Geophysical Research Abstracts
Vol. 19, EGU2017-17197, 2017
EGU General Assembly 2017

Effect of channel width variation on sediment transport in mixed alluvial-bedrock rivers – from case study to concept

Kristen Cook, Jens Turowski, and Niels Hovius
GFZ Potsdam, GFZ Section 5.1, Potsdam, Germany (klcook@gfz-potsdam.de)

In mixed bedrock-alluvial rivers, the response of the system to a flood event can be affected by a number of factors, including coarse sediment availability in the channel, sediment supply from the hillslopes, bedrock-controlled changes in channel width, and the shape of the hydrograph. Local hydraulics and therefore bedload transport capacity depend on discharge and channel geometry, typically quantified by channel width and bed slope. However, the influence of channel width on total bedload transport capacity depends on discharge. For a given slope, narrow channels are more efficient than wide ones at low discharges, while wider channels are more efficient at higher discharges. Therefore, abrupt changes in downstream channel width may affect bedload flux through a channel and have important influences on channel behavior. We use the model sedFlow (Heimann et al., 2014) to explore this effect. We ran the model in a 4.5 km long channel, the center of which contains a 1 km gorge section with a width of 15 m, bounded upstream and downstream by sections with widths of 50 m. We imposed a discharge time series with a random sequence of floods of different size. The channel responds to the imposed floods in complex ways. At high discharges, the gorge reach transports less total sediment than the wide reaches, leading to aggradation in the upper part of the gorge and upstream and erosion in the lower part of the gorge and downstream. At lower discharges, the gorge becomes more efficient at transporting sediment and the trends reverse. The channel may experience both of these regimes during the peak and recession periods of a single flood, leading to a highly dynamic channel bed. This is consistent with observations from the Daan River gorge in western Taiwan, where we observe substantial intra-flood variations in channel bed elevation.
Our modeling suggests that width differences alone can drive substantial variations in sediment flux and bed response, without the need for variations in sediment supply or mobility. Because the relationship between channel width and sediment transport capacity depends on the discharge, the long-term response of a channel with variable width depends on the entire hydrograph, not just on the flood peak. In addition, the net effect of a flood depends strongly on the preceding sequence of floods, as the long profile and channel slopes are continually adjusting to different forcing. Therefore modeling studies that use uniform discharge or a step function discharge will miss these dynamics. The fluctuations in sediment transport rates that result from width variations can lead to intermittent bed exposure, driving incision in different segments of the channel during different segments of the hydrograph.