In addition, the influence of preceding precipitation, infiltration and internal runoff needs to be evaluated.