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Sediment budgets of unglaciated alpine catchments – the example of the Johnsbach and Schöttlbach valleys in Styria

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Extensive research has been performed in glacier forefields and in glaciated catchments in order to predict their future behaviour in a warming climate. However, the majority of medium-scale torrential catchments in the European Alps are non-glaciated and their response to disturbance events (e.g. changing climate) is more subtle and hard to predict. We report from two torrential catchments in the Eastern Alps, the Johnsbach and the Schöttlbach valleys, that have been monitored for several years. The catchments are located in Styria (Austria) and are remarkably similar in terms of size (60-70 km^3) and elevation (600/800 – 2400 m). The main difference is the geological setting of the sediment delivering areas which is limestone and brittle dolomite at Johnsbach, and a prominent late-pleistocene valley fill at Schöttlbach, respectively. Slope processes in both areas were monitored by means of repeated TLS surveys of active slope and channel areas and by ALS and/or UAV surveys. Fluvial transport in the main channels was measured using Helly-Smith samplers and recorded continuously by means of new developed, low-budget sediment impact sensors (SIS). In both areas, the catchment output was quantified: by regular surveys of a retention basin at Schöttlbach and by a bedload measurement station (geophone sill) at Johnsbach.

The results show that at Johnsbach, the sediment source areas are active tributary trenches in the lower third of the catchment. The sediments derive from brittle dolomite rockwalls and are transported to the main river episodically during rainstorm events. In a 2-yr period, 7400 m^3 yr–1 were eroded in the surveyed areas and 9900 m^3 yr–1 m3 yr–1 were deposited; of this amount, only a minor portion of 650 m^3 yr–1 reached the Johnsbach River. The degree of coupling between tributaries and creek is strongly influenced by anthropogenic measures, e.g. former disturbance by gravel mining and undersized bridge openings. Besides limited bank erosion, sediment transport of the main creek is governed by the reworking of recurrent sediment pulses from the tributaries.

At Schöttlbach, sediment budget is strongly governed by the steep valley sides along the lowermost stretch of the main creek. Here, a catastrophic event in 2011 mobilized huge amounts of sediments which are being reworked since. Many erosional areas and side gullies developed which now become stowly stabilized. The highest average retreat rates of erosional cuts are 0.08 m yr-1 for glacifluvial valley fills while those in weathered bedrock are lower by an order of magnitude (0.006 m yr-1). Sedimentation rates at the outlet decreased from 40–50,000 m^3 in the years after the event to approx. 7000 m^3 yr–1 in recent years. Current catchment-wide sediment production at slope erosion sites is around 2000 m^3 yr–1 and so we assume that parts of the sediment pulse originating from the disturbance event are still being reworked in the channel.

Despite many dissimilarities, both catchments are similar with regard to the sediments being provided in their lowest parts, while large areas of the alpine process domain are widely decoupled from the sediment output. Schematic diagrams showing spatial and temporal distribution of sediment yields will be presented, with the aim to better understand the catchments' response to possibly higher rainstorm frequencies in a warming climate.