

Muddy waters and the Wadden Sea Harbours

E. van Eekelen, M.J. Baptist, P.J.T. Dankers, B. Grasmeijer,
T. van Kessel and D.S. van Maren.

WODCON XXI, 13-17 June 2016, Miami, Florida, USA



EcoShape

Erik van Eekelen, Programme Manager, EcoShape
Environmental Engineer, Van Oord Dredging and Marine Contractors

building with nature

Introduction

Key message:

Even in a UNESCO listed site such as the Wadden Sea, harbour development is possible when ecosystem services are used and provided for, ie. when a Building with Nature concept is put at the heart of an engineering design.



Building with Nature

'A design process focused on working with natural dynamics while providing ecosystem services as part of designing hydraulic structures.'

BwN : establishing paradigm shift



not this...



but this!



Building in Nature

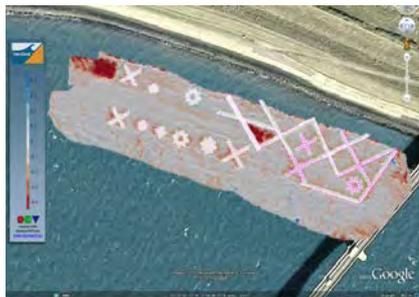


Building of Nature



Building with Nature

BwN I program: some project examples



BwN I results: Design process & range of solutions



Step slopes

Moderate slopes

Flat slopes

1 m - 10 m

Spatial scale

100 m - 1000 m

More information:

De Vriend, H. J.; Van Koningsveld, M.; Aarninkhof, S. G. J.; De Vries, M. B. & Baptist, M. J.

“Sustainable hydraulic engineering through Building with Nature”

Journal of Hydro-environment Research vol. 9 (2015), pp.159-171.

BwN II program: 2013-2020

Another challenging program >38 mln € started by the EcoShape-consortium

Diverse pilot projects and fundamental research programs

From 'show that it works', to 'make it happen'

Sandy solutions: Sand motor Delfland coast

More info: Challenges in developing sustainable sandy strategies, J. van Thiel de Vries et al. – also on WODCON XXI



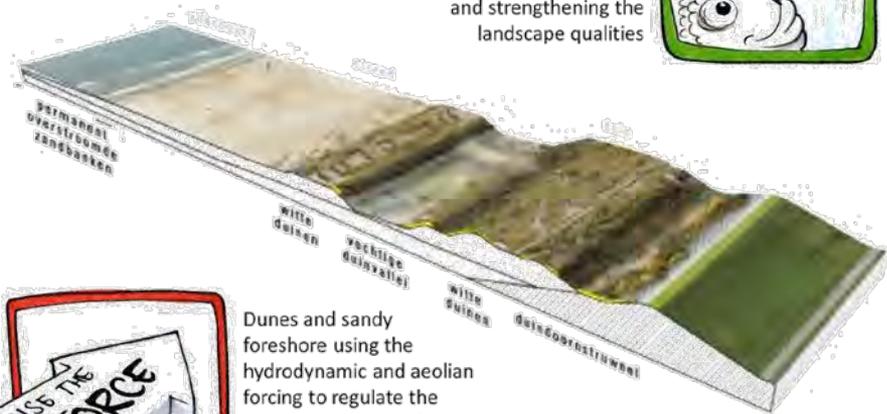
Mangroves Demak



- WODCON XXI, 13-17 June 2013

Sandy solutions: HPZ reinforcement

More info: Challenges in developing sustainable sandy strategies, J. van Thiel de Vries et al. – also on WODCON XXI



Dunes and sandy foreshore providing opportunities for nature development and strengthening the landscape qualities



