Preservation of mud layers in tidal bars: Shoal of Walsoorden

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Objective

Mudflats and mud layers can have a large influence on the morphology of estuaries due to different erosion and deposition characteristics compared to sand. Over decades to centuries, mud deposits can confine the estuary and increase the hight of intertidal bars (Braat, 2017; subm). However, the precise effects are hard to predict, because it is generally unclear how the sand-mud stratigraphy looks like and under what conditions mud is deposited and preserved.
The **objective** of this research is to determine when mud layers form and under which conditions they are preserved in the stratigraphy.

Approach

We compare stratigraphy generated by morphological modelling of the shoal of Walsoorden, Western Scheldt, in Delft3D with stratigraphy build from field data. Field data is used to determine where the mud layers are and the model helps to identify under what conditions mud layers are deposited and preserved. (Fig. 1)

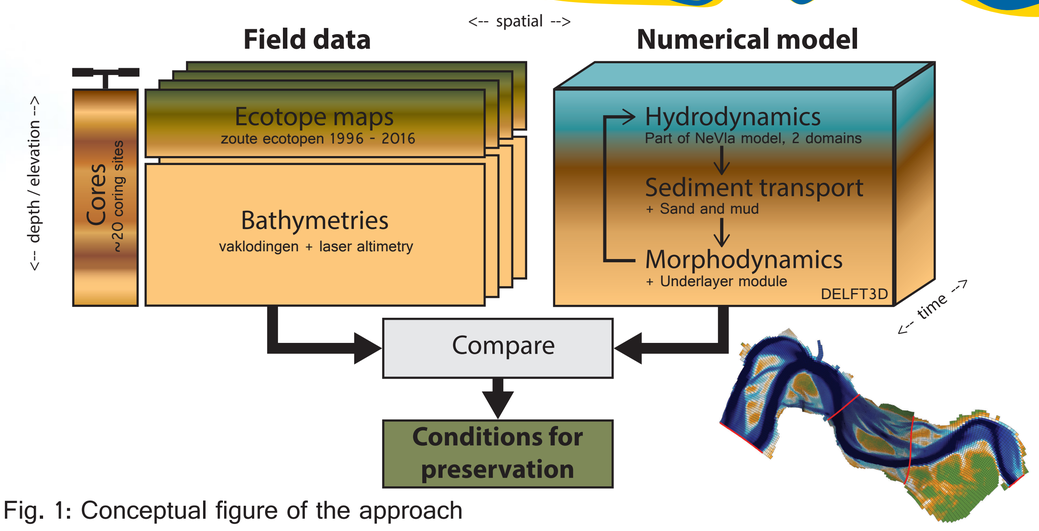


Fig. 1: Conceptual figure of the approach

Stratigraphy from field data

- Mud (brown overlay) and vegetation (green) occurs most on the eastern part of the shoal (Fig. 2)

