

MODEL FOR RIVER DUNE DEVELOPMENT INCLUDING A PARAMETERIZATION FOR FLOW SEPARATION

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During floods in rivers, the interaction between flow and sediment transport may result in the development of dunes on the river bed. Those dunes influence the flow resistance and thus the water levels. Since flow resistance is strongly related to bedform dimensions, prediction of bedform dimensions during floods is essential for water management.

In this paper we describe an approach to simulate dune development. The approach is set up to be appropriate in a sense that (1) it meets the requirements/goals of end-users, and (2) that there is no unnecessary level of modelling detail.

The used model is based on the two-dimensional vertical hydrostatic flow equations. The eddy viscosity is constant over depth and at the bottom boundary a partial slip condition is applied. The sediment is assumed to be transported as bedload only, and a general transport formula, which takes into account bed slope effects, is adopted.

Since the model is originally developed to simulate the development of offshore sand waves, the parameters need to be recalibrated. This is done based on flume data.

A train of identical bedforms is simulated using periodic boundary conditions. This implies restrictions to the behaviour of bedform length during evolution. It is observed under field and flume conditions that the bedform length gradually increases during the development process. This is not yet included in the present model.

Due to the assumptions made in our model, flow separation cannot be treated explicitly. Therefore, flow separation is included in a parametric way. A zero velocity line is computed using the bedform height, the point of flow separation and the local bed slope at the point of flow separation as important parameters. This zero velocity line is used as new bed level for the next hydrodynamical time step. The sediment that is transported over the crest of the dune avalanches down the lee-side slope, until this slope reaches the angle of repose of the bed material ($\approx 30-35^\circ$). Once the lee-side has reached this critical slope, the bedform is assumed to propagate without changing the angle of the lee side slope.

The model with a parameterization for flow separation included is applied to flume conditions. Extensive datasets of flume experiments are available to calibrate the model. Results will be shown at the conference. A preliminary result is shown in figure 1.

Future research will aim at simulating bedform response to flood waves and design flood conditions, and at estimating the effective roughness caused by dunes.