Deltares
Enabling Delta Life

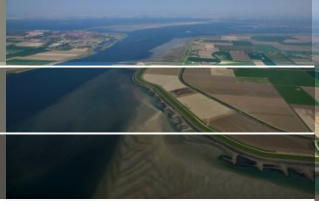
Overview of morphodynamic area models for the Wadden Sea

NCK Theme-day: *Morphodynamics of the Wadden Sea: recent reseach and future challenges*, Leeuwarden

Pieter Koen Tonnon, Deltares

17 May 2019

Setting, aim of presentation



Overview of Deltares process-based morphodynamic models for the Wadden Sea, developed at- or in cooperation with Deltares

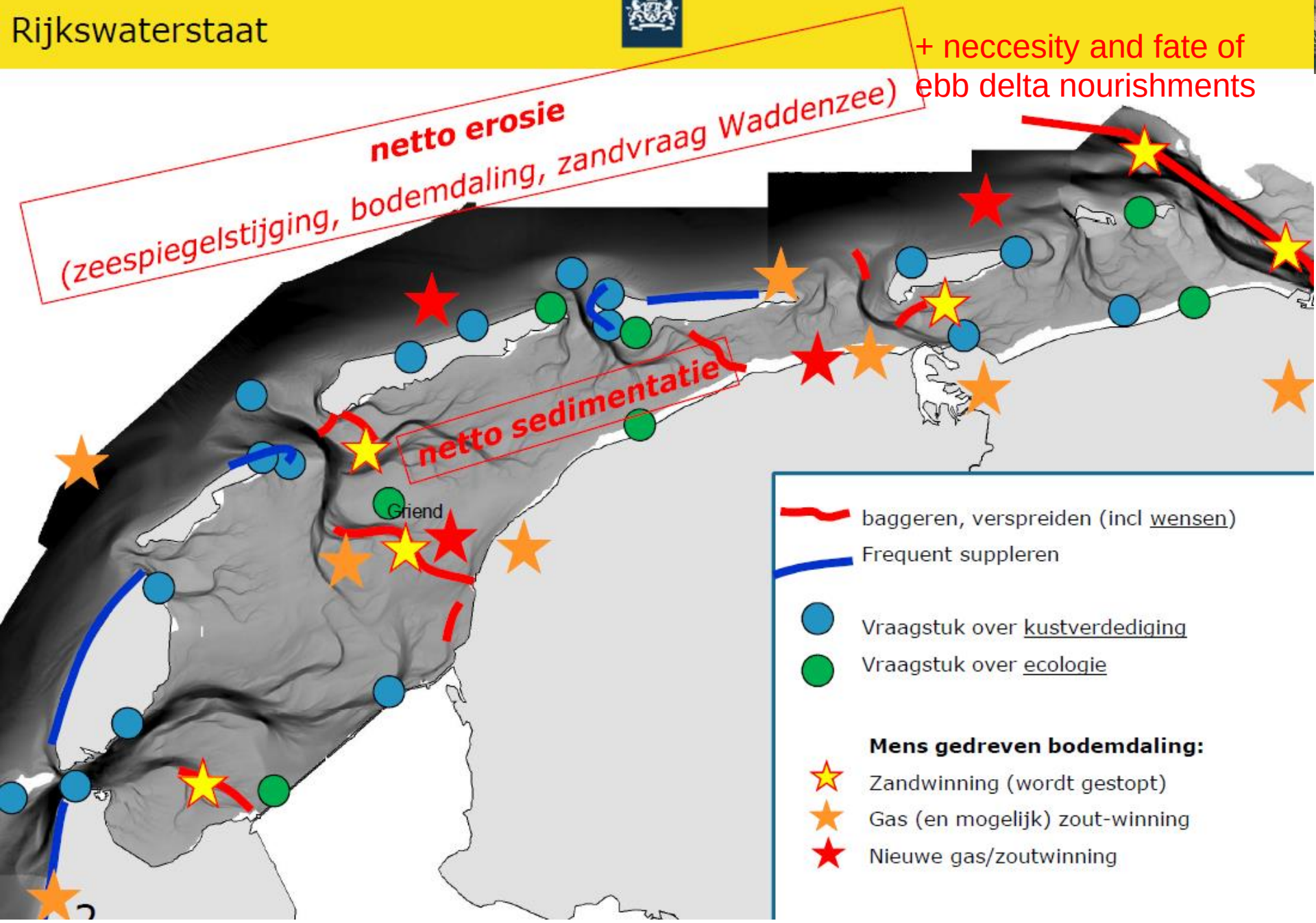
Aim: initiate discussion on priorities for future research

