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Feedbacks between sediment input, bed state and threshold for motion in gravel-bed rivers: an experimental study

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In gravel-bed rivers the relation between the magnitude and frequency of sediment input, the threshold for motion and channel stability is still not fully understood.

Here we present results from a 280-hour long flume experiment, in which poorly sorted sediment was fed episodically in an 18-m long, 2.2%-steep channel. The experiment included 7 consecutive runs lasting 40 hours each characterized by a constant water discharge but different sediment supply regimes (i.e., with no feed, constant feed and sediment pulses). Several measurements of sediment transport, flow depth and bed structures were taken along the flume, to assess how changes in sediment supply influence particle mobility and channel stability.

Our results show that the surface grain□size distribution coarsened quickly, developing an armored layer that persisted throughout the entire experiment with only short-lived changes after sediment pulses. Grain clusters and other bed structures developed continuously during the experiments, changing dynamically in response to sediment pulses.

We estimated the thresholds of motion with three different methods, all of which yielded consistent results. Overall, the threshold for motion increased during the experiment, fluctuating in response to changes in sediment input. Our results provide further evidence to the idea that the threshold for motion in gravel-bed rivers is not a constant, but changes as a state parameter. These changes in our experiments are controlled by (a) the sediment supply regime, (b) the degree of bed structuring, and (c) the history of bed evolution. These outcomes suggest that sediment supply regime is a primary control on bed surface evolution and the channel stabilizing function played by surface structures.