Mud transport and morphology in the Wadden Sea

Thijs van Kessel, Peter Herman, Bob Smits, Julia Vroom, Roy van Weerdenburg (Deltares)
Bente de Vries, Petra Dankers (Royal HaskoningDHV)
Jelmer Cleveringa (Arcadis)

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Scales and feedbacks

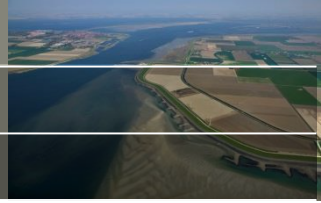
Tidal inlets - Tidal basins - Tidal flats

Sand: - local and present conditions determine transport
- morphological feedback on hydrodynamics and transport
- memory in bathymetry

Mud: - conditions in large area over some time determine transport
- availability feedback on concentration and transport
- memory in spatial mud distribution

Focus on recent work and future challenges

Questions in ongoing WFD mud project

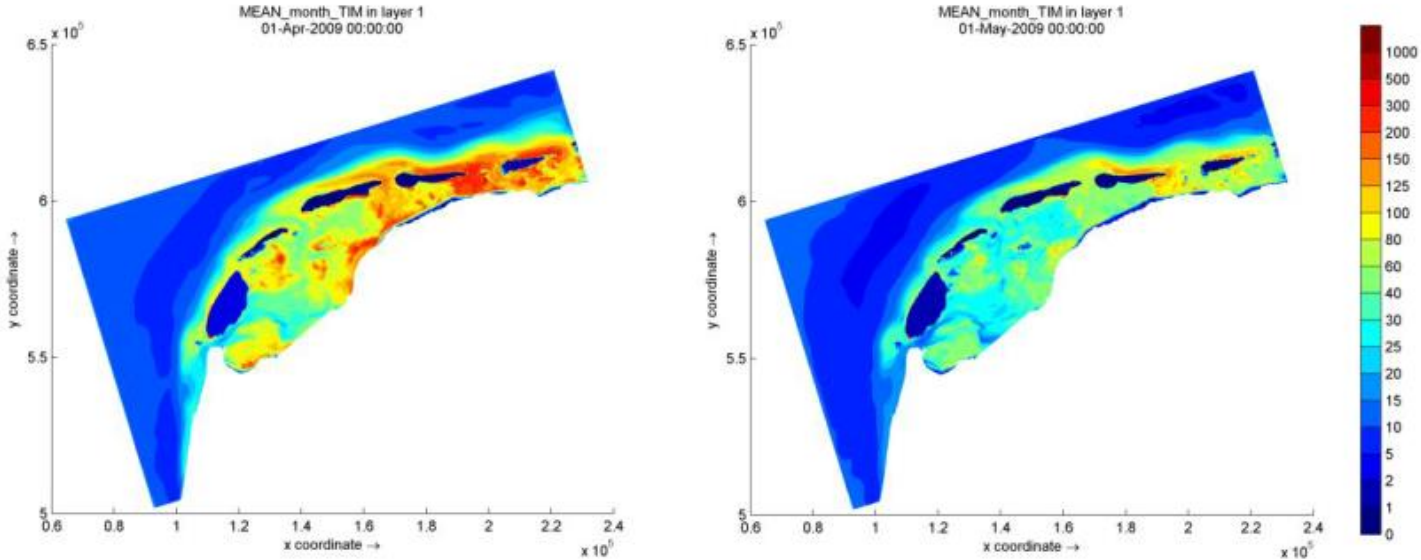


- What are the driving factors for SPM dynamics and mud content?
- On which time scale do concentration levels vary in the water column and in the bed?
- What is the link with morphological evolution?

- Management perspective:
  - Implications for maintenance dredging?
  - Ecological impacts?
  - Adaptation to sea level rise?

