



enabling delta life

Deltares

Dynamic Dikes

Quantifying groundwater salinisation processes in the coastal zone

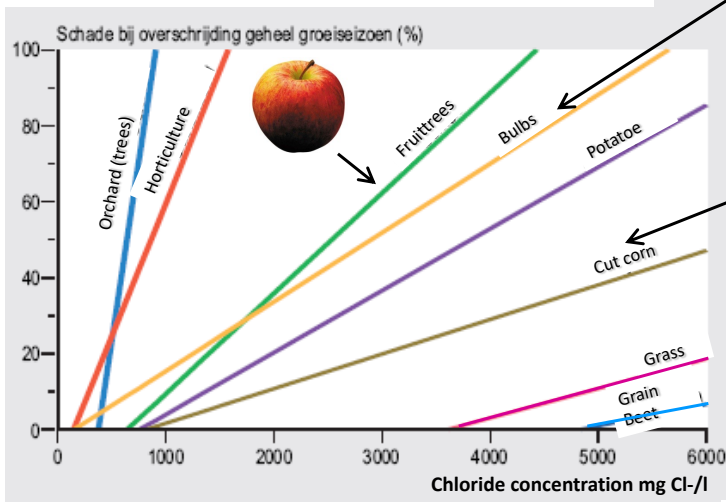
Jude King & Gualbert Oude Essink

19/04/2023

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Salt damage to crops

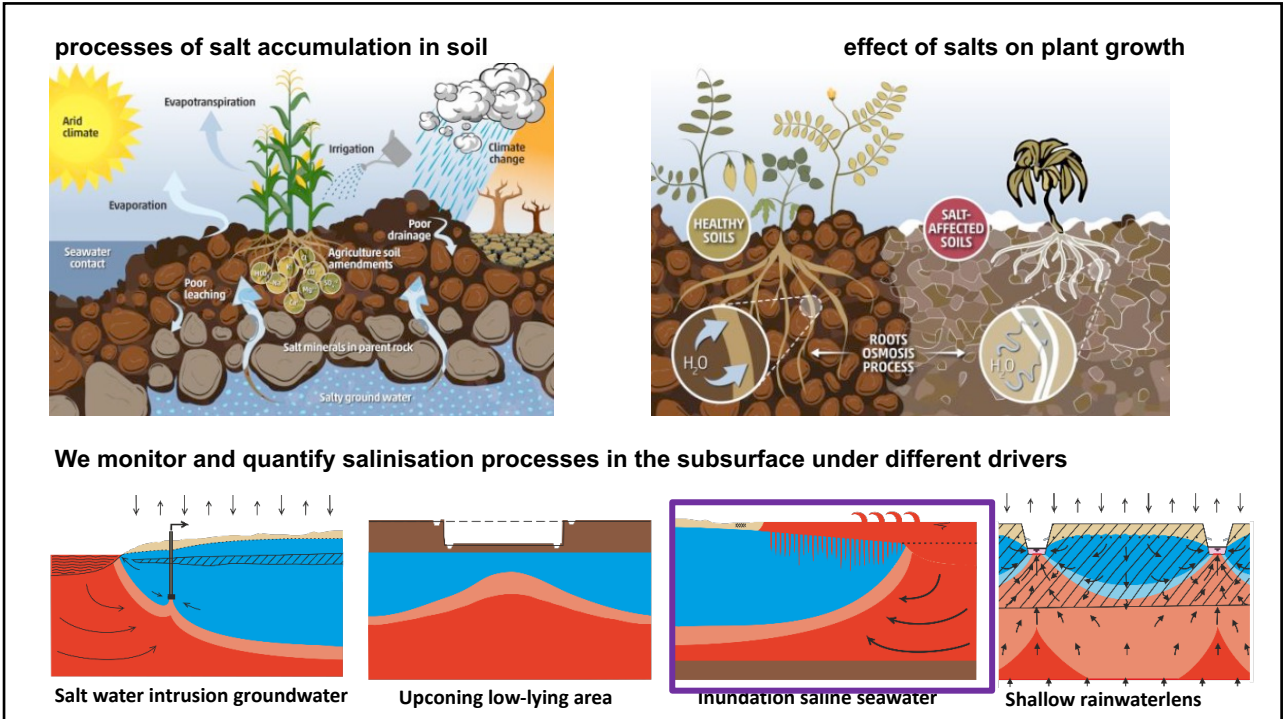
Relation between salt concentration and damage to crops



