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Erosion Rate Variability due to Tectonic Reorganization of River Networks

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Many tectonically active landscapes show disparate erosion rates and geomorphic characteristics. In particular, elevated low-relief landscapes are often interpreted as "relict" and are assumed to reflect pre-uplift tectonic conditions. We argue that tectonic deformation of the Earth's surface induces changes in the river channel network through capture and divide migration. Loss of drainage area leads to lower erosion rate through lower discharge and thus to higher surface uplift rates as erosion fails to keep up with tectonic uplift. The positive feedback of area loss amplifies these variations producing high-elevation, low relief, low erosion-rate branches of a river network that could be misconstrued as relic landscapes. We demonstrate this process through numerical models. Models that include surface strain increase variance of erosion rate as predicted. We test this idea through analysis of river profiles of tectonically active landscapes in the eastern Tibetan plateau transition and in the Central Range of Taiwan. In every case examined, we find no common uplift history and widespread evidence that divides surrounding relic landscapes are moving inward, pirating drainage area and lowering erosion rates. This argues against temporal changes in uplift rate and supports the model for in situ generation of variability of these landscapes.