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New geomorphic constraints on landscape sensitivity to climate in tectonically active areas

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It is widely accepted that channel longitudinal profiles are sensitive to tectonics, and can record detailed information about the location, magnitude, and timing of fault uplift. However fluvial landscapes are also shaped by climate, which controls river incision rates and channel form via surface run-off and discharge controls. While these effects are widely studied in modern rivers, understanding how long-term rainfall differences determine fluvial landscape form remains an outstanding research challenge. Numerical models have hypothesized a relationship between precipitation rate and channel geometry, but to-date few empirical constraints exist. Here, we measure the normalised channel steepness index (k_{sn}) of over 800 channels in 6 study areas, each in a different climatic setting. These regions exhibit a tenfold variation in modern precipitation rate between them ($\sim$100-1000 mm yr^{-1}), with well documented palaeo-climate constraints, but they have similar uplift rates, allowing the tectonic variable to be controlled. Our analysis accounts for glacial-interglacial climate variability, and by considering the orographic coupling of rainfall with uplifted topography, we find that channel steepness is significantly suppressed by higher precipitation rates, as stream power erosion theory predicts. These findings help to resolve why highly variable measurements of channel steepness are reported from different locations, even when tectonic rates are comparable, and our results provide important new constraints on the sensitivity of landscape to climate in tectonically-active landscapes.