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Significance and dynamics of catchment scale instabilities from morphometry and ^{10}Be denudation rates: example of the Strengbach catchment in the Vosges mountains

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Moderate relief and landscape disequilibrium in the mid-mountains of western Europe result from the combined impact of long-term climate change, slow tectonics, and relatively stable piedmonts. Presently unglaciated, the highest summits of the Vosges reach 1400 m asl with a marked imprint of glacial occupation such as large glacial valleys, cirques, and moraines. Lower catchments were probably not occupied by glaciers but exhibit transient landscapes from fluvial incision in steep valleys downstream to wide-open low-relief highlands. Here, we focus on the Strengbach catchment upstream Ribeauvillé (~29 km^2) in the southeastern Vosges aiming to determine the dynamic of topographic evolution by investigating morphological instabilities. The project seeks to untangle the various factors contributing to landscape instabilities at a millennial timescale. To achieve this, a morphometric analysis is combined with cosmogenic in-situ ^{10}Be basin-wide denudation rates.

The morphometric analysis indicates that the catchment is largely departing from the concave river profile of a steady-state landscape as would be expected for a long-lived topography. The catchment topography and χ-elevation profiles provide evidence of relic topographic surfaces upstream of a ~2 km-long convex knick-zone at ~700 m. Below this zone, the catchment is deeply incised and ramified with knickpoints in the tributaries at ~500 m. Above the knickzone, fluvial incision is rather limited up to a knickpoint at ~950 m marking the upper section of the Strengbach stream. Overall, ^{10}Be denudation rates show minor variations along the main trunk upstream, with an increase of denudation rates towards the outlet from 36 ± 2 mm/kyr to 44 ± 3 mm/kyr. In contrast, the denudation rates derived from the tributaries are more variable and range from 38 ± 2 mm/kyr to 75 ± 5 mm/kyr. A weak correlation between denudation rates and large outcrops of the lower Bundsandstein sandstone formation suggests that some of the variability in denudation rates may be related to the heterogeneous lithology outcropping in the watershed. Additionally, the increase in denudation rates downstream may be related to steeper slopes and enhanced incision. Altogether, the 10Be denudation rates suggest slow evolution of the landscape in the Strengbach catchment over Quaternary timescales.