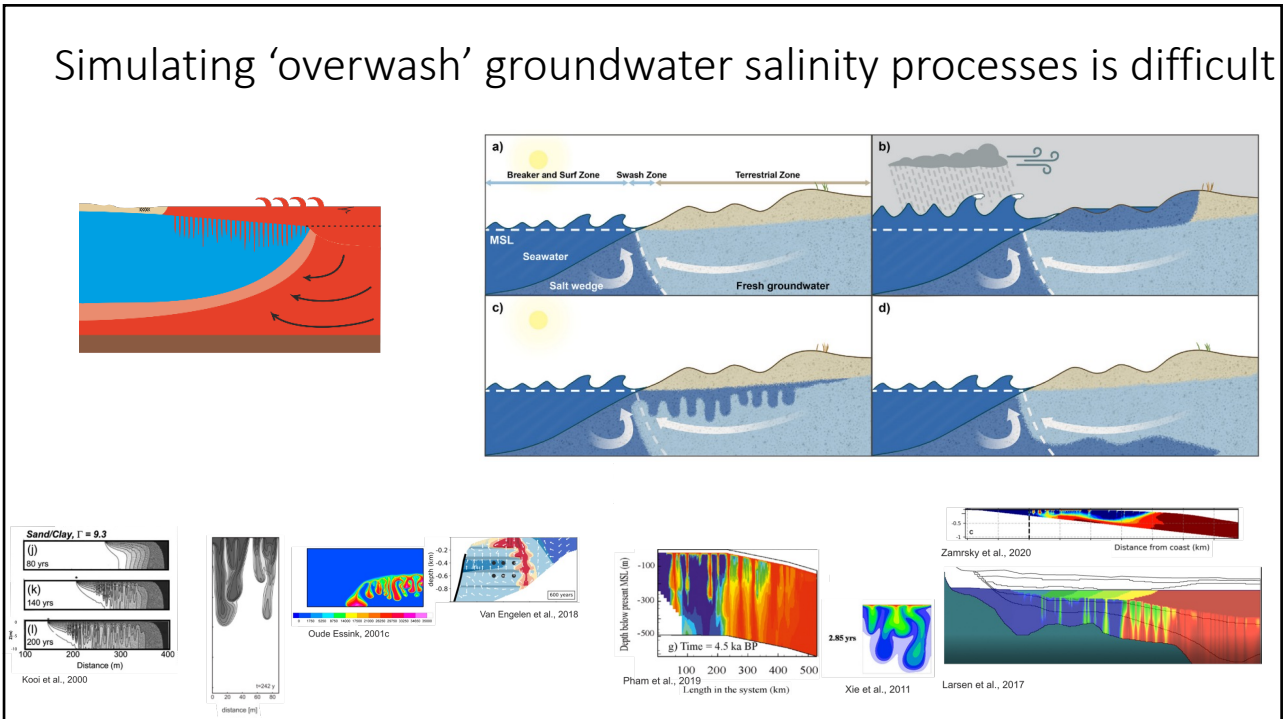
Source: MNP, 2005



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Simulating effects on groundwater salinity

Simulating effects on groundwater salinity using available models

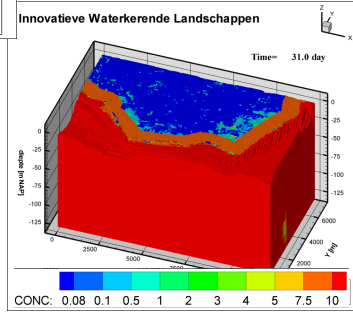
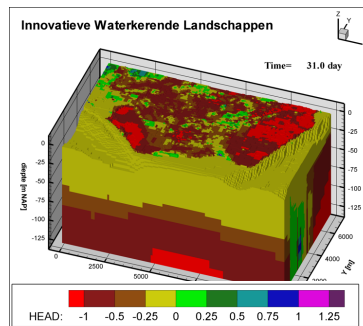
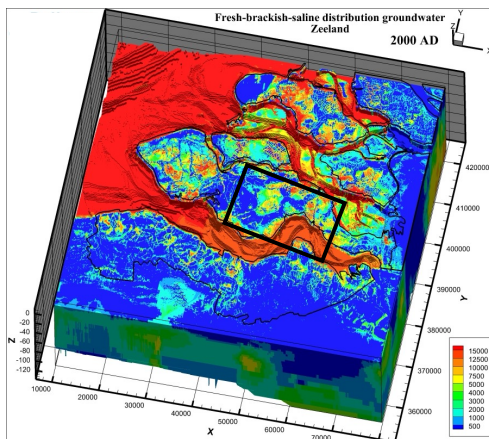
- Two possible approaches:
 1. Use simplified conceptual 2D sections
 2. Edit existing 3D models to simulate interdike scenarios
- **Approach #2** was chosen given the availability of latest 3-D Zeeland model
- Realistic synthetic modelling



