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Long-term morphodynamic evolution of the Western Scheldt estuary, the Netherlands, using a process based model

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ABSTRACT

1. OBJECTIVE

Different attempts have been made to predict estuarine morphodynamic evolution both in terms of pattern formation and longitudinal profile development. Pattern formation was investigated by Schuttelaars et al (1999) and Seminara et al (2001) using a process based approach and focussing on *initial* shoal formation under conditions of highly schematised tidal forcing. The development of the width averaged longitudinal profile was described by numerous authors who used a 1D hydrodynamic and morphodynamic models leading to equilibrium profiles using different types of sediment transport formulae. Hibma et al (2003) and Van der Wegen & Roelvink (in prep) combined these investigations using a 2D numerical model described by Lesser et al (2004) solving the shallow water equations and a sediment transport formulation with an advanced morphodynamic update scheme.

All research thus far focussed on highly schematised model configurations with a fixed uniform or exponentially decaying width. Only Van der Wegen et al (2006) allowed lateral erosion of banks using a simple formula for the erosion of dry cells, see Figure 1. It shows the “free” morphodynamic evolution of a tidal embayment, in the sense that both the bed and the banks are subject to erosion.

The objective of the current research is to asses the value of process based long-term morphodynamic modeling in case of a real geometry, nl the Western Scheldt estuary in the Netherlands.

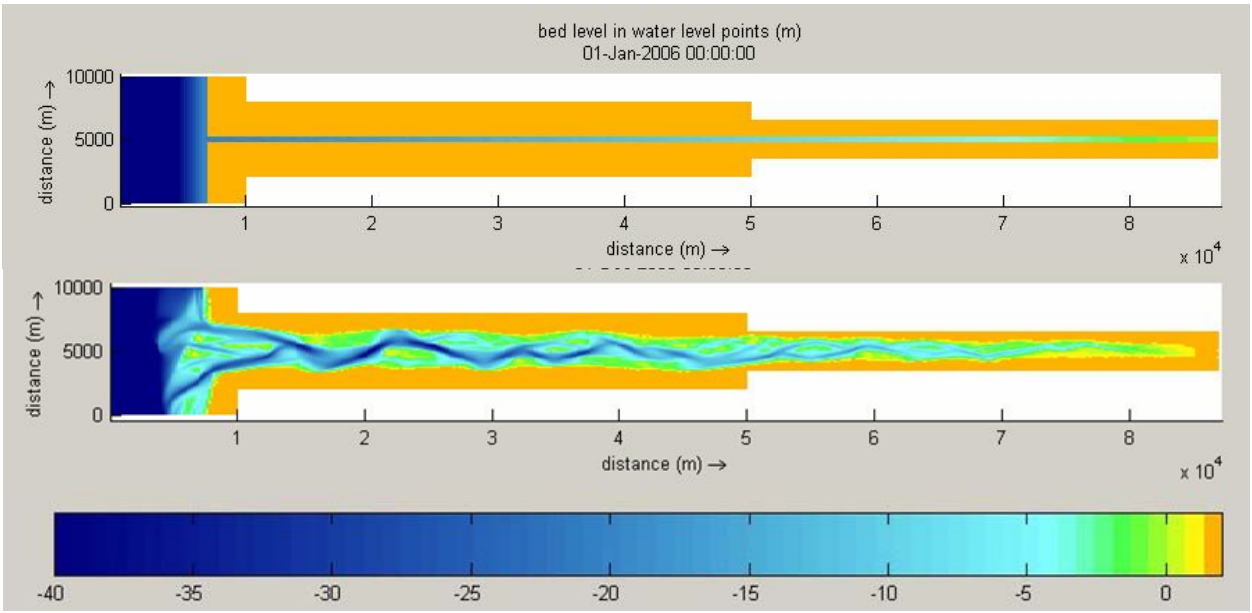

Figure 1- Morphodynamic evolution of a tidal embayment: linearly sloping initial level (upper part) and bed level after 800 years (lower part).

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2. MODEL DESCRIPTION

The initial conditions are formed by an initially flat bed randomly perturbated by max 5% of the waterdepth, with fixed banks defined by the location of the current Western Scheldt banks. Model formulations are based on the shallow water equations which are solved for a staggered grid. The sediment transport formula applied is the one developed by Engelund-Hansen. Drying and flooding of cells was allowed using threshold values for the water level. Erosion of dry cells was allowed by assigning the erosion of a wet cell to the adjacent dry cell. Figure 2 presents preliminary results.

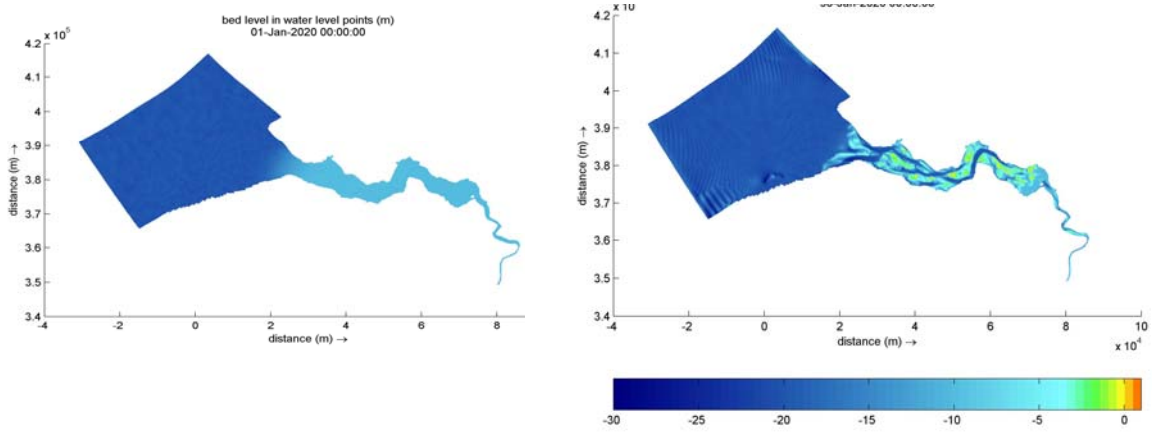

Figure 2 – Development of bed level in a Western Scheldt geometry over 50 years.

3. SUMARRY OF PRESENTATION

The contribution to COPEDEC 2008 consists of a validation of model results against the current, measured bathymetry in terms of % of intertidal area, hypsometry and channel locations. Also comparison will be made with settled empirical relationships, like the relationship of O'Brien (Tidal prism versus the mean cross sectional area) and Eysink (Channel volume versus tidal prism). Additionally, a sensitivity analysis will be made with respect to different sediment transport formulations including total transport or a separated specification of bed load and suspended load. Finally, results will be presented on a 1000 years development with and without sealevel rise starting from the current bathemetry.

4. REFERENCES

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