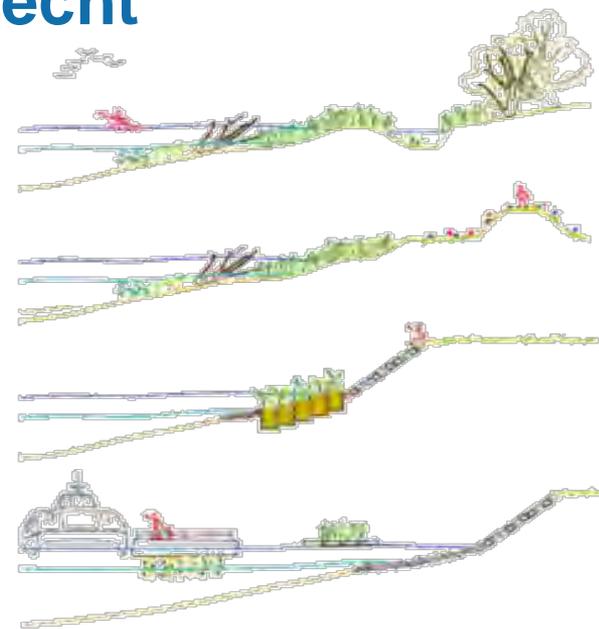
Dunes and sandy foreshore using the hydrodynamic and aeolian forcing to regulate the sediment balance of the shallow coastal zone

building with nature

Project nominated for Environmental Excellence Award!