1. Management issues
2. Models and scales
3. 1990’s, SBW, Ameland
4. Kustgenese 2.0
5. Lessons learned
6. Future challenges

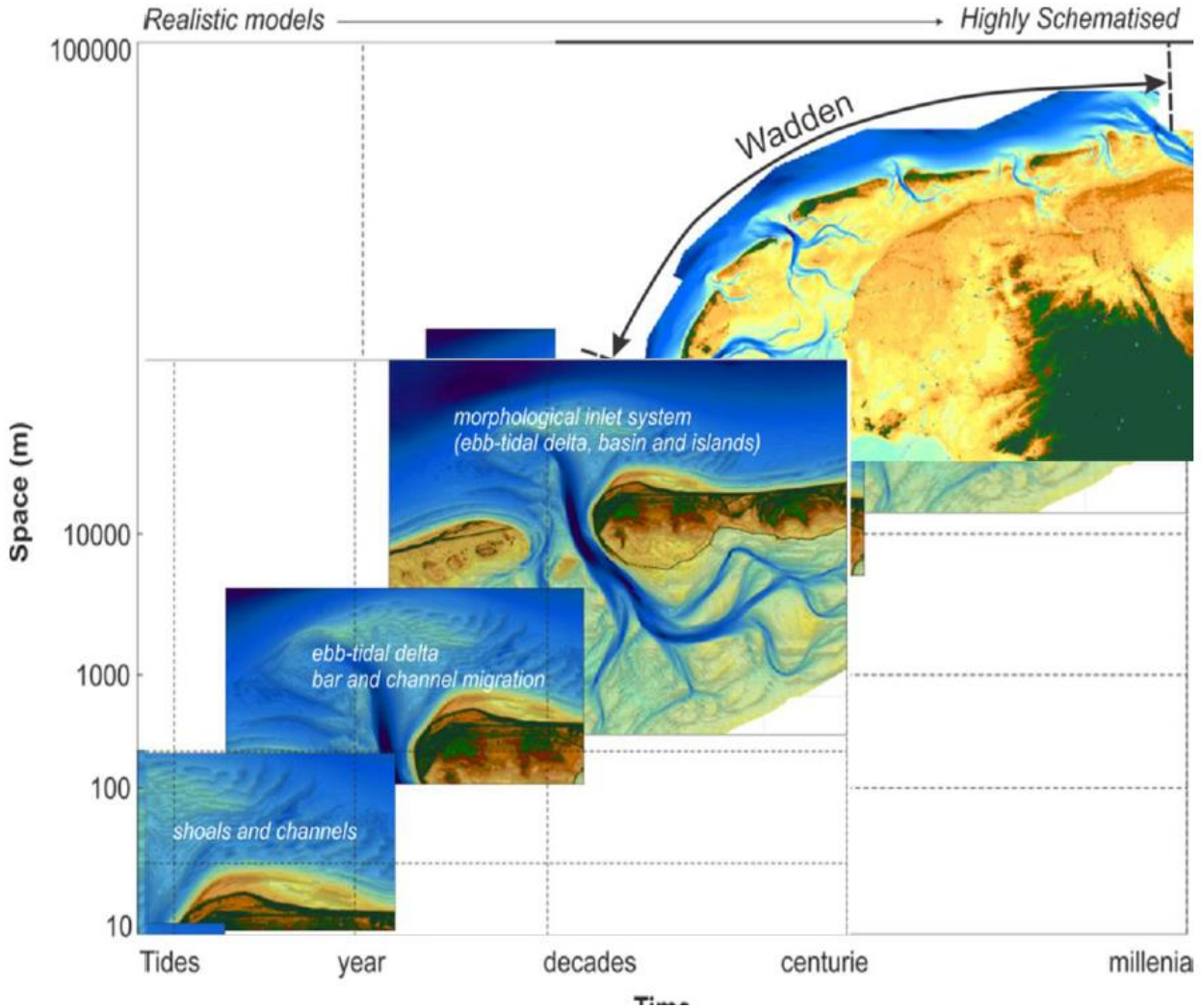
Morfologische aandachtsgebieden

