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Quasi-universal relationship for alluvial river long-profile evolution

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Alluvial rivers aggrade and incise by moving sediment while simultaneously evolving their hydraulic geometries. For both gravel- and sand-bed rivers, stress-based criteria for equilibrium channel width in turn maintain a constant bed shear stress and therefore linearize the sediment-transport response to changing river discharge. Here we demonstrate that realistic sediment-transport and width-closure relationships yield a stream-power form for sediment discharge. Differentiating this in space (i.e., taking the divergence) yields a slightly nonlinear diffusion equation that describes long-profile evolution. This simple equation-coupling work suggests that a single equation may suffice to describe river long-profile evolution from the bedrock--alluvial transition to the point at which backwater effects become significant.