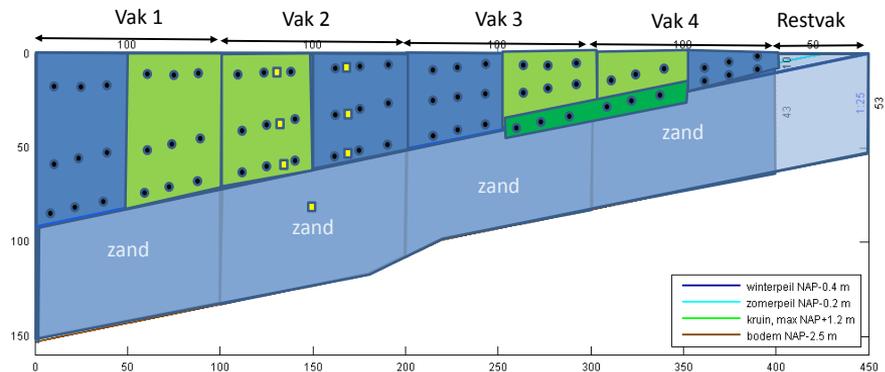
BwN in the city: Rotterdam & Dordrecht

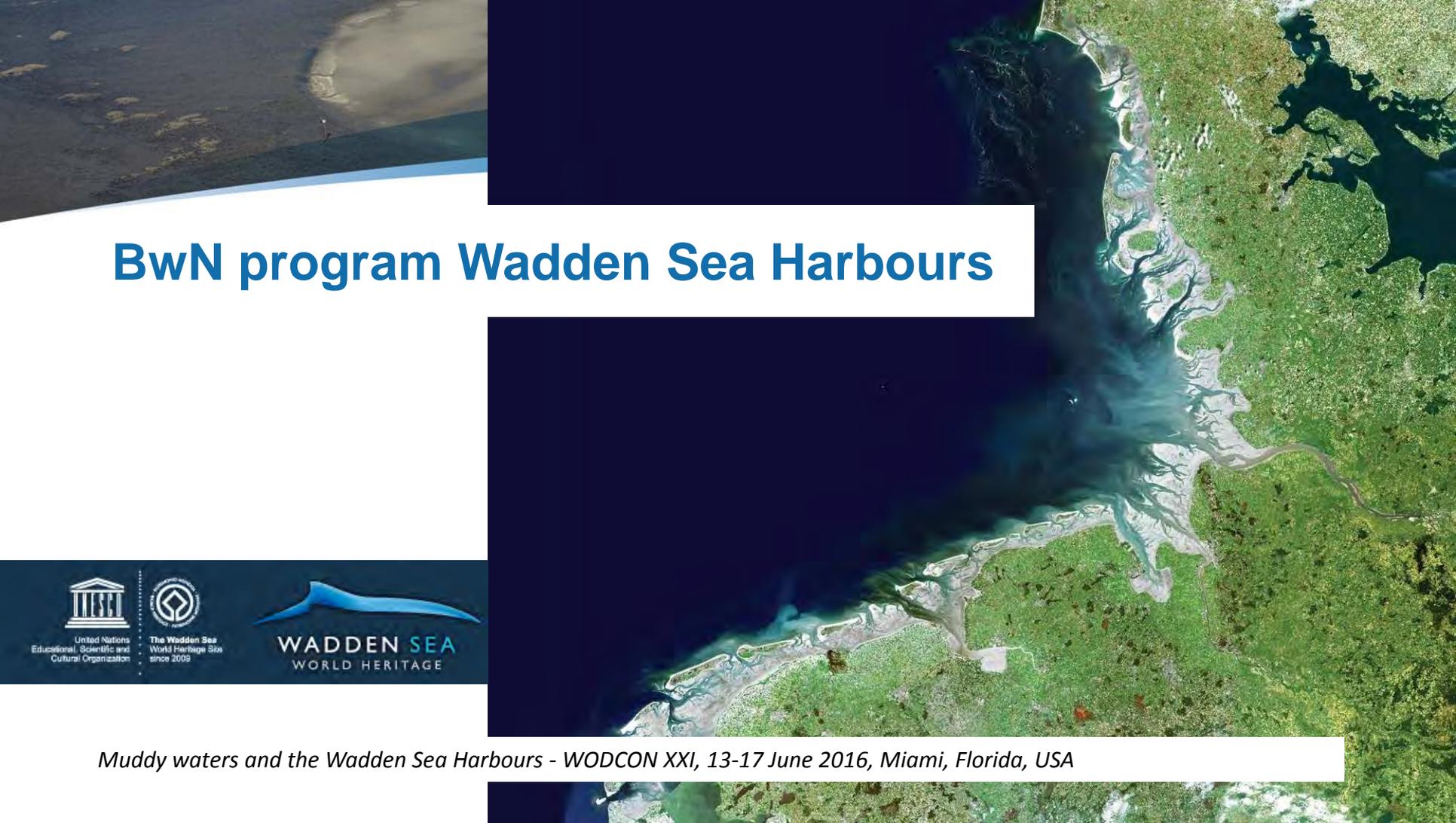
- *‘Stepping stones’ of natural shoreline in the city*
- *Use soft structures and create habitats*
- *Improve quality of life in the city*



Sandy solutions: Pilot Houtribdijk

More info: Challenges in developing sustainable sandy strategies, J. van Thiel de Vries et al. – also on WODCON XXI





BwN program Wadden Sea Harbours



United Nations
Educational, Scientific and
Cultural Organization



The Wadden Sea
World Heritage Site
since 2009



WADDEN SEA
WORLD HERITAGE

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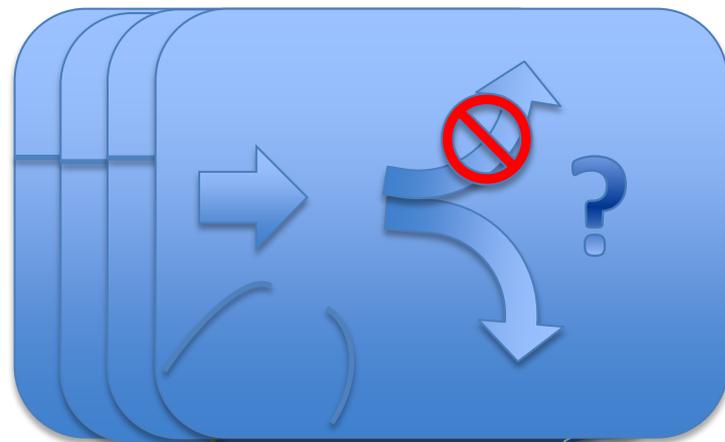
BwN program Wadden Sea Harbours

- *Cooperating Wadden Sea Harbours*
- *Studies BwN concepts relevant to all harbours*
- *'Learning by doing' approach*
- *Status: 3 pilot projects in execution, at least 1 more in development*



