EGU21-10291
https://doi.org/10.5194/egusphere-egu21-10291
EGU General Assembly 2021

Upscaling sediment-flux-dependent fluvial bedrock incision to long timescales

Jens Turowski
GFZ German Research Centre for Geosciences, 4.6 Geomorphology, Potsdam, Germany (turowski@gfz-potsdam.de)

Fluvial bedrock incision is driven by the impact of moving bedload particles. Mechanistic, sediment-flux-dependent incision models have been proposed, but the stream power incision model (SPIM) is frequently used to model landscape evolution over large spatial and temporal scales. This disconnect between the mechanistic understanding of fluvial bedrock incision on the process scale, and the way it is modelled on long time scales presents one of the current challenges in quantitative geomorphology. Here, a mechanistic model of fluvial bedrock incision that is rooted in current process understanding is explicitly upscaled to long time scales by integrating over the distribution of discharge. The model predicts a channel long profile form equivalent to the one yielded by the SPIM, but explicitly resolves the effects of channel width, cross-sectional shape, bedrock erodibility and discharge variability. The channel long profile chiefly depends on the mechanics of bedload transport, rather than bedrock incision. In addition to the imposed boundary conditions specifying the upstream supply of water and sediment, and the incision rate, the model includes four free parameters, describing the at-a-station hydraulic geometry of channel width, the dependence of bedload transport capacity on channel width, the threshold discharge of bedload motion, and reach-scale cover dynamics. For certain parameter combinations, no solutions exist. However, by adjusting the free parameters, one or several solutions can usually be found. The controls on and the feedbacks between the free parameters have so far been little studied, but may exert important controls on bedrock channel morphology and dynamics.