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Simulating effects on groundwater salinity

Latest 3-D Zeeland model

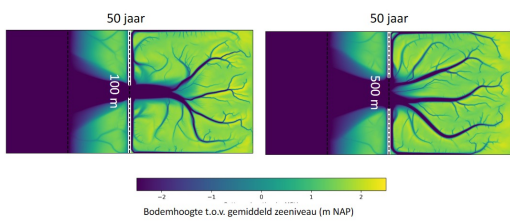


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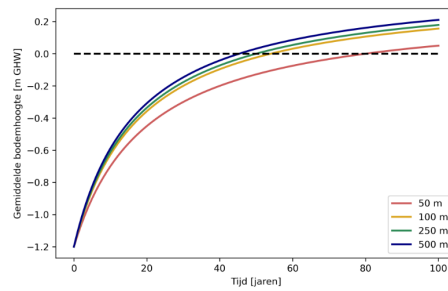
Simulating effects on groundwater salinity

How do we use this data to investigate freshwater lens growth / parameterise our existing models?

Voorbeeld verschillende grootte doorlaat openingen



Grootte doorlaat op bodemophoging

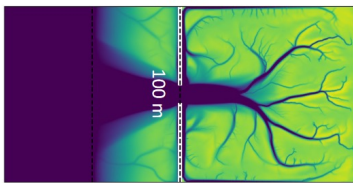


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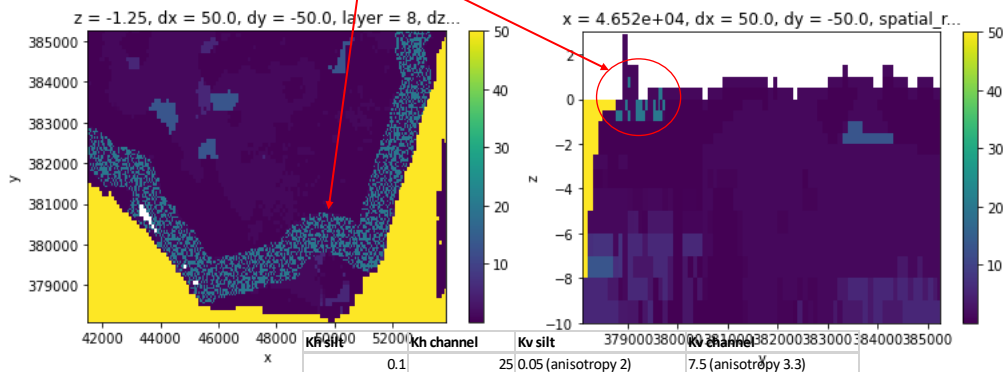
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Model Parameterisation

50 jaar



- Randomly generated "tidal channels"
- Hydraulic properties based on known model properties
- Changed in top 3m, as per NIOZ predictions



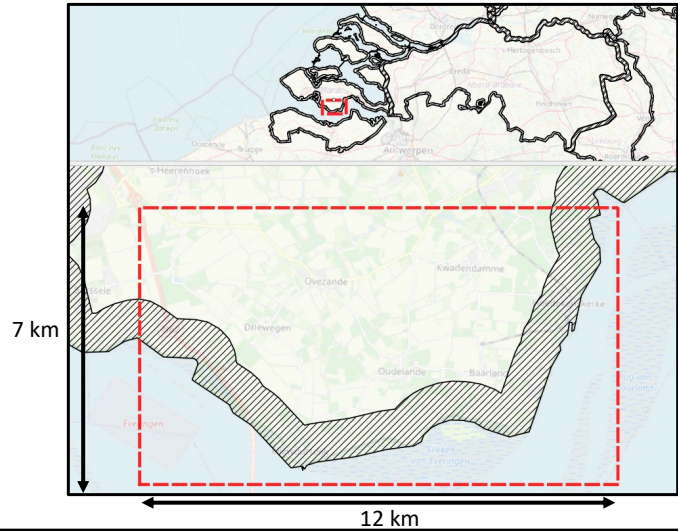
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Simulating effects on groundwater salinity

Model concept

Clipped data from 100 x 100m Zeeland fresh-salt model, refined to 50 x 50m

- Western Scheldt area used as proxy for realistic model.
- Interdike area given approximate features of brackish water inundation and channels/silting.

