Long-term numerical biomorphological modeling of estuaries: dynamic vegetation model

Muriel Brückner[P], Ivar Lokhorst, Sanja Selakovic, Mijke van Oorschot, Lisanne Braat, Bente de Vries & Maarten G. Kleinhans

Utrecht University, Faculty of Geosciences, Department of Physical Geography, Utrecht, The Netherlands. P) Presenting author, m.z.m.bruckner@uu.nl

Universiteit Utrecht

Faculty of Geosciences
Research group
River and delta morphodynamics

Muriel Brückner

Eco-engineering determines the evolution of estuaries

The long-term evolution of estuaries is determined by the interaction of a large number of processes, including a wide range of biomorphological processes. The distribution of plants and their growth as well as inclusion of mud alter the river pattern (Kleinhans, 2010; Oorschot et al., 2015). The interactive loop between flow pattern, geomorphodynamics and species growth and mortality is complex and not yet fully understood.

Research questions

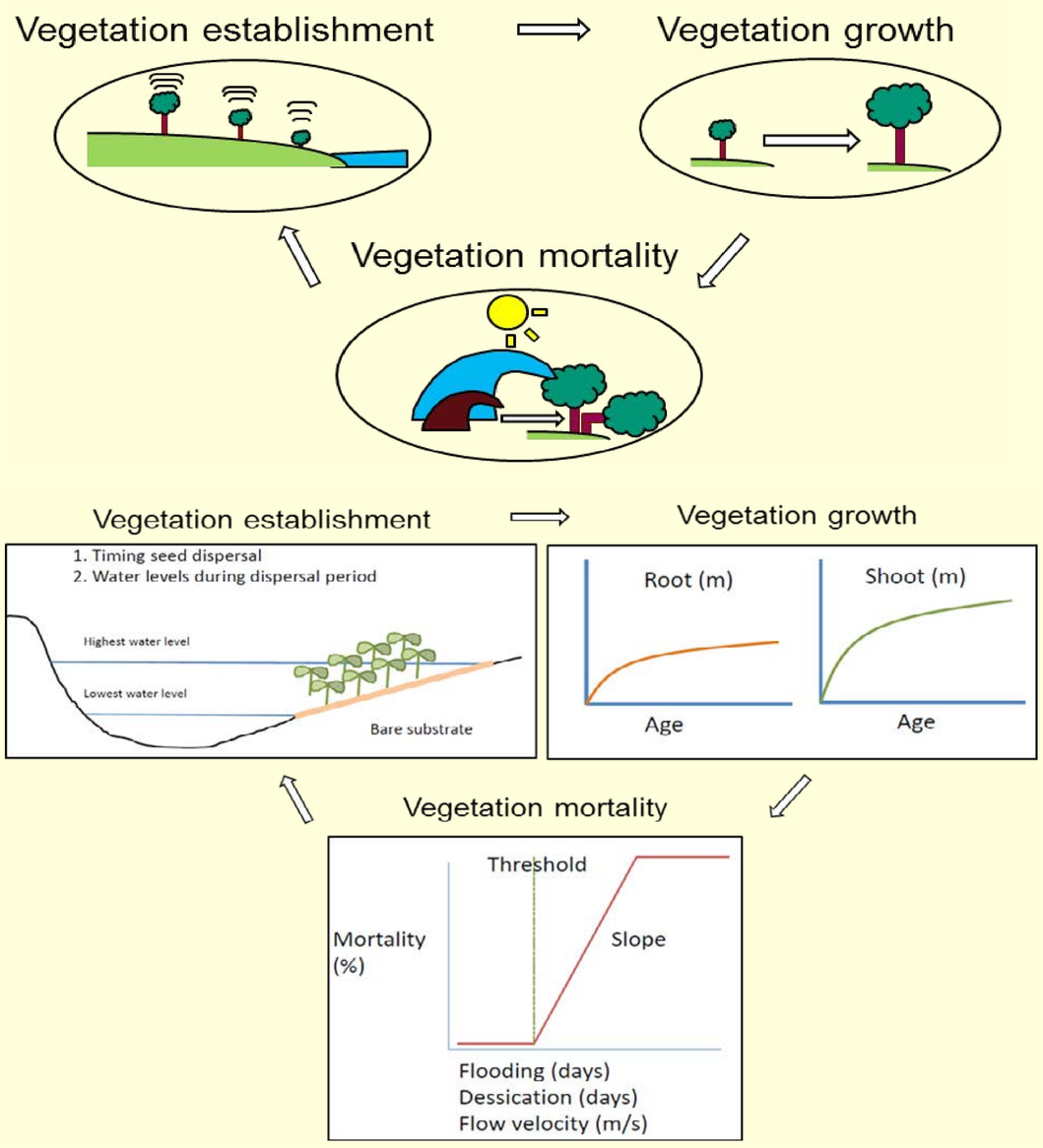
With the help of a numerical model of a Dutch estuary, we would like to answer:

