ESTUARINE-WIDE SEDIMENT DYNAMICS UNDER HUMAN INTERVENTIONS AND CLIMATE CHANGE EFFECTS; AN IDEALISED MODEL STUDY

Rutger Siemes, University of Twente, r.w.a.siemes@utwente.nl
Trang Minh Duong, University of Twente, IHE Delft, Deltares t.m.duong@utwente.nl
Pim Willemsen, University of Twente, Deltares, p.willemsen@utwente.nl
Bas Borsje, University of Twente, b.w.borsje@utwente.nl
Suzanne Hulscher, University of Twente, s.j.m.h.hulscher@utwente.nl

INTRODUCTION

Estuaries worldwide are under constant anthropogenic pressure. They are susceptible to climate change effects, from the sea (sea level rise, changing wave climate) and from the river-side (changing river discharge). Besides, estuaries are channelised and embanked to improve flood safety and to reclaim land, and channels are deepened to allow bigger ships to enter the ports. To optimise estuarine functions and sustainably prepare for future challenges, improved understanding of estuarine sediment dynamics after potential changes in the systems configuration and forcings is desired. This paper aims to assess the annual sediment dynamics of an estuary under a climate change effects, and how this is affected by human interventions.

STUDY AREA

The Nieuwe Waterweg estuary is the main connection of the Rhine-Meuse Delta to the North sea (Figure 1). It has an average discharge of 1700m^3/s, a mean tidal range of 1.6m and typical average wave heights of 1.1m near the inlet, which is 15m deep and 500m wide. Extensive human interventions to this estuary resulted in an embanked and channelised estuary, constantly filling up with sediment and being dredged for port operations.

MODEL SETUP

An idealised, morphological model is developed (in 2DH, using Delft3D-FM). A schematised bathymetry is developed for the contemporary estuarine system (Figure 1). The domain is forced by an M2, M4 and S2 tidal cycle, an annual monthly averaged wave climate from the coast, and an annual monthly average discharge regime, with average fluvial sediment concentrations of around 20-25mg/L entering the estuary. The model is validated by hindcasting 20 days of hydrodynamics and reproducing annual sedimentation rates.

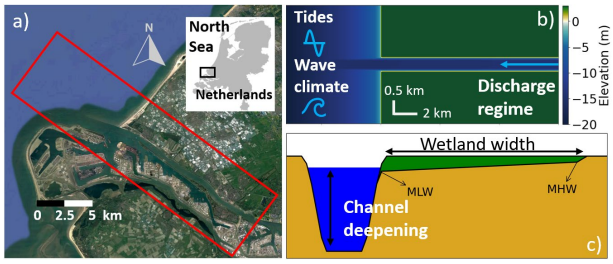

Figure 1 - a) The New Waterway estuary, the Netherlands. b) Schematised bathymetry of the estuary. c) Cross-section of the bathymetry, and implemented human interventions within the model. Intertidal area is only implemented along the northern bank of the estuary.

FUTURE FORCINGS AND HUMAN INTERVENTIONS

System sensitivity in sediment dynamics is assessed under future forcings, using 1 year snap-shot simulations (see Duong et al., 2016). Following projected climate changes for the year 2050 and 2085 (e.g. using the 6th IPCC report), model forcings are adjusted for SLR, future wave climate, and future river discharge regime. Moreover, the impact of SLR induced basin infilling is assessed. CC impacts are simulated in combination, representing a future climate, but also in isolation.

In both the contemporary and future climate, the impact of human interventions on estuarine sediment dynamics is explored (Figure 1). Hereby, this study focusses on two large-scale interventions: 1) Intertidal area restoration and; 2) changing channel depth.

RESULTS AND DISCUSSION

First, human interventions are implemented in the contemporary system. Results indicate how measures can steer local sediment dynamics. On the estuarine scale, results highlight how increased sediment infilling caused by channel deepening can be compensated for by increasing intertidal area (Figure 2).

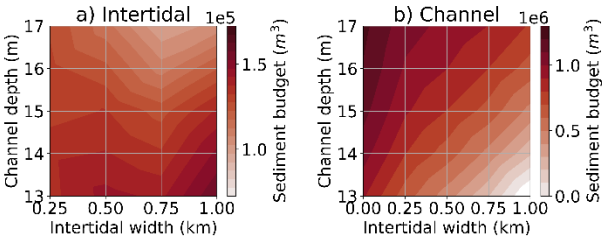

Figure 2 - Impact of channel depth and intertidal width on sediment budget in the a) Intertidal and b) within the channel of the estuary.

Next, the impact of climate projections on annual sediment dynamics will be assessed. The approach will give insight on how CC projections will affect morphological trends within the 'New Waterway'. By isolating CC impacts, key drivers on local and estuarine wide morphological development can be identified. Moreover, simulating the impact of human interventions in present and future climates will aid estuarine management to improve estuarine functions in a constantly changing estuarine environment.

REFERENCES

Duong, T. M., Ranasinghe, R., Walstra, D., & Roelvink, D. (2016). Assessing climate change impacts on the stability of small tidal inlet systems: Why and how? Earth-science reviews, 154, 369-380.