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ALTERNATE BAR INSTABILITY AS A VERIFICATION TEST OF A MORPHODYNAMIC-NUMERICAL MODEL

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The verification of a morphodynamic-numerical model is the test of the numerical model code for its accuracy in solving the mathematical model equations. This way the coding as well as the numerical algorithms are tested in different parameter ranges. Clearly this task would be solved best by comparing the numerical model results with the exact solution of the mathematical model equations. Analytical solutions exist only for simplified, i.e. schematised situations. Also hydraulic model results may be used for comparison. Different prominent test cases are commonly used for morphodynamic models.

A comparably advanced test is the simulation of an instability inherent in the model equations. In this case not an analytic solution, but a practically very important property of the mathematical equations is tested. In rivers alternate bars are a common feature that influences the morphodynamics heavily. Of course morphodynamic models are expected to reproduce this feature. However numerical diffusion may cause a failure of the model.

The alternate bar test is complete in the sense, that different terms in the mathematical equations are involved. Moreover it is challenging, because the dispersion and diffusion properties of the numerical algorithm are tested. Only bed-load transport is accounted for, to keep the test simple. A linear perturbation analysis of the mathematical equations delivers the disturbance that should develop in a laboratory flume as well as in the numerical model. Numerous laboratory experiments, like Tubino 1991 or Lazoni 2000 are documented in the literature. Ikeda 1984 compared the observed bars with the theory. However often the nonlinear deformation phase after the initiation is not accounted for. Additionally the flumes have a limited length for the bar development.

In the alternate bar test besides correct coding of the model and calibrated coefficients the properties of the numerical scheme are important. Instead of the amount of bed level change in this test the self organisation of structures is most important. The result of the model is tested for the form, i.e. qualitatively, but also for the length of the alternate bars. In certain cases the number of rows of alternate bars may switch to two or more. The growth rates may also be compared, but are more difficult to determine. Besides the ability to compute the instability at all, the most important parameter in this case is the wave length of the computed alternate bars for the given set of hydraulic and sedimentologic parameters.

This test exemplifies the more difficult applications of morphodynamic models when no hard structures influence the system development. In the application of morphodynamic models this is a very challenging field. Whatsoever the applicability of the models and the limitations of forecasts are concerned with this type of instability.

The model tested is a two-dimensional FE morphodynamic model Smor3D as well as a new model that is based on the FE flow model Bubble that solves the shallow water equations on a

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triangle element mesh. Sediment transport is calculated separately for bed- and suspended load and the Exner equation is solved. Non-equilibrium transport is accounted for in the suspended load transport computation. Transverse transport is implemented in a formulation proposed by Mewis 2002.

In Figure 1 results obtained with model Smor3D are shown for the case of Tubino's experiments. From left to right the nonlinear deformation of the bars and in the upper part of the right figure a lengthening of the bars is to be observed. The calculated wavelength compares well with the wavelength observed by Tubino 1991 in the range between 3 and 4 meters.

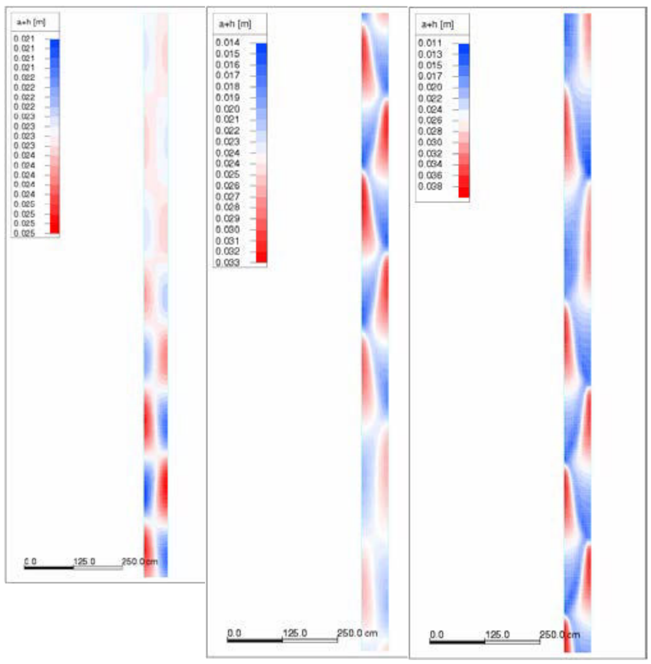

Figure 1 Alternate Bars calculated with Smor3D (Mewis 2002)

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