Building with Nature in Wadden Sea Ports

Sediment Management in Ports, Eemshaven, October 29th 2019

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EcoShape
building with nature

EcoShape Building with Nature Programme

- **EcoShape** is a Dutch consortium of private parties, government organisations, research institutes, universities and NGOs founded in 2008.
- They carry out the **Building with Nature** (BwN) innovation programme to test and develop a new design philosophy in hydraulic engineering that utilizes the forces of nature, thereby strengthening nature, economy and society.
- One of the cases within the BwN Programme concerns the **Wadden Sea Ports** and is carried out in co-operation with the Programme Towards a Rich Wadden Sea and the Dutch Programme Wadden Sea Ports since 2012.
- Visit https://www.ecoshape.org/en/

Smart design for sustainable port development

Dutch Wadden Sea Ports

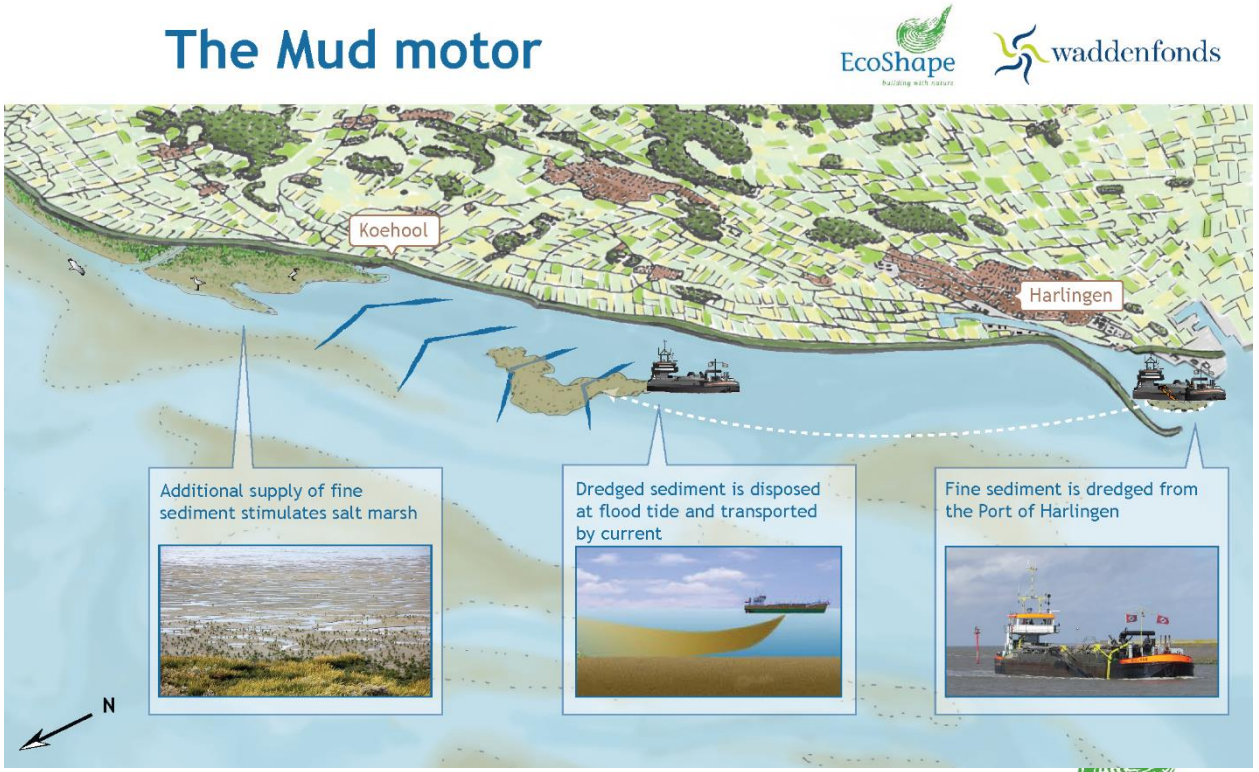
How did the Harlingen project start?

1. Large maintenance dredging volumes in the Port of Harlingen (~1,2 million m^3/y).
2. Close-by dredge disposal locations, possibly leading to high return flow of sediment into port.
3. Local nature organisation desired expansion of salt marshes.

1+2+3 gave the idea to bring dredged sediment to salt marshes.

Case study Port of Harlingen

A ‘mud motor’ was tested to promote the growth of salt marshes acting as sediment sink.