BwN program Wadden Sea Harbours - concepts

- *Optimizing dredging strategies*
- *Enhancing salt marsh development*
- *Creating estuarine gradients*
- *Optimizing flow patterns*



BwN program Wadden Sea Harbours - projects

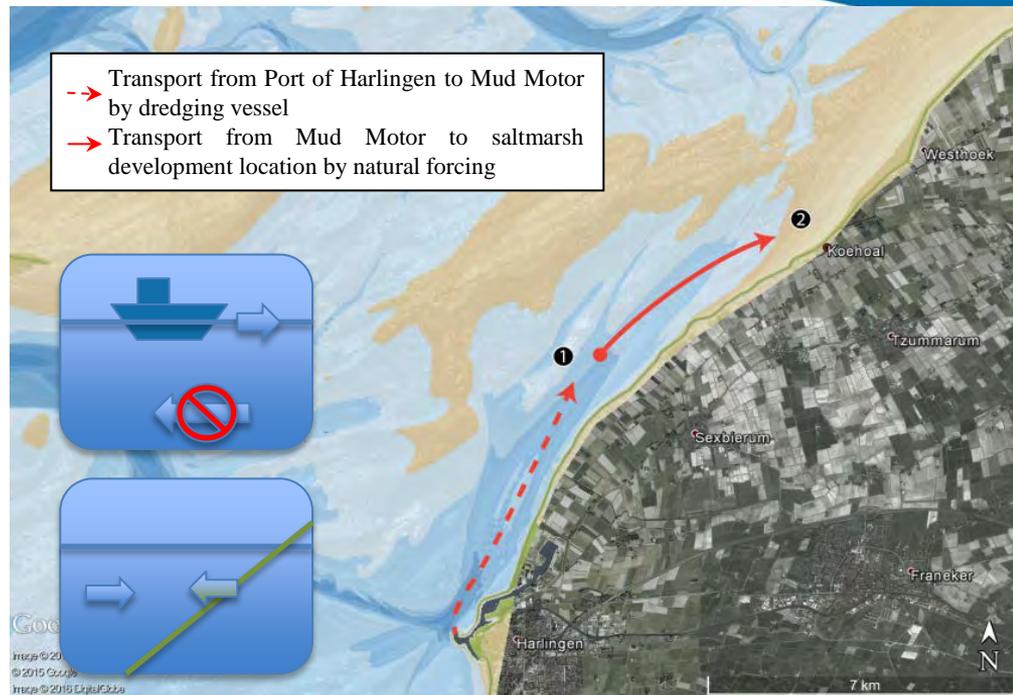
- *Mud motor, Harlingen*
- *Marconi, Delfzijl*
- *Integrated port & nature development, Den Helder*



Muddy waters and the Wadden Sea Harb

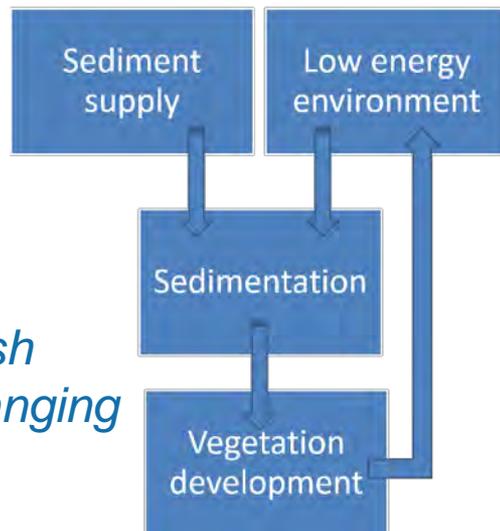
Mud motor

- *Strategic spreading of (clean) maintenance dredged material*
- *Enhancing salt marsh development Koehoal*
- *Less return flow towards harbour Harlingen*



Mud motor

Enhancing salt marsh development by changing sediment supply



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Sediment for Saltmarshes: Physical Aspects of a Mud Motor