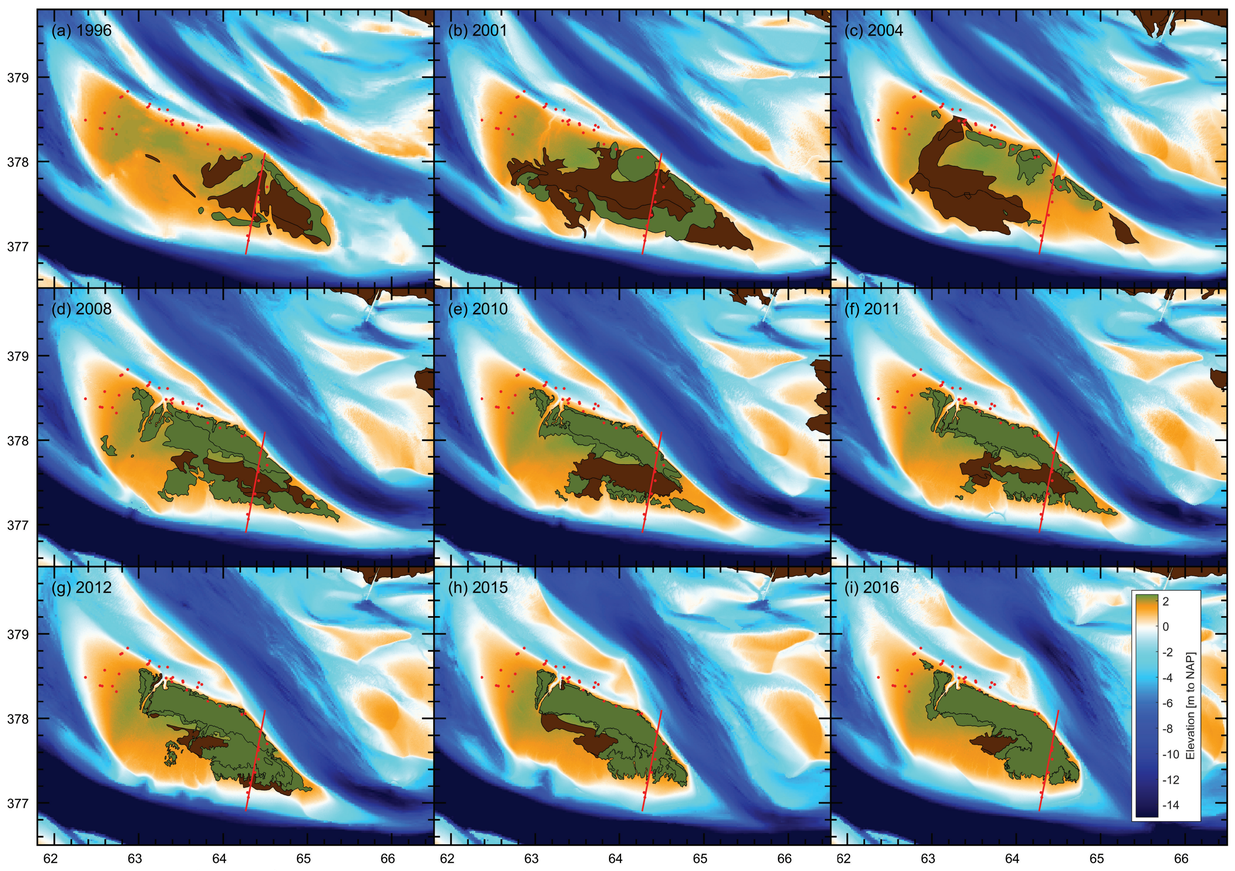
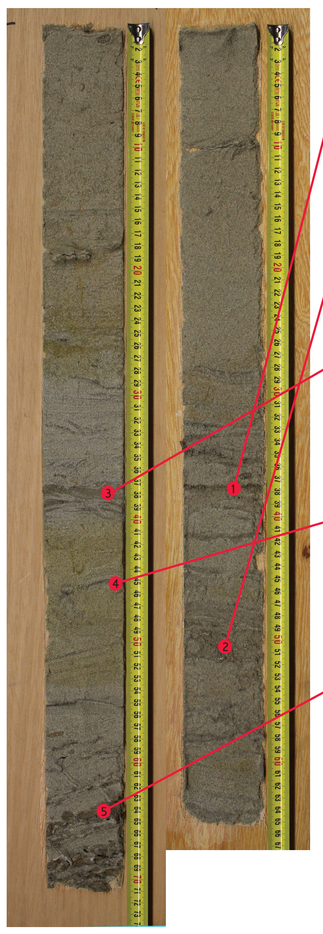


Fig. 2: Mudflats (brown) and marshes (green) plotted for several years on top of bathymetry of the shoal of Walsoorden, Western Scheldt.



1. **Layer by storm event**
   - 1 cm mud layer
   - Diatoms: planktonic and tychoplanktonic, marine
   - Organic material
2. **Layer from slow accretion**
   - 2 cm mud layer
   - Diatoms: benthic and tychoplanktonic
   - Roots and shells
3. **Fast accretion by bed migration**
   - Assemblage of very thin mud drapes
   - Diatoms: benthic and tychoplanktonic
   - Few forams and diatoms
4. **Event layer**
   - Curved 0.5 cm mud layer
   - Diatoms: planktonic
   - Many forams, few diatoms
5. **Layer from reworked mud**
   - +6 cm layer with mud clasts under an angle
   - Diatoms: benthic and tychoplanktonic, many species and (sub-)aerofyl genus
   - Shell fragments

Fig. 3: Two cores from the side of the flood channel in the north. 1-5 environmental interpretation of mud layers based on diatoms and sedimentary structures.