Computed monthly-average SPM levels

Source: PACE-model



> 100 MT/year exchange, few MT/year net deposition

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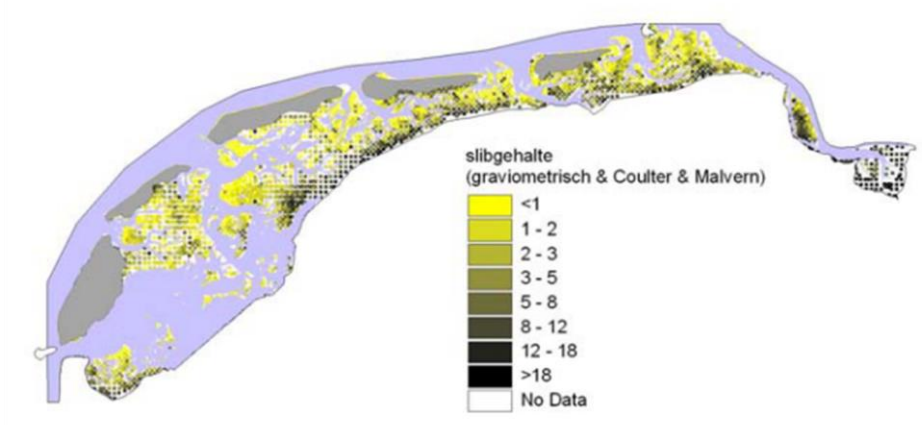
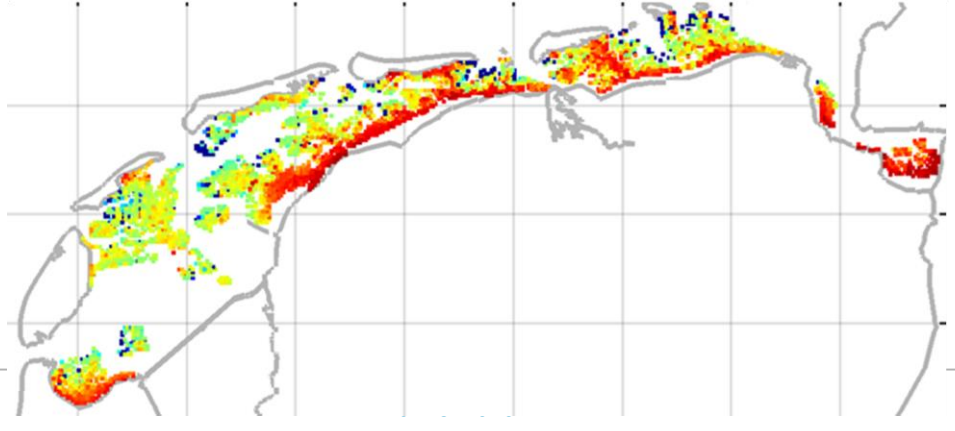
Observed mud content in the bed



Zwarts, 2004



SIBES, 2008-2013
(Van der Veer, NIOZ)