Rijkswaterstaat

+ neccesity and fate of ebb delta nourishments

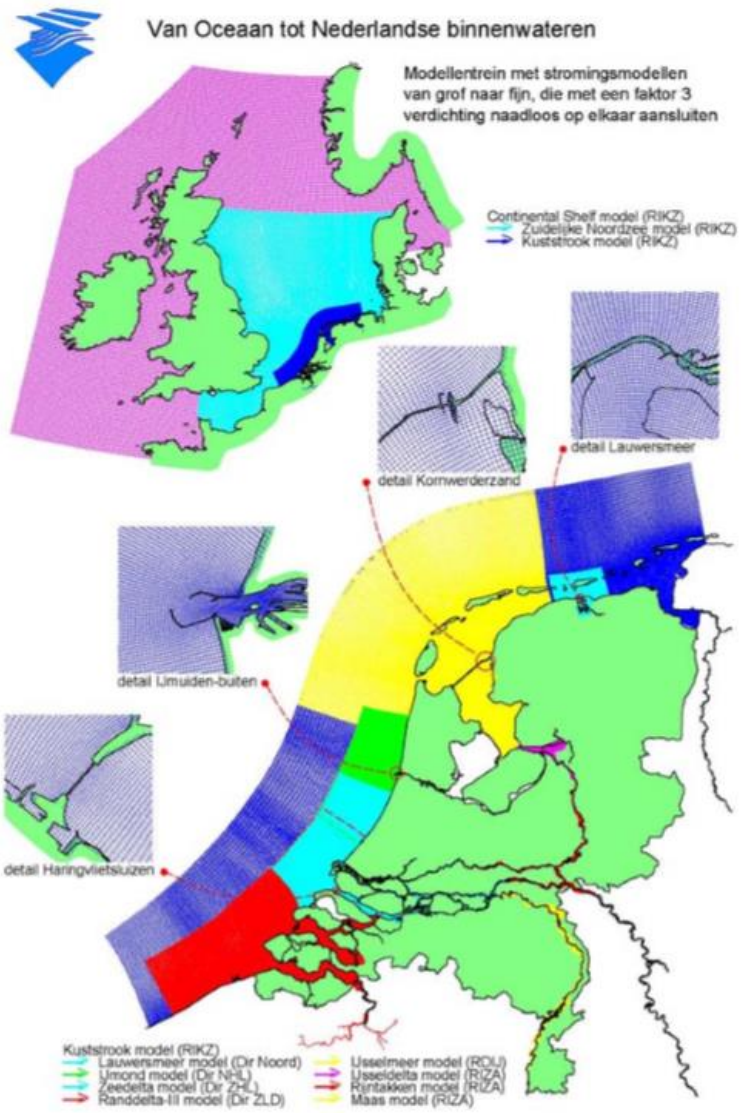


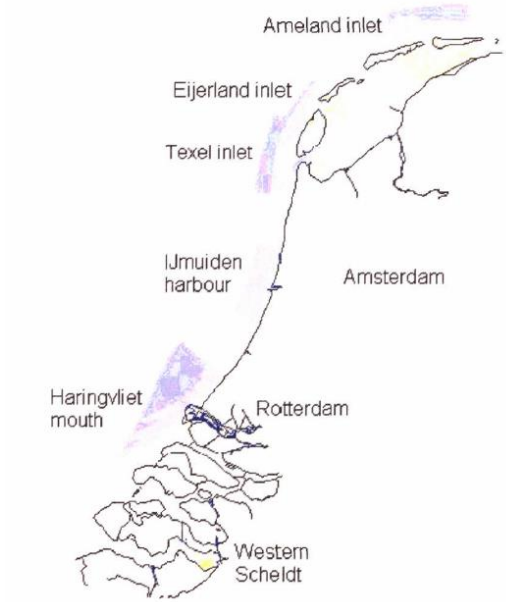
Types of models, scales,' bridging the gap'

