Selection of bedform morphology in an experimental flume under supply-limited conditions

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ABSTRACT

Our understanding of bedform dynamics is still limited because of the complex coupling between hydrodynamic forcing, sediment transport and bedform evolution, the time dependency of bedform development and the spatial variability of bedform morphology. In the case of exhaustible supply, as for instance in the presence of a thin erodible bed, the influence of sediment availability on bedform development constitutes an additional key control factor on hydrosedimentary processes. Dréano et al. (2010) carried out flume experiments on the development of bedform instabilities at the sediment-water interface in conditions of limited sediment supply. The goal was to identify mechanisms responsible for the selection of bedform morphology, in the context of river dynamics and bedform diversity. Dréano and coworkers studied the properties of equilibrium bedforms by analyzing time series of three-dimensional bed topography obtained in 46 different configurations with varying sediment size, sediment supply rate and water flow rate. Bedform morphology was characterized with parameters evaluated along flow-parallel profiles and averaged in the transverse direction: equilibrium height, length and spacing as well as migration speed. Here, we examine other parameters taking further account of the morphological complexity and heterogeneity of bedforms. The objective is to identify parameters that can be interpreted in terms of relevant near bed hydrodynamics processes, eventually leading to relationships between bedform-scale morphological parameters and mechanisms of sediment entrainment. A threshold applied to the topographic data allows generating binary images on which bedforms are identified. Bedform sinuosity and spatial density, which show little dependence on the threshold value, reveal efficient at discriminating the equilibrium morphologies. Scaling laws are proposed for these two parameters as a function of the sediment flux trapped by the bedform face Qc and the cube of the shear flow velocity u*. Their applicability to bedforms in other environments could be assessed, noting that sinuosity and bedform density may be quantified provided the outline of bedforms can be determined. Additional parameters should be tested, in the idea of better exploiting 3D topographic data of bedforms by extracting local signatures that are relevant to the study of bedforms sensitivity to their formation conditions.

REFERENCES

Dréano J., Valance A., Lague D. and Cassar C. 2010. Experimental study on transient and steady-state dynamics of bedforms in supply limited configuration. Earth Surface Processes and Landforms 35(14):1730-1743.