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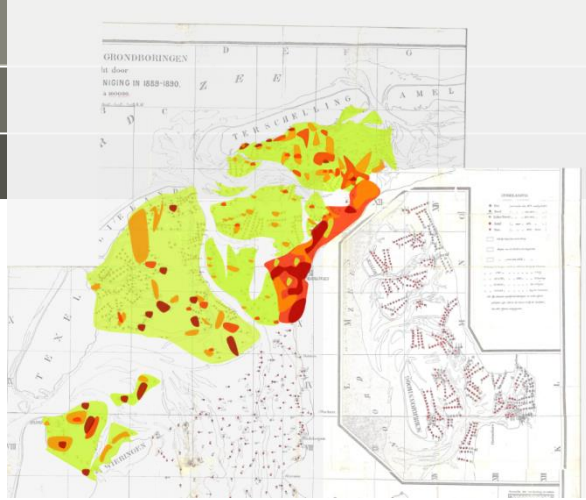
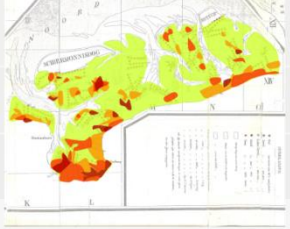
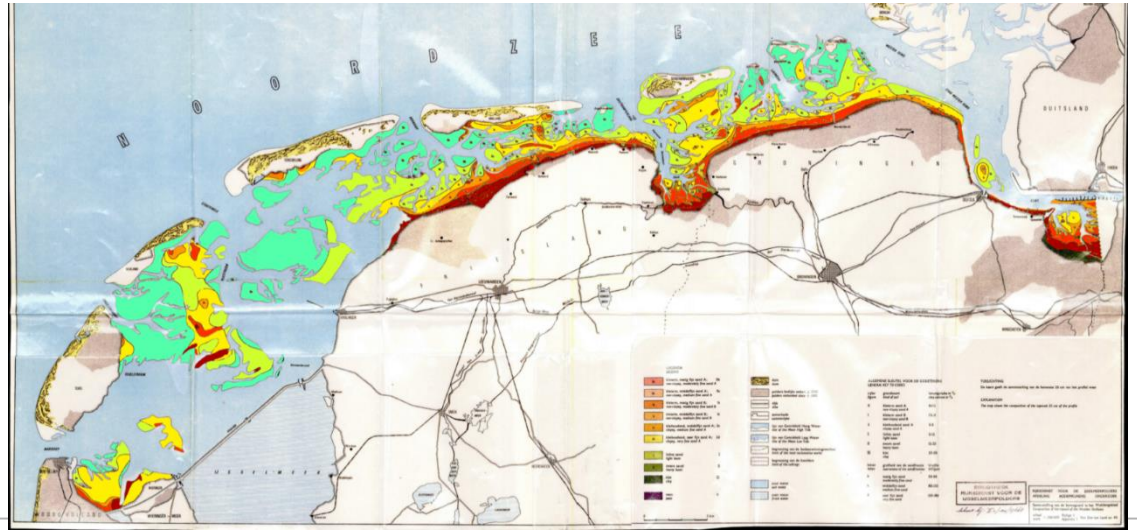
Some history





Lely, 1892



De Glopper, 1967

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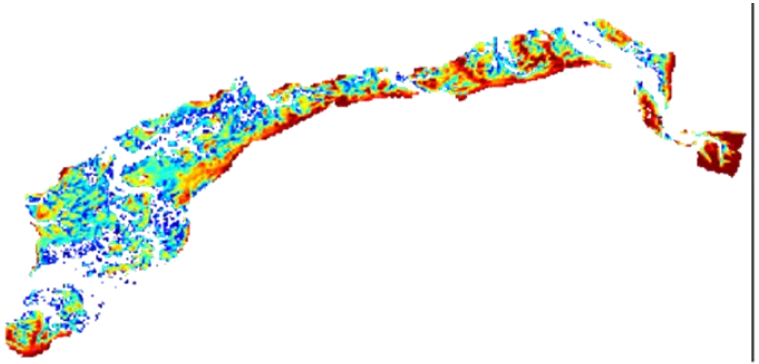
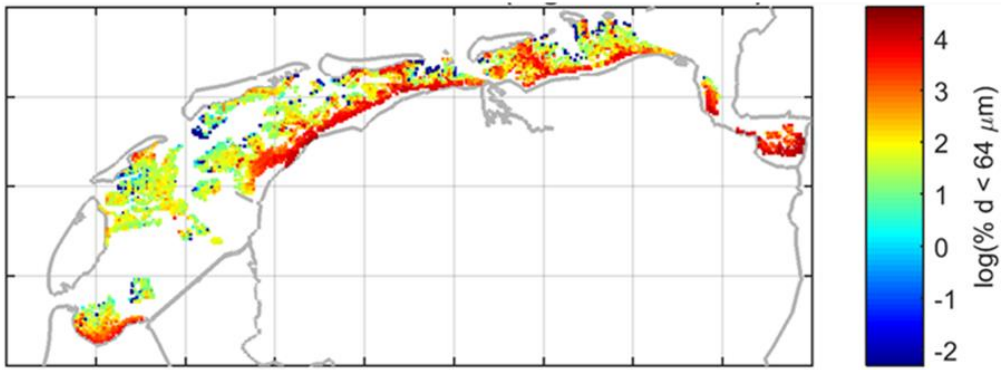
Link with microphytobenthos



