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Quantifying long term evolution of fluvial channel in glacier forefield

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Alpine rivers have experienced considerable changes in channel morphology over the last century. Human disturbance and natural factors are the main drivers of changes in channel morphology that modify natural sediment and flow regimes at local, catchment and regional scale. River sediment loads are likely to increase due to increasing snow and glacier melt runoff, facilitated by climate changes. Additionally, channel erosion and depositional dynamics and patterns are influenced by sediment delivery from rock walls, hillslopes, and sediment in the forefields of retreating glaciers. Land cover changes may facilitate or obstruct runoff and soil degradation.

In order to reliably assess the magnitudes of the channel changing processes and/or their frequencies due to recent climate change, the investigation period needs to be extended to the last century, ideally back to the end of the Little Ice Age. Moreover, a high temporal resolution is required to account for the history of changes of channel morphology and for better detection and interpretation of related processes.

The increasing availability of digitised historical aerial images, together with advancements of digital photogrammetry, provides the basis for reconstructing and assessing long-term evolution of the surface, both in terms of planimetric mapping and generation of historical digital elevation models (DEMs). This work presents the temporal evolution of fluvial channel morphology in Kaunertal, Austria, spanning twenty periods from 1953 to 2019. Here we use photogrammetric analysis of recent and historical images, together with LiDAR and drone-based photogrammetric DEMs, to quantify the river changes in terms of channel incision, riverbank erosion, as well as the spatial patterns of channel erosion and deposition and the amounts of mobilized sediment. We show that geomorphic changes are mainly driven by deglaciation, i.e. glacier retreat, and sediment delivery from recently deglaciated steep lateral moraines. Overall, this work contributes to better understand the links between channel changes and climatic factors and highlights similarities and differences in the evolutionary trajectories of the main rivers in the catchment.