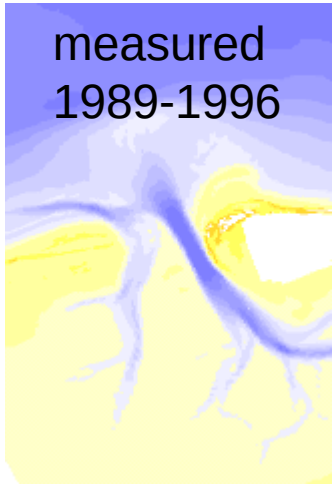


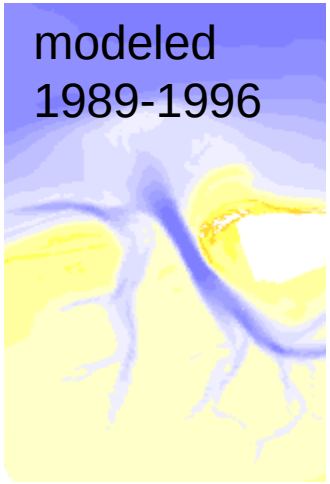
Deltares

90s: development & validation of coastal morphodynamic area models (D2DMOR)





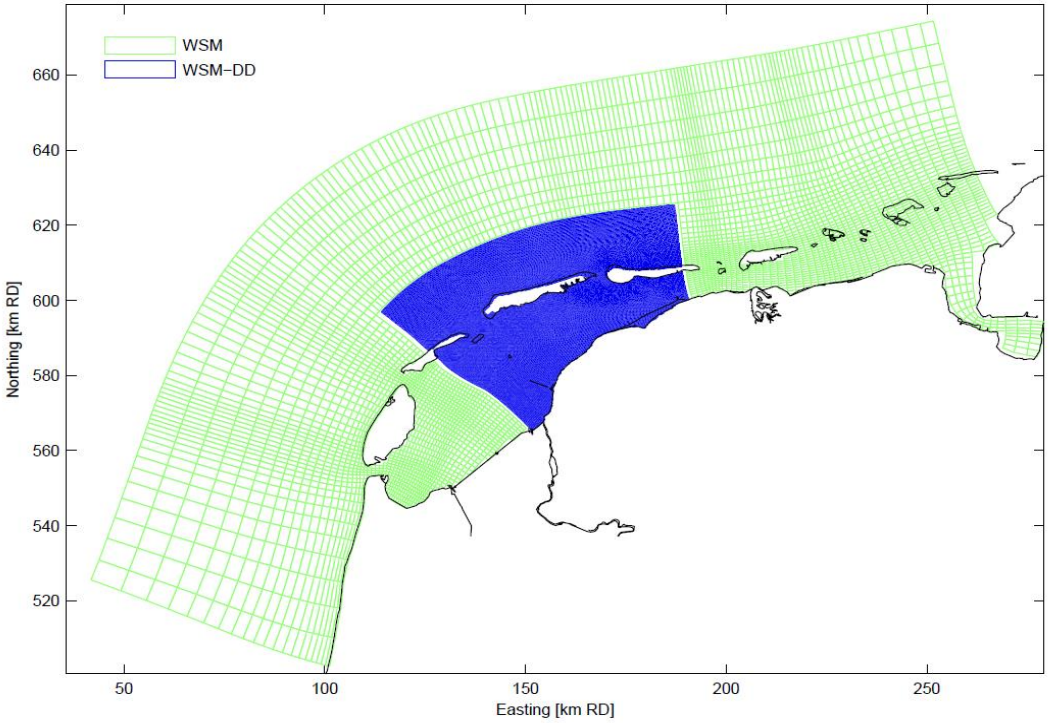


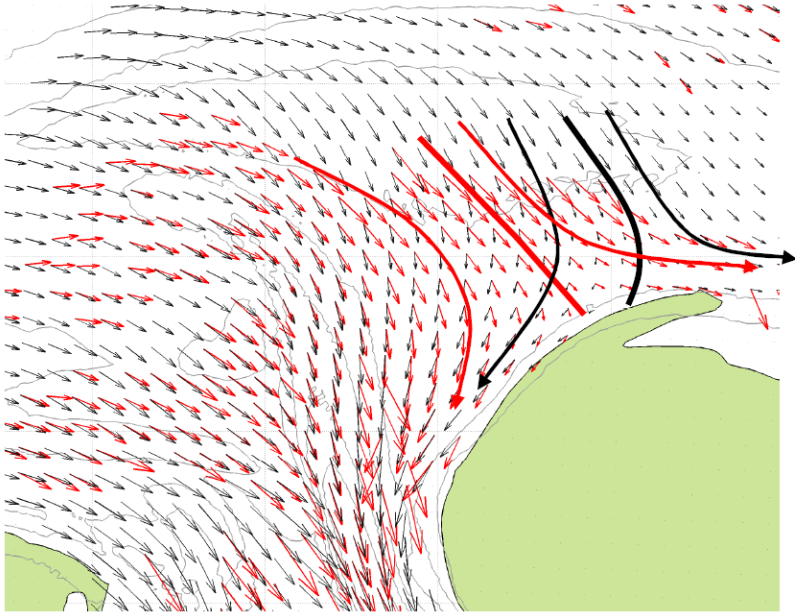


Deltares

00's: SBW & van Rijn 2007

- improved SWaN wave modelling, including wave, hydrodynamic and bathymetric measurements in the period 2008-2011
- validated 2D hydrodynamic Wadsea model & DD Ameland model (with van Rijn 2007 transport formulations and bed roughness predictor)