NDVI
vdWal et al., 2010

Index mfb



SIBES
mud content
(Van der Veer, NIOZ)

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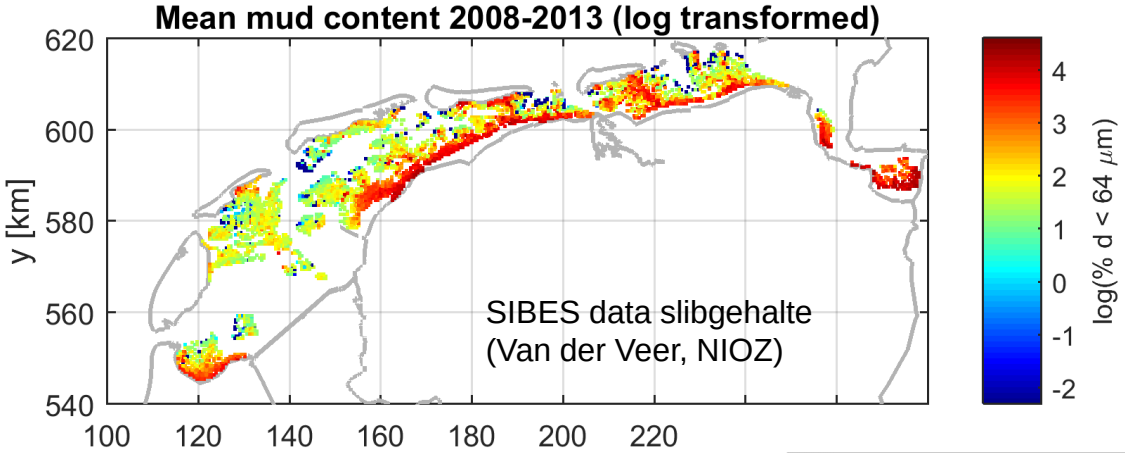
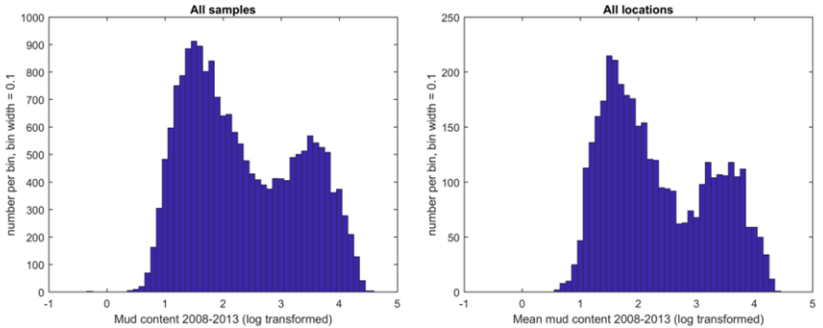
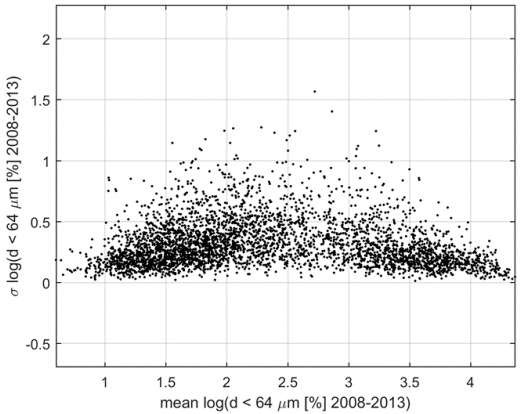
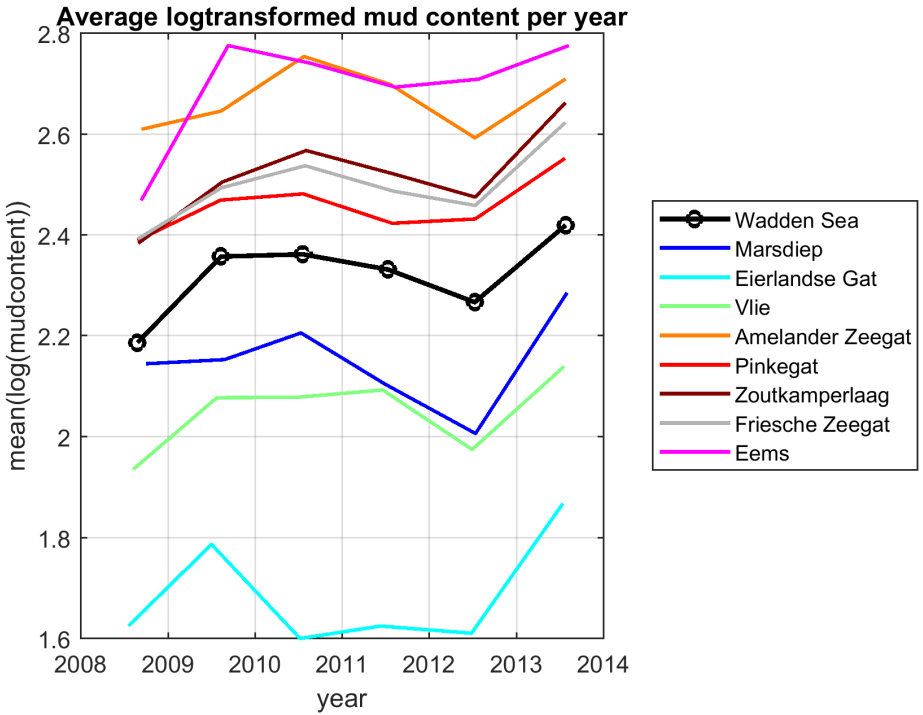
Bimodal distribution of mud content