NCK days 2016
 March 16-18
 Spoor/Groen Centre for Coastal Research

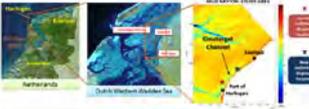
1. Colomo, B.C. van Prooijen, D.S. van Marrewijk, J.C. Witternberg*, A.J.H.M. Reijnen*
 2. Delft University of Technology - Civil Engineering and Geosciences, The Netherlands
 *Rotterdam - 4000 BC 237, 3000 SW Delft, The Netherlands

Introduction

Worldwide harbour need maintenance dredging. In the Haringen harbour (Netherlands) 1.1 million m³ of mainly fine sediments are yearly dredged and disposed in the neighbouring areas.

THE MUD MOTOR IS A BUILDING WITH NATURE INITIATIVE WITH THE AIM TO RE-USE DREDGED SEDIMENTS FOR ECOLOGICAL PURPOSES.

PILOT PROJECT AREA
 Haringen harbour - Kattendijk Channel - Kaaihoek Mudflat



The MUD MOTOR STRATEGY

How Strategy: Dredge Disposal Locations → Mud Transport onto Kaaihoek Mudflat → Increasing Mudflat bed level due to Natural Processes

Positive outcomes:

- Prevent Ecological Services
- Site Reclamation: No Invasive Piping Protection
- Reduced Accumulation towards the Harbour Area
- Reduced Dredging Costs

Salmarshes development



Port of Haringen | Kaaihoek Mudflat | Saltmarshes

0 Dredge transporter in the intertidal channels
 0 Dredge transport towards the Kaaihoek Mudflat

Research Focus and Questions

RESEARCH FOCUS

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    graph TD
      HF[Hydrodynamic Forcing] --> W[Wind - Waves]
      HF --> TC[Tidal - Currents]
      W --> WICS[Wave-Current Induced Bed Shear Stress]
      TC --> WICS
      WICS --> ST[Sediment Transport]
      ST --> E[Erosion]
      V[Vegetation and Benthos] --> ST
  
```

...ON MUDDY BEDS!

RESEARCH QUESTIONS

- What are the effects of flocc properties and settling velocity on the transport of newly deposited fine sediments?
- How does the interaction between wind-waves and tidal-currents affect the bed shear stress on intertidal muddy beds?
- What is the effect of the wave-current induced bed shear stress on intertidal sediment transport?
- What is the role of event-driven processes on the mud transport in intertidal areas?

A Multi-Scale Approach!

Will the disposed sediments end up in the envisaged location?

Future Field Measurements

Measurements on the Mudflat