(1) How do eco-engineers influence the large-scale development of estuaries in north-western Europe?

(2) How do the species-specific mortality and growth patterns affect morphology?

(3) How important is bioturbation for geomorphological development?

Dynamic vegetation model in combination with Delft3D

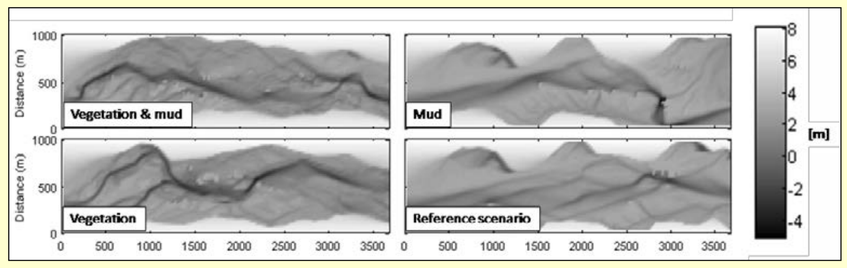


- The vegetation establishes on wet cells between high and low water levels at specific time of the year which assumes seed transport by the water flow.
- For plant growth both shoot and root size follow logarithmic growth over the years.
- During the morphological calculations vegetation can die from disturbances, whereby long flooding, high velocities or dry periods as well as sedimentation and erosion processes cause mortality.
- This way, plant specific traits can be included into a morphodynamic model in Delft3D.

What we did so far:

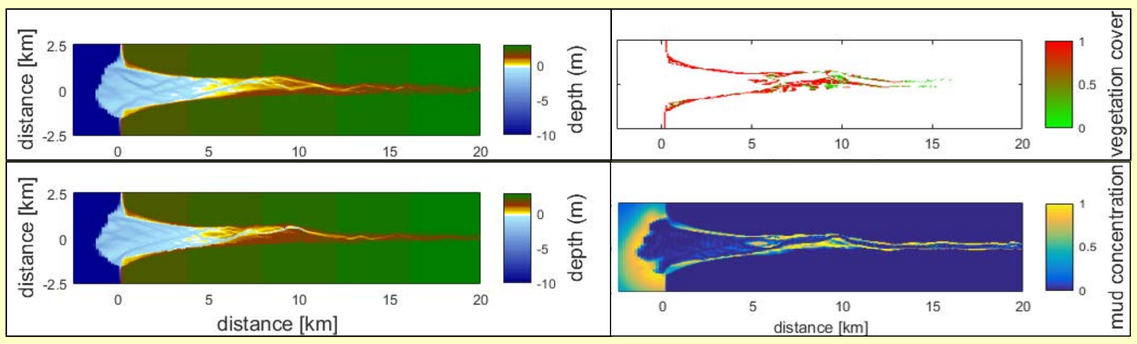
Step 1 - Exploratory model of the Allier river: Freshwater environment with vegetation and mud

- Comparison of changes in bathymetry with willows, poplars, and mud
- Vegetation and mud enhance bank stability
- A more pronounced river channel is visible



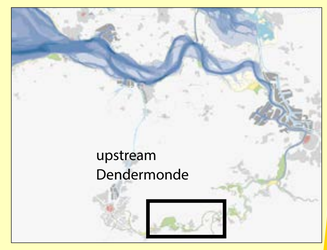
Step 2 - Exploratory estuarine model: Marine environment with vegetation and mud