Inter-annual variation (SIBES): coherent



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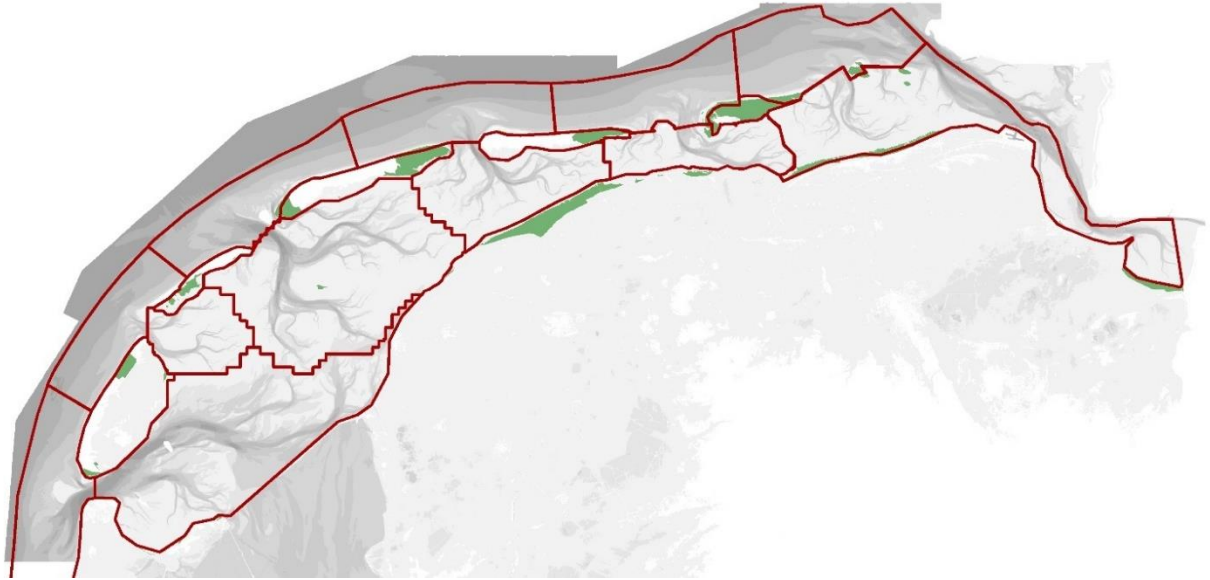
Effect on volume balance