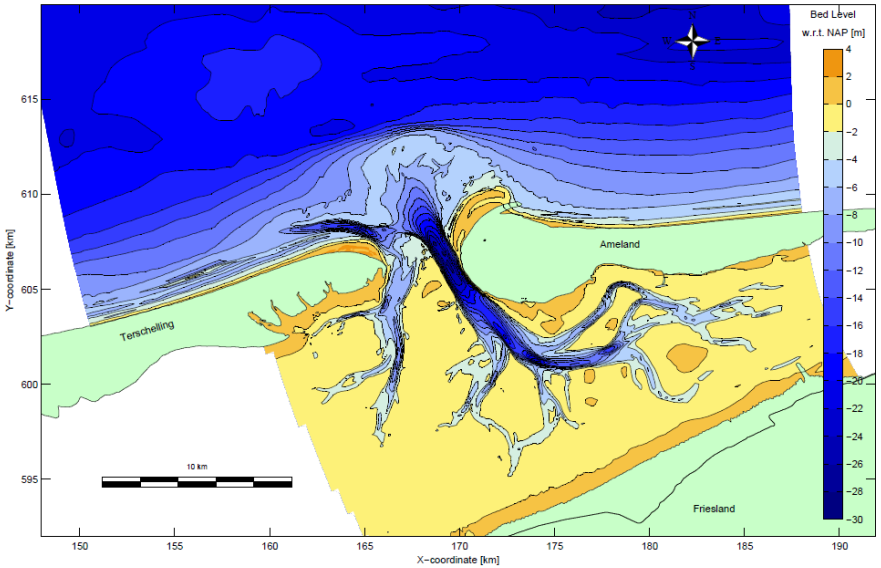


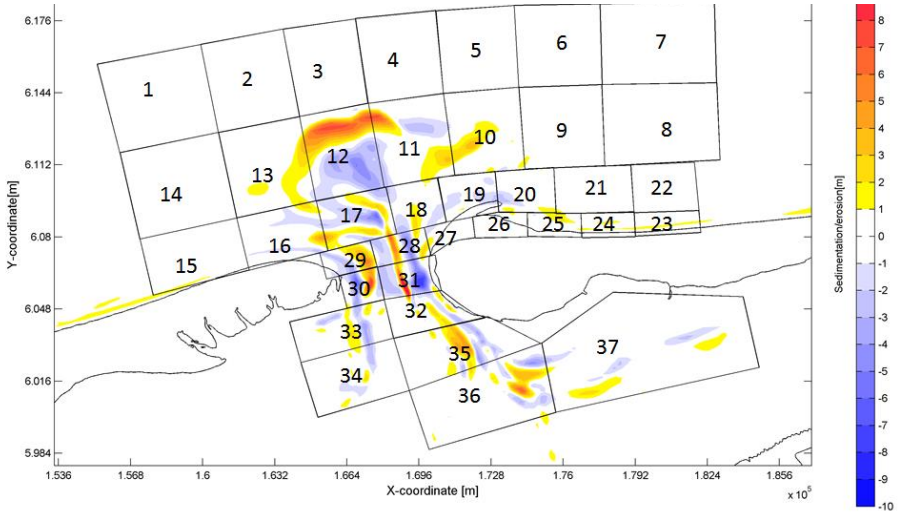


Deltares

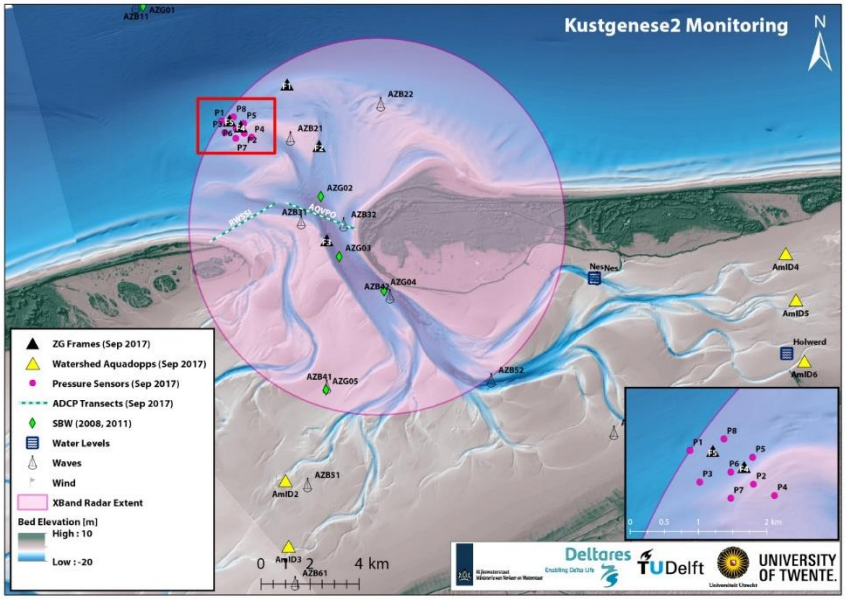
Ameland

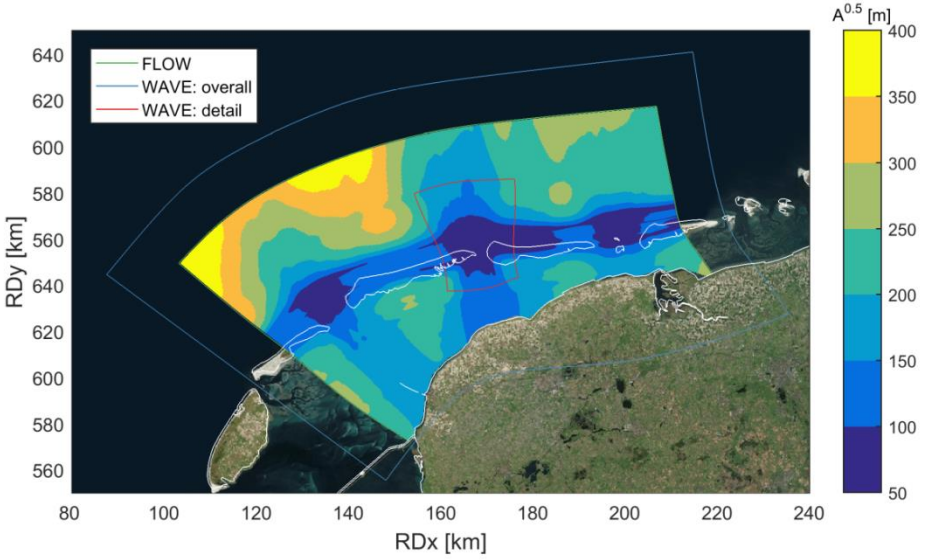
- **Roelvink and Steijn, 1999:** closed basin, representative tide, 4 wave/wind conditions, Soulsby-van Rijn
- **De Fockert, 2008:** closed basin, improved representative tide, 12 wave/wind conditions, van Rijn 2007 + bed roughness predictor
- **Teske, 2013:** sensitivity analysis focusing on channel incision.
- **Jiao,2014:** improved representative tide, 2 fractions
- **Bak 2017:** 4 fractions, nourishments