```

    graph TD
      WWS[Wave Pressure Sensors] --> CS[Current velocity sensors: Doppler Current Profiler - ADCP]
      WWS --> SC[Sediment Concentration: Optical Back Scatter - OBS]
      CS --> BS[Bed Shear Stress]
      SC --> BS
      CS --> TF[Turbulent Fluctuations: Acoustic Doppler Velocimeter - ADV]
      SC --> FS[Flocc Size & Settling Velocity: In-Situ Laser Particle Sizer - ILS]
      TF --> BS
      FS --> BS
  
```

LIWV Surveys

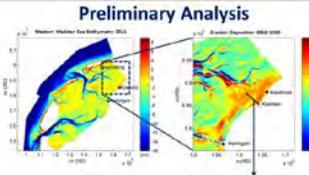
Drone level Monitoring using DRONES

Tripods Measurements

Drone level Monitoring using DRONES

Traders in the NEW Disposal location
 Extended bed sediment sampling

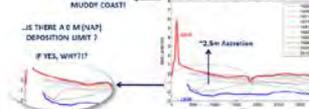
Preliminary Analysis



ACCRETING MUDDY COAST!

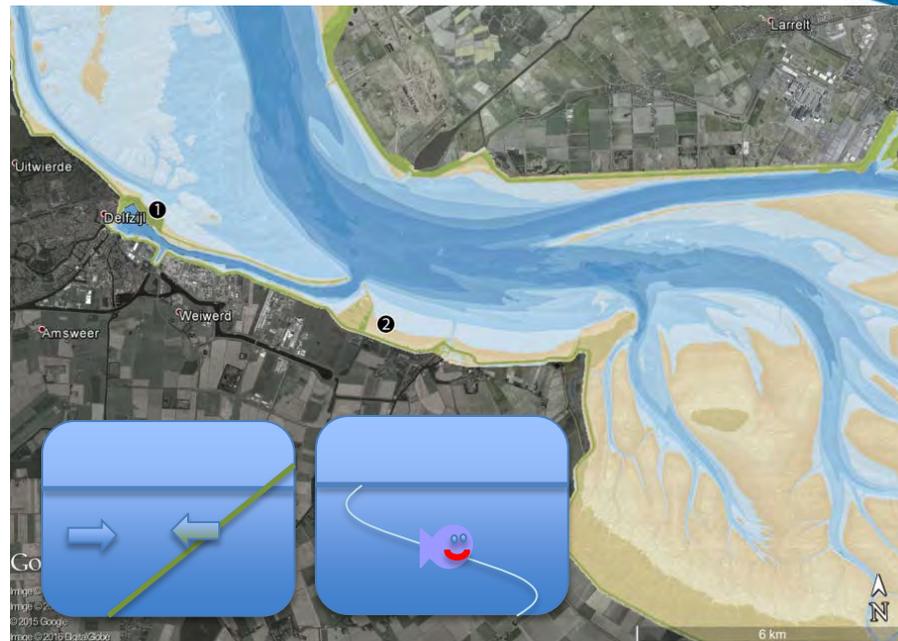
IS THERE A C M [NA] DEPOSITION LIMIT?

IF YES, WHY???



Marconi

- *Integral approach to improve:*
 - *Flood safety*
 - *Spatial quality*
 - *Reduction of siltation*
- *Full ecodynamic design made for the area*
- *Several aspects further tested*



Marconi

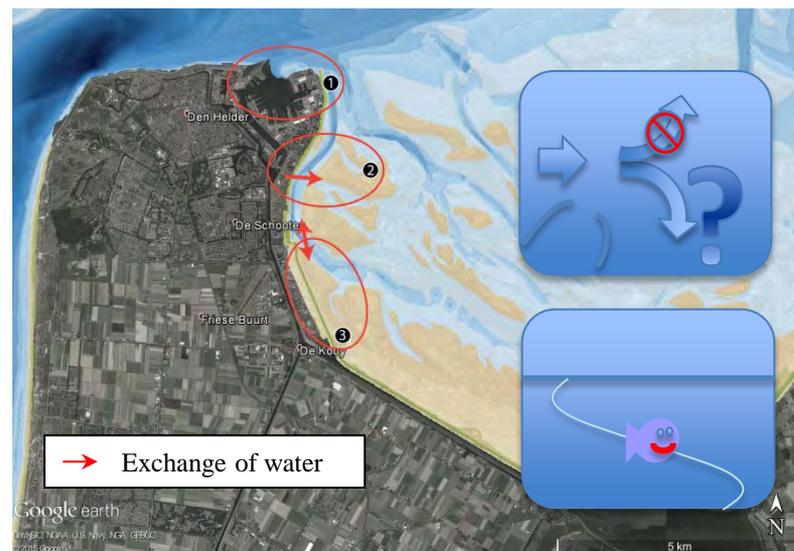


40-50
years



Integrated port & nature development

- *Adjusting flow patterns by breakwater development*
- *Creating estuarine gradients by:*
 - *Relocation of fresh water discharge*
 - *Creating smooth salinity gradient in Balgzandkanaal*
- *Combinatory benefit: less siltation and more space in harbour*



Conclusions

- *Several concepts are being tested in BwN Wadden Sea harbours program, following the EcoShape-approach of ‘learning by doing’*
- *BwN Wadden Sea harbours program shows that co-creation of ecologic and economic development is key to success for support*

Thank you for your attention!

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Contact: erik.vaneekelen@ecoshape.nl

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