Exploring the relationship between hydrograph characteristics and time evolution of sand bed surface morphology

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The development of sand bed morphology in response to steady uniform flow is well described by phase diagrams. This includes the predications of bedform spacing, and individual bedform characteristics, both important parameters on describing flow resistance. However during time varying flow such as that experienced during the passage of a flood wave, the implicit assumption that bed form adjustment tracks changes to flow does not hold true with evidence of bed form hysteresis in flood cycles. Consequently there is a need to understand which characteristics of unsteady flow drive the disequilibrium between bedform geometries and the hydraulic conditions.

This paper describes a series of experiments set up to identify the impacts of hydrograph characteristics on the morphodynamic evolution of alluvial dunes. A series of mobile bed experiments were undertaken in a 16m long, 1.6m wide flume, using a uniform sediment of medium sand (D_{50} of 450μm). Sediment was water worked under steady flow until quasi equilibrium bed conditions were met whereupon a hydrograph consisting of a rising and falling rising limb was applied. At the end of the hydrograph a period of steady flow was once again run until equilibrium conditions were attained. During the experiments profiles of bed morphology were measured continuously along a 5m long, 0.6m wide transect taken along the channel centreline using ultrasonic sensors. Flow was measured with a suite of Acoustic Doppler Velocimeters and suspended sediment with Acoustic Backscatter Sensors.

Results are reported for two different hydrographs applied to two different initial starting conditions. The impact of the differing rising-limb characteristics are discussed in terms of differences between equilibrium bed morphologies, flow field characteristics and suspended sediment concentrations.