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Evidence for enhanced debris flow activity in the Northern Calcareous Alps since the 1980s (Plansee, Austria)

Andreas Dietrich and Michael Krautblatter
Technische Universität München, Chair of Landslide Research, Arcisstraße 21, 80333 Munich, Germany (a.dietrich@tum.de)

From 1950 to 2011 almost 80.000 people lost their lives through the occurrence of debris flow events (Dowling and Santi, 2014). Debris flows occur in all alpine regions due to intensive rainstorms and mobilisable loose debris. Due to their susceptible lithology, the Northern Calcareous Alps are affected by a double digit number of major hazard events per year. Some authors hypothesised a relation between an increasing frequency of heavy rainstorms and an increasing occurrence of landslides in general (Beniston and Douglas, 1996) and debris flows in special (Pelfini and Santilli, 2008), but yet there is only limited evidence. The Plansee catchment in the Ammergauer Alps consists of intensely jointed Upper Triassic Hauptdolomit lithology and therefore shows extreme debris flow activity. To investigate this activity in the last decades, the temporal and spatial development of eight active debris flow fans is examined with GIS and field mapping. The annual rates since the late 1940s are inferred accurately by using aerial photos from 1947, 1952, 1971, 1979, 1987, 2000 and 2010. These rates are compared to the mean Holocene/Lateglacial debris flow volume derived from the most prominent cone. The contact with the underlying till is revealed by electrical resistivity tomography (ERT). It shows that the mean annual debris flow volume has increased there by a factor of 10 from 1947-1952 (0.23 ± 0.07 $10^3 m^3/yr$) to 1987-2000 (2.41 ± 0.66 $10^3 m^3/yr$). A similar trend can be seen on all eight fans: mean post-1980 rates exceed pre-1980 rates by a factor of more than three. This increasing debris flow activity coincides with an enhanced rainstorm (def. 35 mm/d) frequency recorded at the nearest meteorological station. Since 1921 the frequency of heavy rainstorms has increased there on average by 10% per decade. Recent debris flow rates are also 2-3 times higher compared to mean Holocene/Lateglacial rates. Furthermore, we state a strong correlation between the non-vegetated catchment area and the annual debris flow volume. This might indicate a decadal positive feedback between enhanced rainstorm frequency and the occurrence of debris flows.
The study contributes to a better understanding of the sensitivity of alpine catchments to heavy rainfall events in the context of climate change.

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