0.4-1.2 10^6 m^3/year mud trapping in salt marshes

0.7-3.4 10^6 m^3/year mud in Wadden Sea (Oost, 2018)



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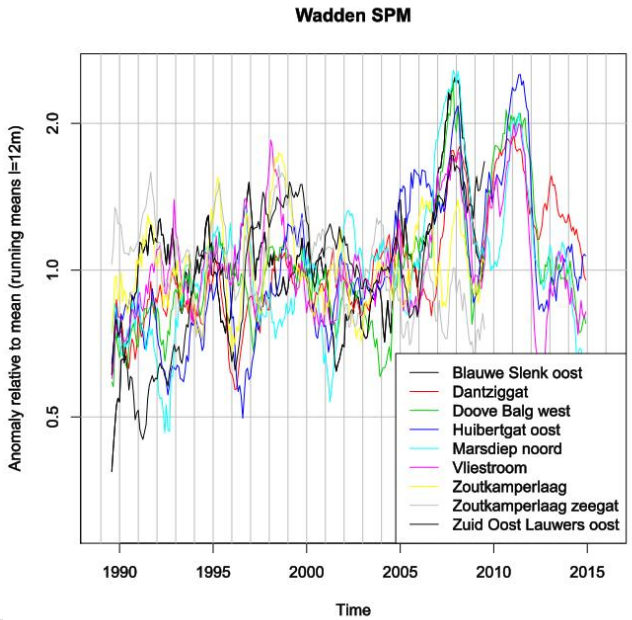
Long-term SPM dynamics

More or less synchronous, long term variations in SPM

-> suggest some form of temporal and spatial autocorrelation

-> mechanism?



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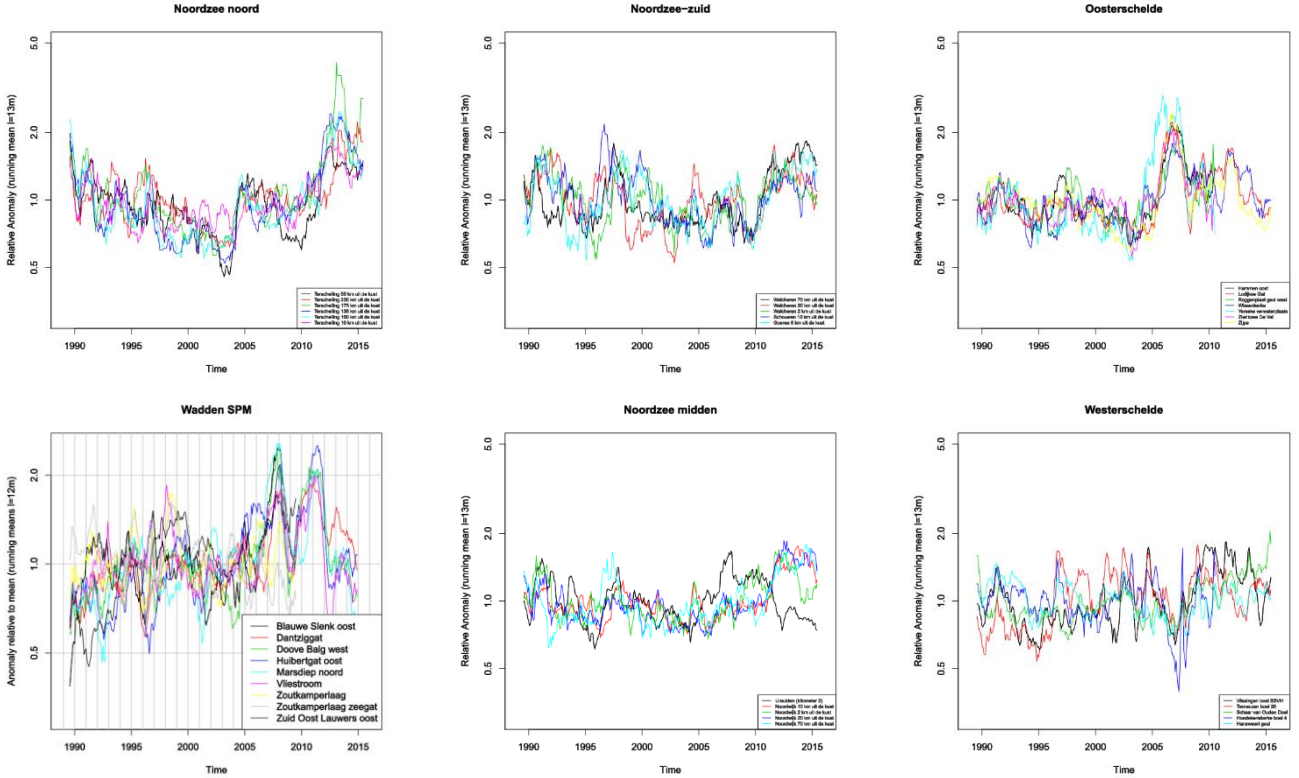
Coherence within but not among systems