Outline

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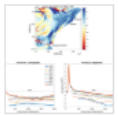
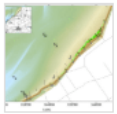
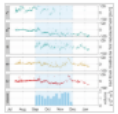
Figures (7)





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Beneficial use of dredged sediment to enhance salt marsh development by applying a 'Mud Motor'

Martin J. Baptist [a], T. Gerkema [b], B.C. van Prooijen [c], D.S. van Maren [c, d], M. van Regteren [a], K. Schulz [b], I. Colosimo [c], J. Vroom [d], T. van Kessel [d], B. Grasmeijer [d], P. Willemsen [b, d, h], K. Elschot [a], A.V. de Groot [a], J. Cleveringa [e], E.M.M. van Eekelen [f], F. Schuurman [g], H.J. de Lange [a], M.E.B. van Puijenbroek [a]

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https://doi.org/10.1016/j.ecoleng.2018.11.019

Highlights

- Salt marsh sediment dynamics increases with a well-designed Mud Motor.
- Small salinity gradients can significantly affect mud transport fluxes.
- The success of a Mud Motor is highly dependent on wind and wave forcing.

https://www.ecoshape.org/en/themes/sustainable-harbour-development/#/en/projects/mud-motor/

Reports

Beneficial use of dredged sediment to enhance salt marsh development by applying a 'Mud Motor': evaluation based on monitoring

M. Baptist et al./2019

Transport of Mud Motor sediment - Modelling hydrodynamics and sediment transport

B. van Maren et al./2019

Building with Nature Guideline

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Building with Nature Guideline > Projects > Mud Motor port of Harlingen – Koehoal - NL

Mud Motor port of Harlingen – Koehoal - NL

Title: Mud Motor Port of Harlingen, (Koehoal)
Location: Port of Harlingen, Wadden Sea (NL)
Date: 2016-2018
Involved parties: Van Oord, Royal Haskoning DHV, Arcadis, It Fryske Gea, Wageningen University, Deltares
Technology Readiness Level:7 (system prototype demonstration in operational environment)
Environments: Estuaries, Ports & Cities
Keywords: salt mash, dredge, flow chart, mud, intertidal areas, port

Building With Nature Design | Traditional Design

EcoShape pilot project

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building with nature

5 Basic steps towards Building with Nature

Lessons learned from the Mud Motor

- Environmental regulations prescribe particular seasons and time slots for the disposal of dredged sediment that is affecting the strategy for mud disposal.
- Longer dredge cycle times and a loss of flexibility in temporal windows for the disposal are putting the contractor under higher strain and this leads to considerable extra costs.
- The feasibility of a Mud Motor depends on an assessment of additional cycle time for the dredger (extra costs), the valuation of salt marsh growth (nature profits), reduced dredging volumes in a port (reduced costs), and many practical issues (depth at the disposal location, time slots, natural dynamics).

