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Suspended sediment and discharge dynamics across multiple spatial and temporal scales in a glaciated alpine environment: the case of the upper Ötztal, Austria

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High alpine areas are affected disproportionately by global warming and are thus found to be in a transient state. This causes accelerating glacial retreat, which can have severe impacts on discharge and potentially sediment dynamics. Possible effects include changes in water quantities and hydrograph timing as well as changing sediment source areas and the associated magnitude and timing of transport capacities. In turn, the resulting changes in water and sediment supplies and timing have the potential to severely impact downstream ecosystems and infrastructure.

An essential step towards estimating the effects of future changes and developing sustainable management strategies is to quantify the behavior in the past and present. We therefore used the excellent data availability of discharge and suspended sediment concentrations in our study area in the upper Ötztal in Tyrol, Austria, to make such an assessment. We study discharge and suspended sediment concentrations, which have been monitored at three gauges and for a minimum of seven years in the case of the youngest gauge. The resulting nested catchment setup, with catchment sizes ranging between 98 km² and 785 km², allows us to learn about discharge and sediment fluxes and their spatial distribution, thus allowing us to quantify the relative importance of the glaciated areas as compared to the lower-lying catchment areas. It also allows us to study the temporal dynamics, such as the seasonal timing of the peaks and their interannual differences. In turn, the nested catchments allows us to investigate the spatial variability of these temporal dynamics.

The results confirm the high specific sediment yields for alpine catchments in the order of 10^3 t/km² per year and higher yields in areas with higher glacier cover as well as a very pronounced seasonality.