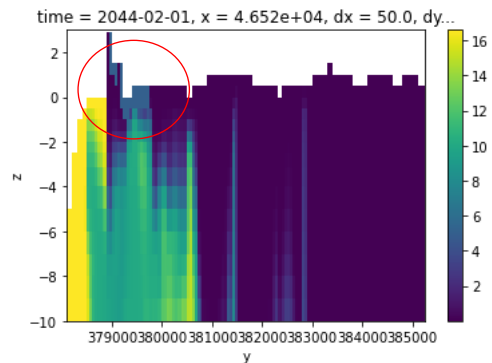
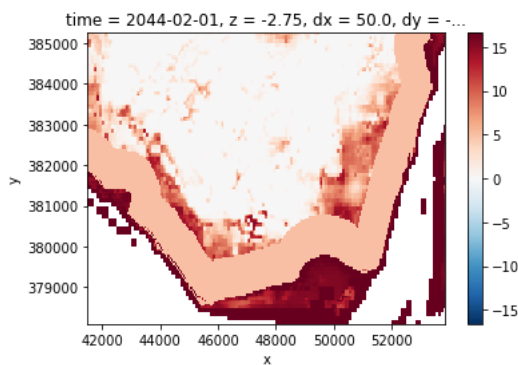


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Model Parameterisation

Adding brackish water inundation

10 g/l brackish water added to top 3m



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Model Scenarios

Four main scenarios tested

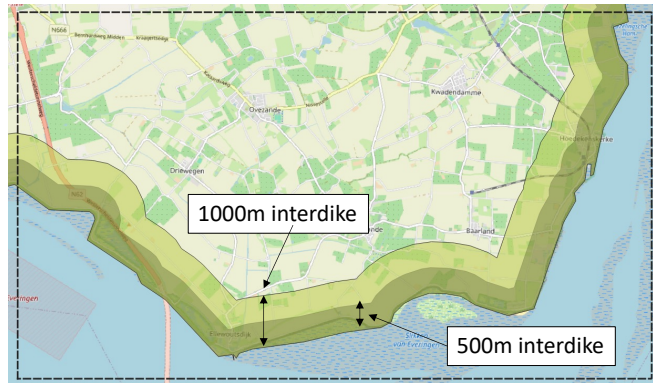
1. 1000m interdiike
2. 500m interdiike
3. 1000m interdiike without drains
4. 1000m interdiike without rivers

Additionally, sensitivity analysis:

- a. Brackish inundation thickness (1, 2 & 5m)
- b. Hydraulic properties (high conductivity and low conductivity)

All results tested against a reference case (no interdiike).

All models run for 100 years.



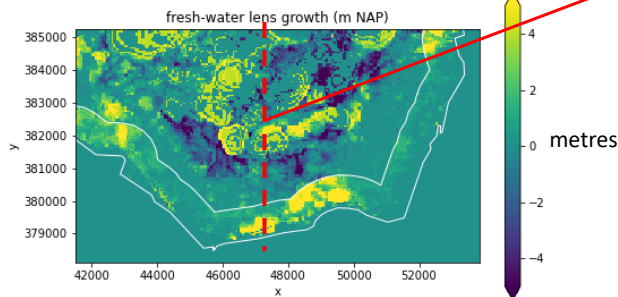
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Results

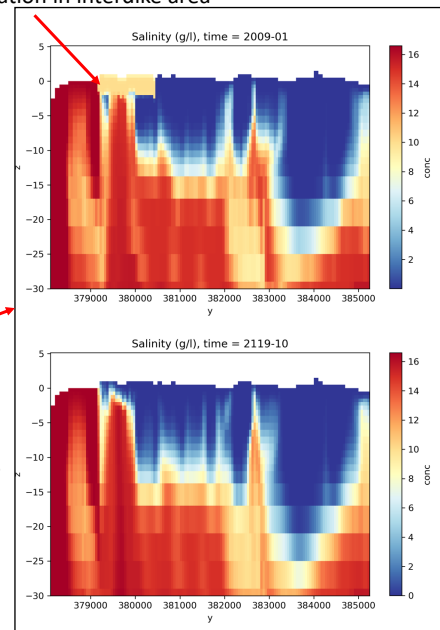
Sensitivity analysis showed no significant levels of uncertainty.