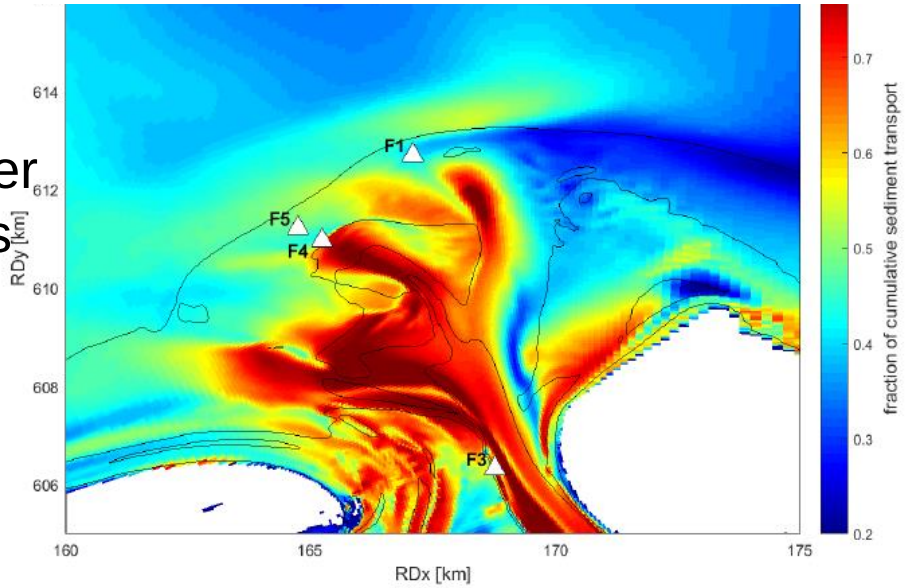




10's: KPP + Kustgenese 2,0

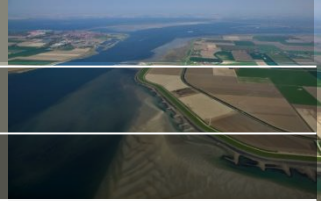






- 2D flow-wave-sediment coupled model with validated waves, water levels, flow velocities, discharges (frame locations, gorge and tidal divides)
- large-scale sediment transport computations using offline approach

Lessons learned



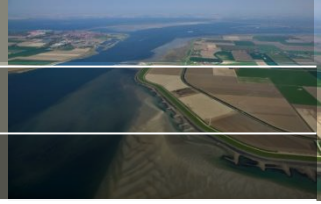
- both quasi-realistic, short-term and higly schematized long-term morphodynamic simulations feasible, intermediate time-scales challenging (especially for stable systems close to equilibrium that are dominated by subtle changes/balances between processes)

- wave schematization needs to be carried out with great care, tidal schematization and closed basin boundaries likely result in inaccurate representation of residual flow through inlet

- overprediction of channel incision in Delft3d was reduced with the van Rijn (2007) transport formulations + bed roughness predictor. The latter also improves prediction of spatial flow fields

- data shows that initial small-scale perturbations develop, grow, migrate and start to dominate the developments of the entire ebb-tidal delta.

Future Challeges



- trend is more detail: larger domains, higher resolution, less input reduction/schematization, upscaling from brute-force approach/short-term
- processes: sand-mud interaction and bed composition, 3D, hybrid modelling/long-waves, dry cell erosion, wave skewness/coastal profile & bed slope effects
- set-up and maintain a large-scale calibrated flow-wave sand-mud model, maintain/improve smaller-scale refined or nested models of inlets, basins or island coasts. Collaborate on model development
- transition to faster DFM unstructured models better suited for parallelization may results model issues

- **application** of models to predict fate of ebb tidal nourishments, sediment transport pathways and channel siltation