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Effect of unsteady flows on the development and magnitude of bed forms

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Sediment transport and associated morphological changes in alluvial rivers occur primarily under unsteady flow conditions that are manifested as well-defined flood hydrograph events. At present, typical bed forms generated by such unsteady flows is far less studied and, thus, more poorly understood, than equivalent bed forms generated under steady flow conditions. In view of this, the objective of this work is to investigate the development of morphological bed features, and specifically variability in the length, height and steepness of bed forms that develop in a mobile coarse-sand bed layer under unsteady flow hydrographs under zero sediment feed conditions. A series of laboratory flume experiments is conducted within which different flow hydrograph events are simulated physically by controlling their shape, unsteadiness and magnitude. Experimental results indicate that different categories of bed forms such as dunes, alternate bars or transitional dune-bar structures develop within the erodible bed layer when subject to varying hydrograph flow conditions. Examination of relative importance of three parameters used to describe the hydrograph characteristics (i.e. asymmetry, unsteadiness and total water work) on bed form dimensional descriptors (i.e. wavelength, height and steepness) reveals that hydrograph unsteadiness and total water work are the primary and second-order controls on bed deformations or corresponding bed form dimensions. By contrast, hydrograph asymmetry appears to have minimal or negligible influence on bed form development in terms of their type and magnitude. Based on these findings, a physical model was developed and tested to describe the effect of unsteady flow hydrographs with varying unsteadiness and total water work on the nature and size of resulting bed forms that are generated in sand-bed layers.