Geophysical Research Abstracts
Vol. 20, EGU2018-13834, 2018
EGU General Assembly 2018

Order and disorder in gravel bed rivers: History-dependent variation to the onset of motion revealed by continuous bedload transport measurements

Claire Masteller (1), Noah Finnegan (2), Jens Turowski (1), Joel Johnson (3), and Dieter Rickenmann (4)

(1) GFZ-Potsdam, (2) University of California Santa Cruz, Earth and Planetary Sciences, Santa Cruz, United States , (3) Jackson School of Geosciences, University of Texas - Austin, (4) Swiss Federal Institute for Forest, Snow, and Landscape Research WSL

Fluvial bedload transport is typically treated as a process that is independent of any previous time step, and is solely dependent on concurrent flow strength. However, in some well-documented examples, bedload sediment transport clearly displays short- and long-term dependence on prior flow history. Thus, it is natural to ask what processes cause the threshold for motion to vary over time.

To explore this, we use a 19-year record of coarse sediment transport from the Erlenbach torrent, a steep stream in Switzerland. In 11 of the 19 years on record, we observe an order of magnitude increase in critical shear stress from March to September. In the remaining years, the threshold for motion does vary, but weakly or less systematically. However, no years on record show a negative trend. Critical shear stress appears to revert to a baseline value at the beginning on each year on record. Across the entire record, the threshold for motion is significantly, positively correlated across $\sim$14 consecutive events, indicating long-term, inter-event memory.

We observe a strong dependence of the threshold for motion on the magnitude of previous inter-event flow, during which active sediment transport is not observed, for shear stresses from 100-340 Pa. For inter-event flows below 100 Pa, we do not observe significant correlation between prior flow and the onset of motion. This finding is consistent with prior experimental work, which shows that inter-event flows play an important role in building bed structure, increasing order, and stabilizing individual grains. This result is also of significant note, as it highlights the importance of inter-event flows in modifying sediment mobility, which are typically considered irrelevant for changing alluvial channels.

A similar dependence of the threshold for motion on prior transporting flows is observed for peak stresses within this 100-340 Pa range. For peak stresses exceeding 340 Pa, the pattern of increasing critical shear stress is disrupted. This loss of correlation between the threshold for motion and prior flow is supported by previous flume experiments, which indicate that transporting flows may increase bed roughness, restore disorder to the bed, and destabilize individual grains.

These observations provide support for the implementation of a history-dependent function for sediment transport. This type of function is already widely-used to describe earthquake nucleation, frictional sliding, and damage accumulation. We present preliminary results related to the implementation of a discharge-dependent state function in order to predict the evolution of the threshold for motion in response to prior flow magnitude.