Results from 1000m interdiike model (story does not change significantly with 500m interdiike).

100 year change



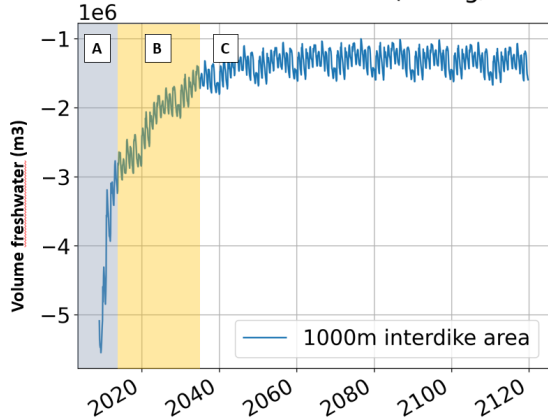
Brackish inundation in interdiike area



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Results

Freshwater volume over time (<1.5g/l chloride)



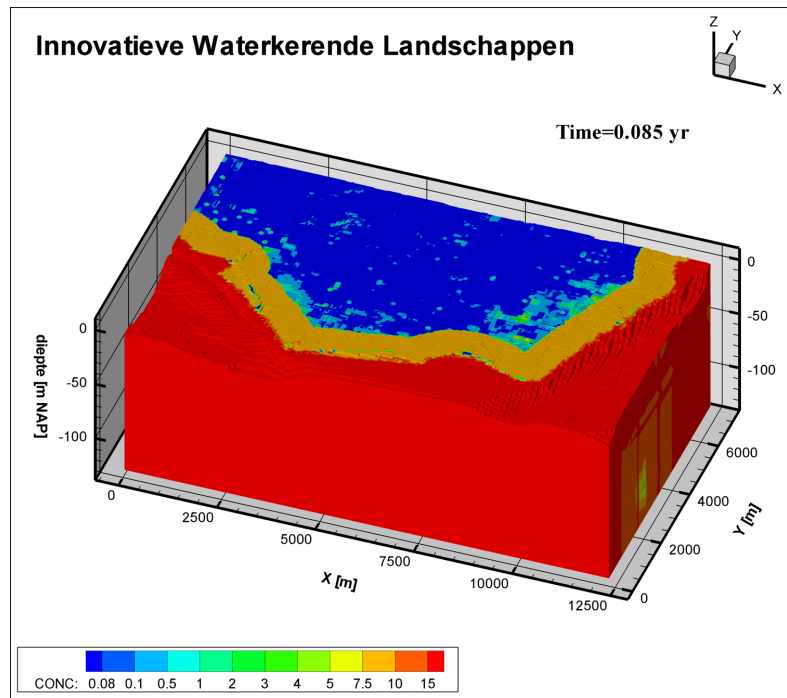
- A. Rapid freshening of interdiike area within first few years.
- B. Slower period of recovery for 20yrs
- C. State of equilibrium

Volume freshwater change over time

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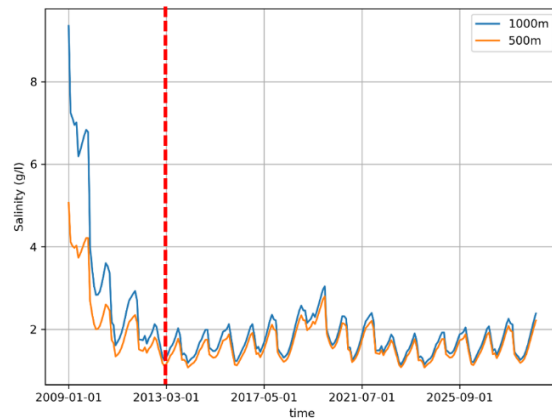
Results, 8.3 yrs

blue-green areas are okay for grass land – crops like beats



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Results



Average salinity (g/l) in top 1m for both 1000 and 500m interdiike scenarios

- Change in salinity in top 1m approximate changes within the root zone
- Rapid freshening for four years
- Equilibrium thereafter at $\sim 1.5\text{g/l} - 2\text{g/l}$ chloride (seasonal)

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Conclusions

- A dynamic dike system causes brackish water inundation, probably within top 3m (more detailed modelling needed to understand fully).
- System recovers rapidly with first few years.
- Slower but consistent freshening for another 20 years, followed by equilibrium.
- More detailed modelling required to understand exact effects of dynamic dikes, like exact thickness of brackish inundation – but a good overview of effects

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