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Short and long term sediment flux in an inner-alpine sedimentary basin (Hohe Tauern, Austria)

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Combined analyses of short and long term sediment fluxes in mountain environments have been rarely carried out until now. However, the relation of integrated postglacial landform volumes to single events (e.g. debris flows) provide the opportunity to establish meaningful frequency-magnitude-relationships, to evaluate present day geomorphic activity more reasonable, and to complement time series data typically covering only a short period of time.

In this study we investigate recent and postglacial sediment flux in a small-scale denudation-accumulation system in the Hohe Tauern Range (Austrian Alps) using a complementary multi method approach including surface, subsurface and temporal analyses. We reconstructed the infill history and sedimentary architecture of the almost closed Gradenmoos basin, which has been filled up with sediments from different source areas delivered by mainly debris flows, rockfall and avalanche activity, and fluvial processes. In former times, glacial, glacio-fluvial and lacustrine sedimentation contributed to the basin fill as well. This process diversity led to a variety of interfingering and nested sediment storage landforms with a complex postglacial stratigraphy. Most important landforms include floodplain and peat bog deposits in the basin center as well as debris cones and talus sheets adjacent to the surrounding rockwalls.

Postglacial basin sedimentation started after Younger Dryas deglaciation as indicated by radiocarbon ages of early-Holocene sediment core samples taken in the basin. For the following 7500 years, trap efficiency was maximised due to the presence of a former lake which is proved by morphometric, palynologic and stratigraphic data. Peat bog development finally began around 3500 years ago in the distal part of the basin.

We interpolated the bedrock interface below the basin fill deposits using bedrock coordinates derived from core-drilling, geophysical prospection (electrical resistivity tomography, refraction seismic, ground-penetrating radar) and bedrock outcrop mapping at the present surface. Based on this bedrock interface and a terrestrial laserscan model of the present surface, we quantified sediment storage using 3D cut-and-fill modelling. Total sediment storage amounts to c. 19.7 x 106 m^3 whereas postglacial storage is reduced by a portion of formerly deposited basal till to c. 18.3 x 106 m^3. From these volumes we calculated long term rates of postglacial rockwall retreat (160 - 520 mm/ka) and sediment yield (110-770 m^3/a) for three steep cirques supplying sediments to the basin.

Recent sediment input is based on repeated terrestrial laserscanning during the past five years (2009-2014) and the use of surface comparison and surface change detection tools. Sediment input in this 5-year study period is restricted to one smaller and one larger debris flow event delivering c. 41 000 m^3 of sediment in total onto two large debris cones. These two debris flows overbalance the averaged postglacial sediment input into theses cones (770 m^3/a) by more than an order of magnitude. Based on these combined, short and long term analysis we established frequency-magnitude relationships for both debris flows corresponding to a larger 44-year and a smaller 9-year event, respectively.