



Supplement of

Rainfall and tectonic forcing lead to contrasting headwater slope evolutions

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This supplement presents the results of a sensitivity test conducted with a finer grid resolution of 200 m. This test was performed to confirm that the primary findings of our study are robust and not an artifact of the 400 m grid spacing used in the main manuscript. The model run shown here is analogous to Models M2-M4 in the main text, which use a non-zero diffusion coefficient.

Figure S1 illustrates the resulting landscape morphology, which is consistent with the findings presented in the main text. Figure S2 demonstrates that the transient slope change reversal—a temporary decrease in headwater slope following a decrease in rainfall (Fig. S2 a2 and a3)—is clearly reproduced at this finer resolution. This confirms that the mechanism described in the main text is a robust feature of the model and not dependent on the chosen grid scale.

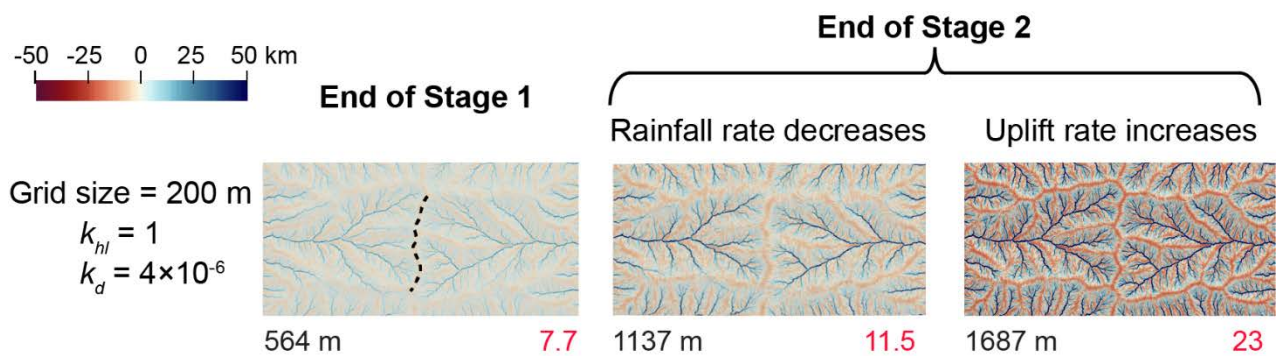


Figure S1. Hillshade maps showing cumulative erosion and deposition resulting from hillslope diffusion at the end of Stage 1 and the end of Stage 2. Blue areas indicate deposition, while red areas represent erosion. Color bar values indicate cumulative depositional (positive) and erosional (negative) amounts (km). Numbers below each map display the mean elevation (black) and roughness (red). Dashed lines on maps at the end of Stage 1 denote the divide. The divide in Stage 2 is similar to that in Stage 1 and is not marked in this stage.

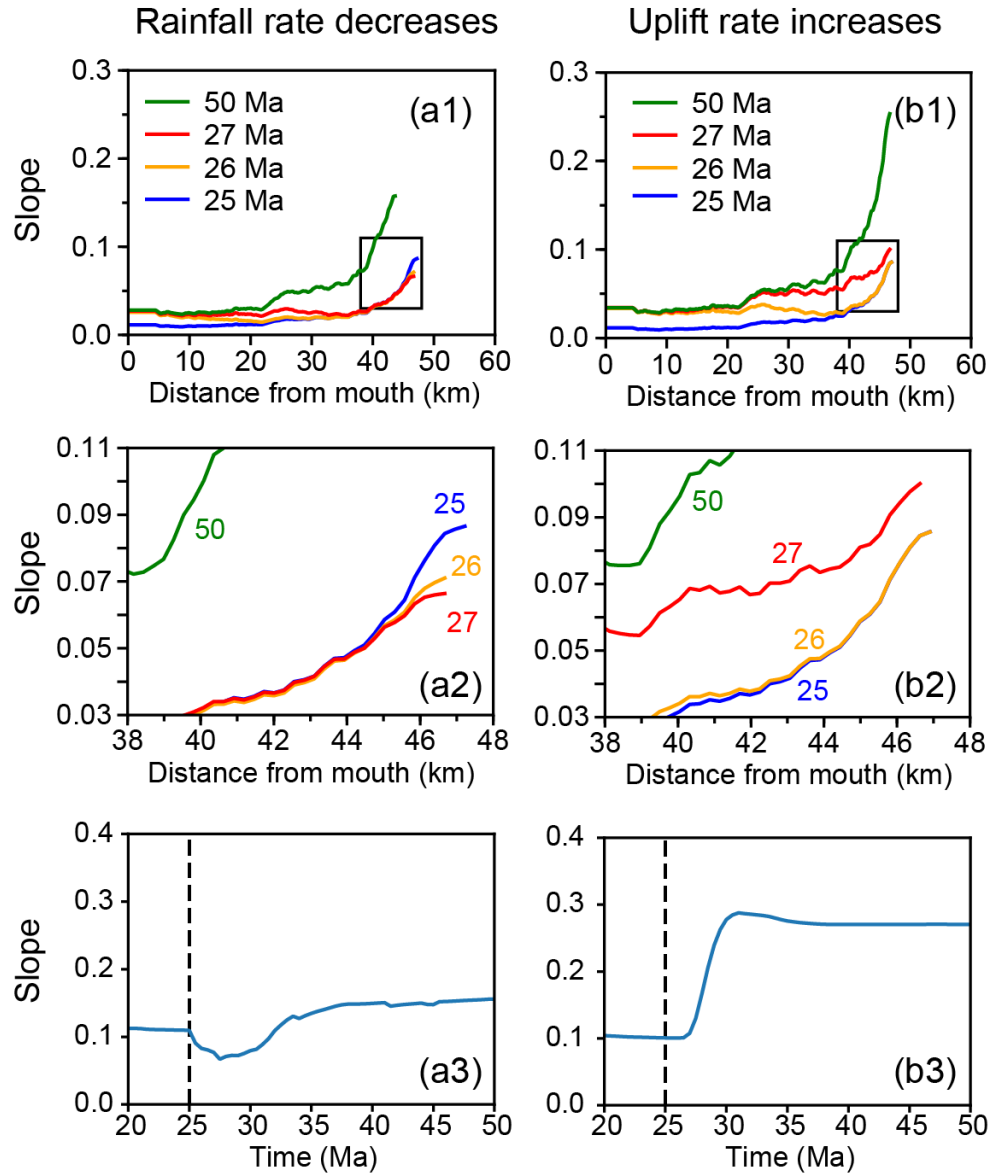


Figure S2. Evolution of trunk stream slope following a decrease in rainfall rate and an increase in uplift rate. (a1-b1) Longitudinal slope profiles of the trunk stream at selected time steps (colored lines). Black rectangles indicate the headwater regions. (a2-b2) Enlarged views of the headwater areas, corresponding to the boxed regions in (a1-b1). (a3-b3) Temporal evolution of the mean channel slope in the upper ~800 m of the trunk stream, capturing the dynamic slope response across model runs. Dashed vertical lines mark the timing of the change in rainfall or uplift rate (25 Ma).