- Lateral migration is fast and vertical accretion is slow (Fig. 4a)
- Most of the vertical accretion is due to mud deposits (Fig. 4d)
- Mud preservation below the surface is rare on this scale (Fig. 4c-d)

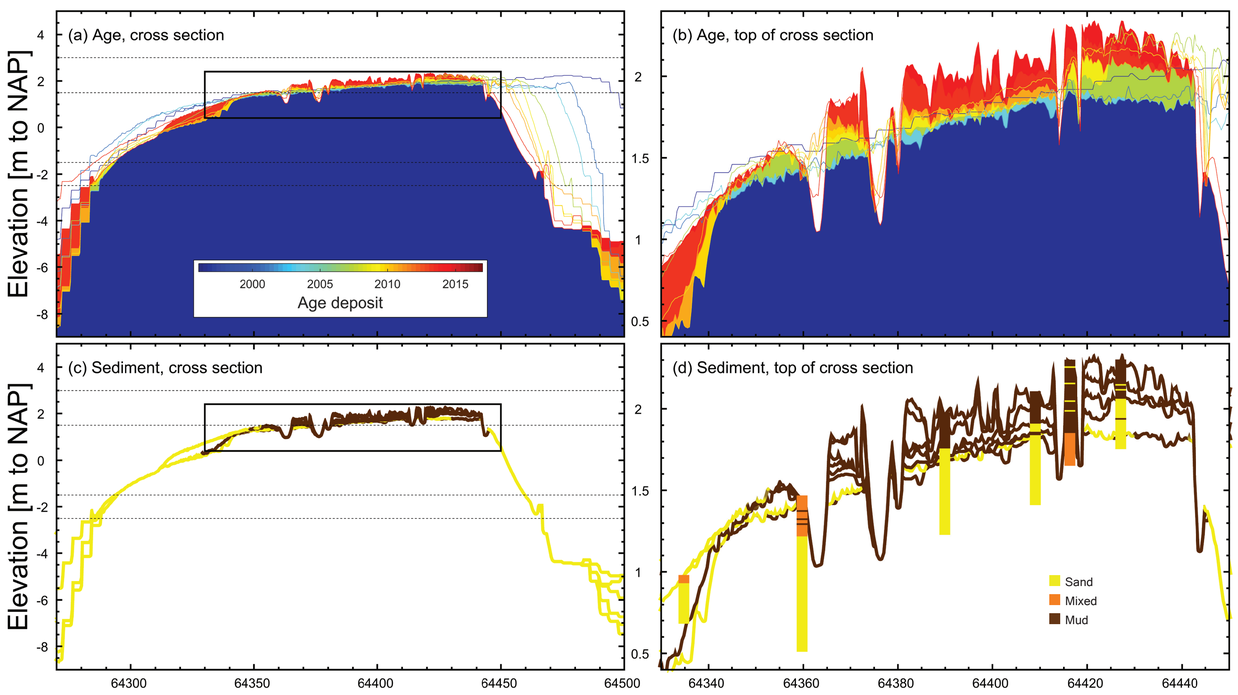


Fig. 4: Shoal stratigraphy of one cross section of Walsoorden (red line in Fig. 2). (a-b) Maximum age of the deposits (solid) and previous bed level elevations (lines). (c-d) Sediment types within the stratigraphy of the shoal based on ecotopes (lines) and fieldwork cores (vertical lines).

Model with mud

- Mud deposits in the east of the shoal similar to the data
- Mud deposits start at high elevations on the east of the shoal (Fig. 5)

