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Self-formed Meandering and Braiding Channel Patterns in a Numerical Model

A. Background

- The initiation of river bars is cause by the interaction between flow and bed material, as demonstrated by field observations, linear stability analyses, flume experiments and numerical modelling
- The bar pattern determines where bank erosion occurs, which may lead to meandering in case of alternating bars combined with cohesive sediment or vegetation
- The numerical modelling is conducted in combination with flume experiments, see Van Dijk et al. (EP31E-06) and Van de Lageweg et al. (EP31E-07)



B. Research objectives

- Model the formation of braiding and meandering channel patterns in a 2D non-linear model
- Model the transformation from alternating, free bars to meandering (forced bars)

C. Methods

Numerical model

2D-morphodynamic model Delft3D Physics-based Autogenetic bar development

Boundary conditions

Initial flat bed Empirically derived (see below) Small random perturbation in discharge and initial bed level

Model parameters

Sediment: Bed roughness: Sediment transport: Bed slope effect: Morphological factor:

Uniform sediment, 200 µm - 20 mm Nikuradse's ks of 0.15 m Engelund-Hansen Koch & Flokstra (1980) and Talmon et al. (1995) 25

Empirically derived boundary conditions 10³

The boundary conditions and channel dimensions are based on the empirical relation between:

- Stream power
- Median grain size
- Channel pattern

(Kleinhans & Van den Berg, 2010)



See also Van den Berg et al. (EP31E-08)



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E. Conclusions

- Modelled bar pattern is according to empirical data
- Braiding is well reproduced in the numerical model
- Single thread channel is reproduced in the numerical model in case of no bank erosion
- Bank erosion can lead to widening of the channel and consequently a braiding bar pattern
- Additional processes (e.g. vegetation) are needed to produce meandering

References

- Kleinhans & Van den Berg (2010, ESPL • Van de Lageweg et al. (EP31E-07)

Braiding bars x-coordinate (km) B) Non-migrating braiding bar pattern emerges at high stream power (w/h >200)

D. Results

No bank erosion

- 1. Autogenetic growth of bars (Figures 1 4)
- 2. Good agreement with empirical relation of Kleinhans & Van den Berg (2010, ESPL)

Figure 4. Modelled bar length:







Bank erosion

Two results:

- 1. Alternate bar pattern does not adjust, no bank erosion at all
- 2. Alternate bar pattern transforms into braiding bar pattern, cause by widening of the entire reach (Figure 5)

Figure 5. Widening of the channel results in braiding:



• Van den Berg et al. (EP31E-8) • Van Dijk et al. (EP31E-06)

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