Long-term morphodynamic behaviour of the Western Scheldt explained: chaotic or self-organizing?

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In this study we aim to examine the long-term morphological change of the Scheldt estuary in the southwest of the Netherlands. Since long, the general view on long-term, process-based morphodynamic modelling has been that model results worsen for longer runs. A unique series of bathymetric maps since 1860 is available, which makes a comparison of model results and measurements possible over a 110 year hindcast period.

We hindcast the Western Scheldt from 1860-1970, using the process-based FINEL2d model, which is based on the finite element method. Contrary to common perception the model shows good results for the erosion and sedimentation pattern with an increasing model skill over time. A Brier-skill score of 0.5 (good) at the end of the computation is obtained.

The question is how it is possible that a fairly straightforward morphological model produces good results over a timescale of 100 years. To answer this question we examined the hypothesis that an estuary strives towards minimum energy dissipation. The results are that both the model and real bathymetries show less energy dissipation (figure 1a) and less morphodynamic activity over time (Figure 1b). This is a clear indication that the estuary is moving towards equilibrium conditions in a self-organising manner and that the system is not chaotic. These equilibrium conditions and self-organising make that the long-term morphology can be predicted using a straightforward 2DH morphodynamic model. Furthermore the results are positively influenced by the geometry, non-erodible layers and the well predictable tidal forcing.

Conclusion is that process-based models are well suited to predict long-term morphology in confined basins such as the Western Scheldt, because of the self-organisation and equilibrium conditions.

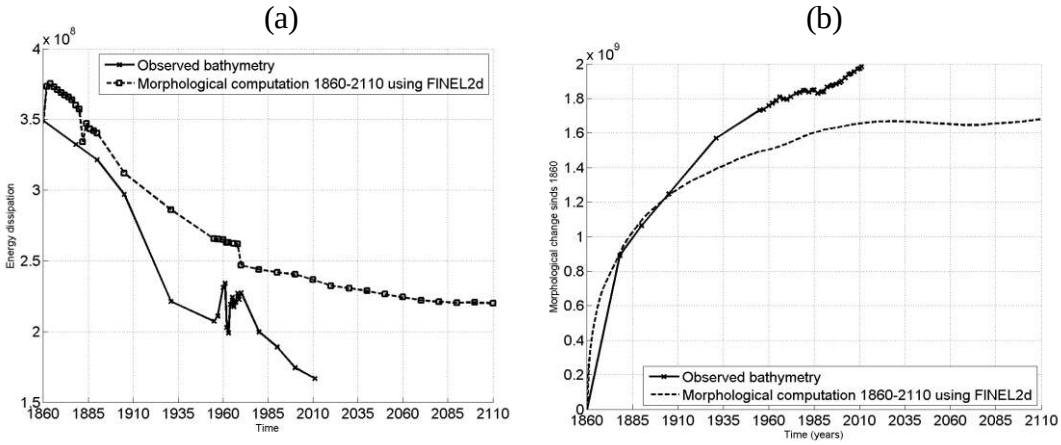

Figure 1. (a): Energy dissipation over time (b): Morphological activity over time