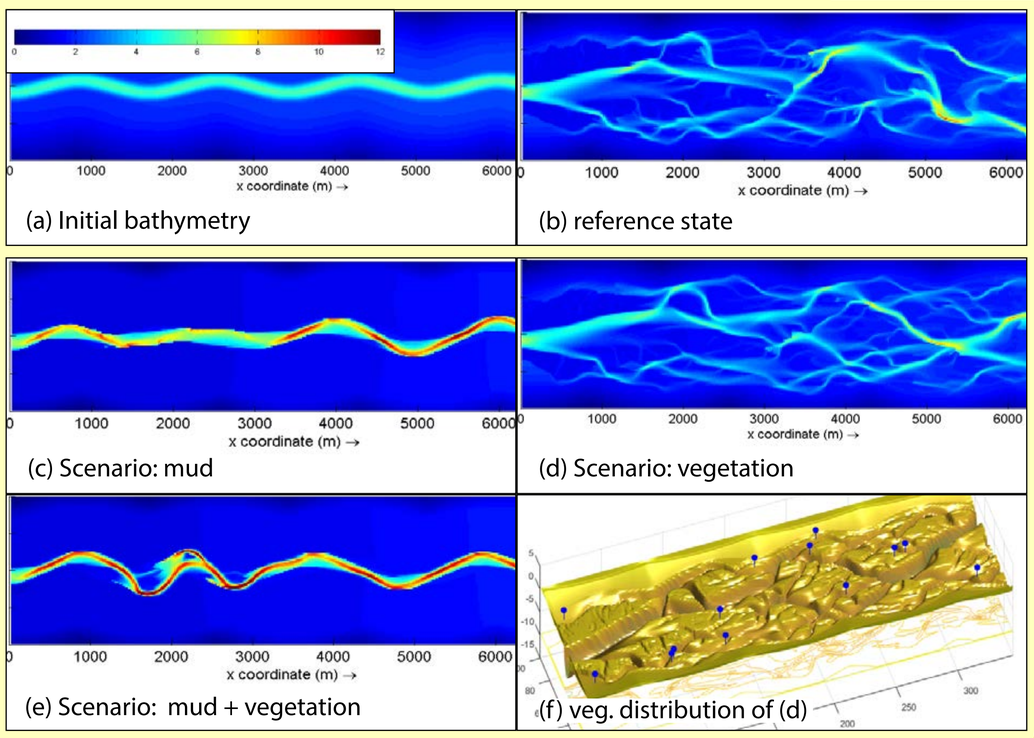
- Comparison of changes in bathymetry with Spartina and mud
- Left: upper picture without vegetation, lower picture with mud and vegetation.
- Enhancement of bank stability through vegetation and mud
- Right: Vegetation cover and mud settlement
- Settlement of vegetation at the banks and enhanced mud settlement through vegetation



Step 3 - Application in NW-Europe: Exploratory model of the Scheldt estuary with vegetation and mud

- First results from the model tested on the idealized freshwater part of the Westerschelde for 45 years morphological time and a constant discharge.
- Different scenarios result in different final bathymetries
- Location of the settlement of willows in the river bed (f)





Next steps

The effect of mud content in combination with vegetation needs to be investigated further with regard to the Westerscheldt estuary as an example.

The effects of bioturbators and their combination with other species and mud interaction needs to be analyzed within further investigations.

What two species are the most relevant for the large-scale morphological development of the Westerschelde estuary, and why do you think so?

Saltwater

Supratidal

Aster

Intertidal

Diatoms

Spartina (+ shells)

Subtidal

Oligochaeta

Freshwater

Aquatic

Algae

Submerged

Reed

Ideas for a species?

?

Riparian

Alnus, Salix, Populus

References: (1) Kleinhans, M. G. (2010). Sorting out river channel patterns. Progress in Physical Geography, 34(3), 287-326. (2) Oorschot, M. V., Kleinhans, M., Geerling, G., & Middelkoop, H. (2015). Distinct patterns of interaction between vegetation and morphodynamics. Earth Surface Processes and Landforms.