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Transient rock slope processes driven by Pleistocene fluvial incision in Alpine valleys

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Major tributary valleys within Canton Valais (Switzerland) display a common morphology along their length, hinting at a shared geomorphic history. Glaciers currently occupy the headwaters of many catchments, while the upper reaches of rivers flow across extensive alluvial planes before abruptly transitioning to steep channels consisting of mixed bedrock and talus fan deposits. The rivers then flow out over the alluvial plane of the Rhone Valley, converging to discharge into Lake Geneva, which defines a long-term local baselevel for the system. Using a 2.5 m resolution LiDAR DEM, we correlate knickpoints common to several of the tributary valleys, which are assumed to be associated with the propagation of ongoing fluvial incision into the steep bedrock/talus sections the river channels. The morphology of valley walls several hundred metres above these steep channel sections is characteristically rough, and large deep-seated landslides which commonly intersect the upstream alluvial planes are not present within this rough region. Assuming knickpoints develop as a result of glacial erosion concentrated below the valley confluences, we use a 1-D stream power erosion model, modulated by mid- to late-Pleistocene glacial/interglacial cycles, to evaluate contemporaneous fluvial incision and knickpoint propagation. We assume baselevel is determined by the elevation of Lake Geneva, and differential uplift between the foreland and inner Alpine valleys is ongoing. We can therefore isolate bedrock erodibility as the sole independent variable for the valleys. The best-fit model results indicate fluvial bedrock incision has taken place during multiple interglacial cycles, possibly since marine isotope stage (MIS) 12 ($\sim$425 ka BP). Modelled erosion rates are typically between 2 and 10 mm/yr, and we calculate up to 700 m of total bedrock incision. We suggest rock slope morphologies associated with this long-term transition to a fluvial landscape have persisted through multiple glacial cycles.