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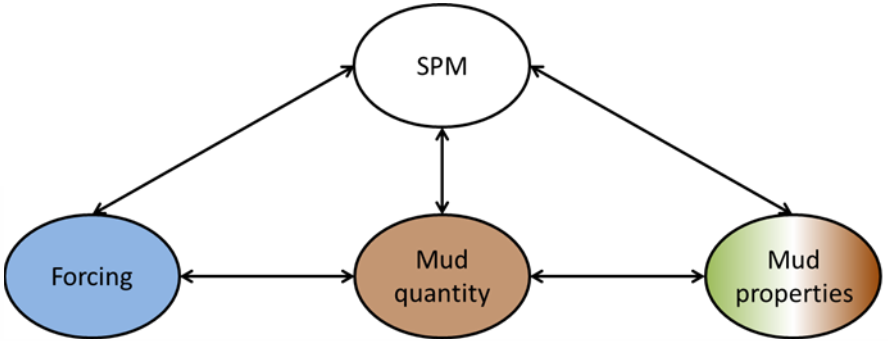
Conceptual model



Non-equilibrium transport:

- At most times and places: supply limitations
- At some times and places: deposition limitations
- Importance of source and sink terms

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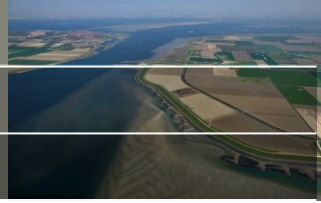
Link mud-morphology

- Effect on sediment budget
  - Salt marshes >20 % sand
  - Mudflats = sand trap, but sand flats also contain mud
  - Mud ~20% of sedimentation volume (most in intertidal zone)
- Effect of salt marsh extension works
  - Koehoal: without ‘support’ no growth
  - Feedback salt marsh – tidal prism – depth – waves – accretion
  - Link with siltation in navigation channels
- Effect on erodibility and permeability
- Shift in chain supply – transport capacity – demand

Management perspective



- Link maintenance dredging – salt marsh extension – dams: can we increase tidal prism on a local/regional scale?
- Limited storage capacity of mud flats -> should we remove dredged mud from system?
- Control on SPM levels?
  - What drives link between SPM and mud content in bed?
  - Is supply (source) or storage capacity (sink) limiting?
- Scenarios for SLR: stability of salt marshes, contribution to import, coastline stability: role of mud?