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Influence of former glaciations on interglacial landscape evolution: A case study from the LGM nunatak Hörnli, Eastern Switzerland

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We assess the effect of glaciations on the subsequent interglacial landscape evolution. The Hörnli-area in eastern Switzerland that, in its central parts, was a nunatak during the last glacial maximum (LGM) is an ideal field location to investigate the hypothesized inheritance effects. The proximity of catchments covering the entire range from formerly fully glaciated to not-glaciated, periglacial allows to exclude most other modifying controls on landscape evolution (especially climate, lithology and tectonics).

30 catchments have been studied combining field investigations, GIS-based landscape analysis of a high resolution DEM and catchment-wide denudation rates based on terrestrial cosmogenic 10Be concentration in fluvial quartz sand.

Landforms and digitally derived geomorphometrics allow the definition of two distinctly different landscape characters: Rugged, high-relief catchments dominated by fluvial and mass-wasting processes comprising high drainage densities are observed in areas outside the LGM extent. A smooth, low-relief landscape with soil-mantled slopes and low drainage densities is observed in the formerly glaciated areas mainly as the result of glacier erosion, deposition and proglacial lake formation during glacier retreat. This gentle landscape character is contrasted by up to 2.5 km long and 100 m deep incised stream reaches towards the main trunk stream (Thur river).

The catchment-wide denudation rates in formerly not-glaciated catchments are around 300 mm/ky, correlated with mean basin slope and in good agreement with results from similar studies in the Northern Alpine foreland (e.g. Wittmann et al., 2007; Norton et al., 2008). In contrast, in the formerly glaciated catchments the average denudation rates measured cluster around 30 mm/ky and are not correlated to any standard morphometric parameter. This finding is surprising as the occurrence of incised gorges is an indicator for strongly transient conditions, i.e. adjustment to base-level lowering.

Therefore, the spatial distribution of the denudation rates is hypothesized to be strongly related to the extent of the former glaciation in a catchment. In the formerly not-glaciated catchments an efficient sediment routing with a close hillslope-channel coupling and a dense river network exist. The average denudation rates equal the high soil production rates measured by Norton et al. (2009). In formerly glaciated catchments the excess of unconsolidated sediments (glacigenic and derived from hillslopes) and the low slope angles seem to prevent the formation of a fully coupled hillslope-channel system. Thereby the Holocene landscape evolution seems to be largely suppressed as indicated by the low average denudation rates. However, the effect of potentially inherited cosmogenic nuclide concentration in glacial sediments has to be considered.

References:
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