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Quantification of debris-flow erosion rates by using high-resolution multitemporal terrestrial and airborne LiDAR data in the Kaunertal/Eastern Alps, Austria

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Geomorphic processes in alpine high mountain areas show very high intensities. Not only high reliefs and steep slopes, but also the availability of recently exposed sediments in proglacial areas contribute to this fact. Furthermore the thawing and degradation of permafrost in high elevation zones trigger rock falls and debris flows in areas above and close to the glacier tongues, which provides for additional sediment input into the proglacial area.

The work presented here is part of the interdisciplinary joint project PROSA (High-resolution measurements of morphodynamics in rapidly changing PROglacial Systems of the Alps) which deals with the quantification of the sediment budget of an alpine catchment, broken down by geomorphic process and accounting for glacial, fluvial and gravitative processes. The investigations are focused on the forefield of the Gepatschferner, Oetztal Alps, Austria which is overtowered by steep moraine slopes of the Little Ice Age glacial maximum. The rather poorly consolidated material of these moraine slopes leads to frequent occurrence of slope type debris flows.

In order to quantify the activity of debris flows, high-resolution terrestrial laser scanning data of the lateral moraine slope of the Gepatschferner were acquired repeatedly from six different scanning positions. The resulting point clouds were used to derive high-resolution digital elevation models (DEMs) of the moraine slopes. Highly accurate co-registration of the multi-epoch LiDAR data was ensured by usage of permanently fixed reflectors on immobile bedrock faces within and next to the area investigated. For investigating larger debris flow events on the catchment scale, high-resolution multitemporal airborne LiDAR data were used to derive DEMs. Very accurate debris flow erosion and deposition rates can be obtained from DEMs of difference and a sediment budget can be calculated. A limit of detection threshold, based on the individual measuring errors of the device, was applied to arrive at reasonable rate estimates.