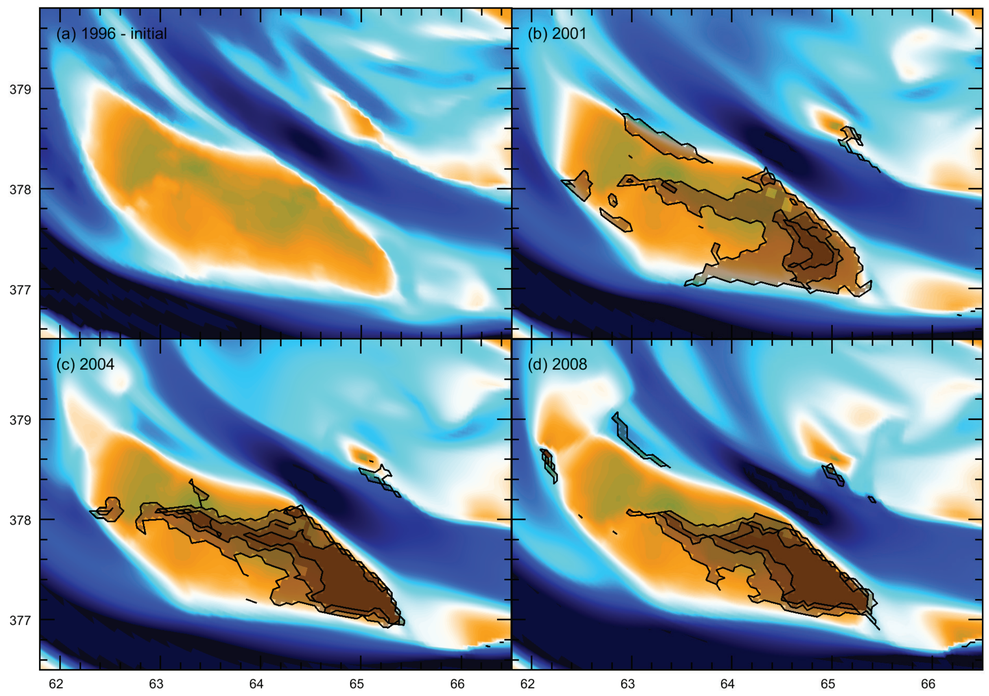


Fig. 5: Modelled mudflats (brown) in morphodynamic model. Mud deposits are somewhat variable in a tidal cycle.

Compared to estuary-scale mud distribution (Dinoloket)

- Mud layers and thicker and more abundant towards the flanks of the estuary and at the surface
- Only one core on Walsoorden in Dinoloket

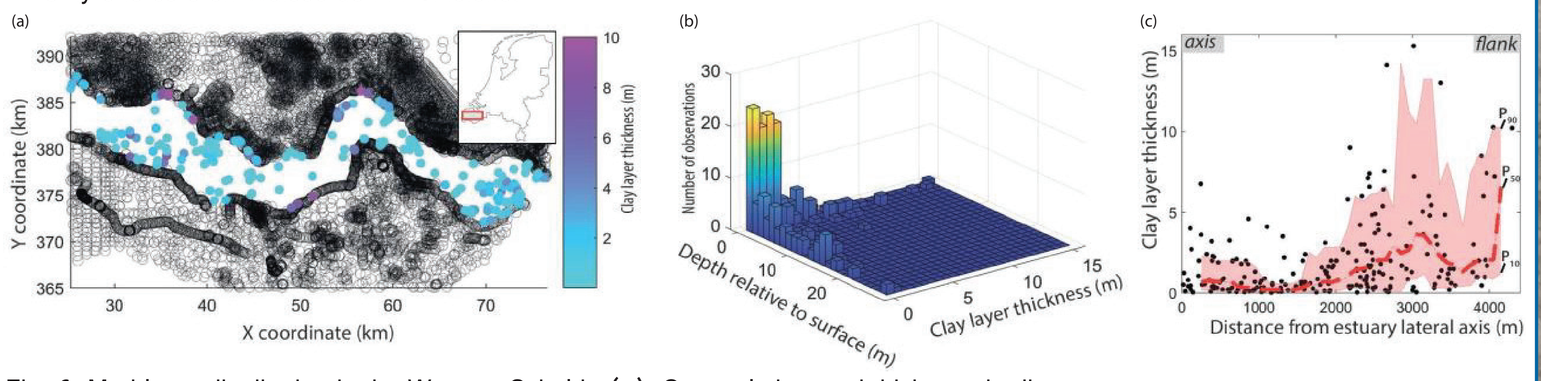


Fig. 6: Mud layer distribution in the Western Scheldt. (a) Cummulative mud thickness in dino cores. (b) 3D histogram of mud depth and thickness. (c) Mud layer thickness accross the estuary.

Conclusions

- The model and field data both show dominant deposition in the East
- Mud deposition starts at the highest areas of the shoal
- Only a limited amount of mud at the surface is preserved in deeper layers
  - large-scale dino cores rarely indicate buried mud layers
  - own detailed cores show thin mud layers below the surface
- Mud seems only to be buried during extreme events (work in progress)

Future work: couple mud layers in the modelled stratigraphy to the environmental conditions under which is was deposited and buried.

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