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The effects of flood history on sediment transport in gravel-bed rivers

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The transport of coarse sediment during floods often exhibits hysteresis patterns from changes in flow fields, channel geometry, bedforms, or sediment supply conditions. Flume experiments that simulate hydrographs tend to confirm that hysteresis is a consequence of the progressive organization of surface sediments in terms of grain protrusion, imbrication, orientation, and roughness. Hysteretic patterns are also highly dependent on the kind of sediment supply conditions, and the type of simulated hydrograph. A factor that has not been investigated extensively is the effect of the timing and sequencing of floods on bedload transport. Depending on its magnitude and duration, each flood leaves the channel bed in a different condition, which influences the bedload transport of the next event, representing the river bed's memory of past floods, which can determine future responses to natural disturbances. In this study, I investigated the effects of different sequences of events, i.e. the flood history, on sediment transport through a series of flume experiments that simulated three types of stepped and symmetrical hydrographs (ranging from short-duration/high-magnitude to long-duration/low-magnitude events) under sediment recirculation conditions. Hydrographs were simulated as a sequence of the same event, and with events in different sequences, in order to explore the effects of different antecedent conditions on sediment transport. The results show that a previous event decreases the rates of sediment transported by a certain hydrograph by around 40% if a high-magnitude event precedes another one and around 70% if a low-magnitude event precedes another event of similar magnitude. A low-magnitude event does not affect the rate of sediment transported by a subsequent high-magnitude flood, but a high-magnitude event reduces the sediment transported by a subsequent long-duration/low-magnitude event.