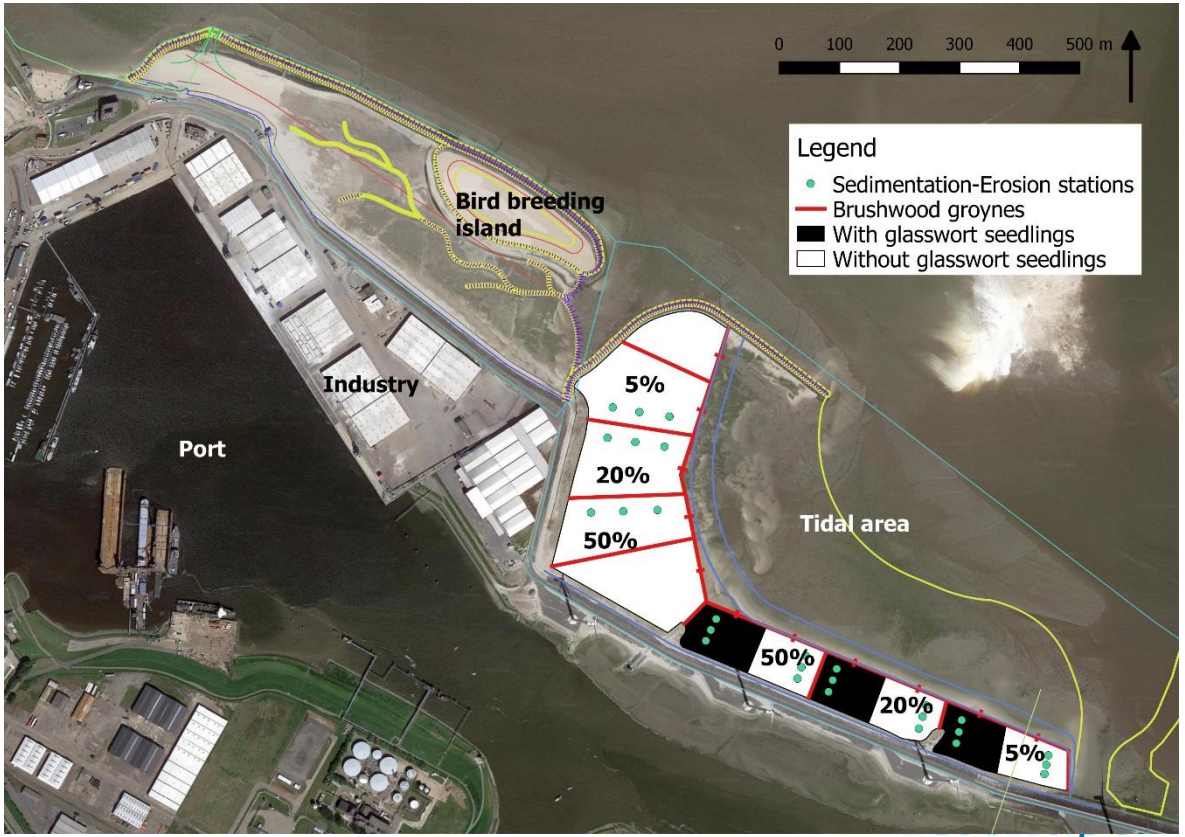
Suitable Mud Motor locations

- Target at salt marshes that are end-stations of sediment transport, for instance at the landside of a bay;
- Particularly bays that have a riverine freshwater outflow, which enhances sediment transport towards the marsh.

Delfzijl Marconi case study

Testing conditions for salt marsh construction

- Salt marsh development is tested in field-scale plots with various clay percentages, and with / without seeding of pioneer plants.



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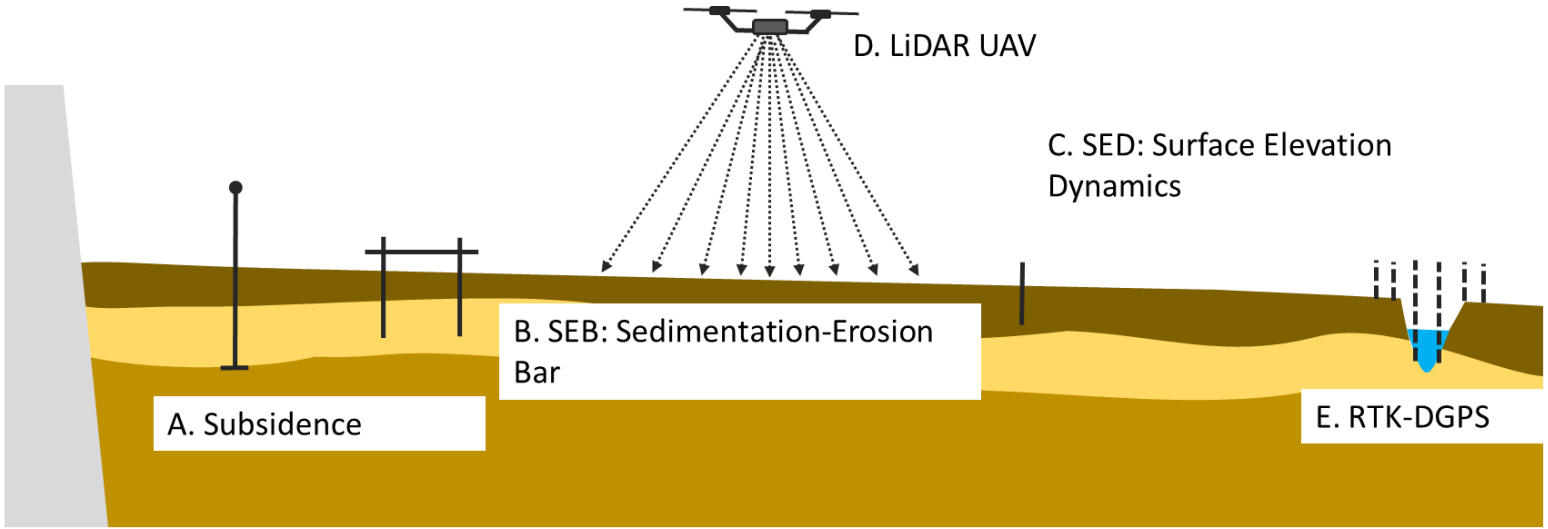
Height measurements



Ongoing work: monitoring

- LiDAR drone (cover), RTK-DGPS measurements (channels).
- Sedimentation-Erosion Bars (27 stations), Acoustic Surface Elevation Dynamics sensors (6 stations).
- Vegetation cover, composition and biomass (147 plots).
- Sediment grainsize composition (27 depth profiles).
- Microphytobenthos cover (27 stations).
- Seed bank in the added clay.