Monday

Monday – morning chair Arjen Kees: 9-15 Anouk:9-13	•9:00 – 9:45 Welcome Introduction to course *(by Arjen), Intro Kees* •9:45 – 10:30 Introduction to JERICO-next *(by Anouk)* *Coffee break* •11:00 – 11:45 Introduction to NatureCoast *(by Arjen)* •11:45 – 12:30 Introduction to coastal observatories (ICON) *(by Stefan Aarninkhof)*
Monday – afternoon chair Arjen	•13.30 – 14:45 Students introduce themselves; 2 slides / 3 min pp *Coffee break* •15:15 - 16:00 Objectives of marine monitoring *(by Marcel Taal)* •16:00 - 17:00 Introduction into MSFD and monitoring *(by Theo Prins)*

Tuesday

Tuesday – morning chair Anouk	**Monitoring** 8:45 – 9:30 HF-radar (incl. Xband radar and ARGUS) (Rinus Schroevers***)*** 9:30 – 10:30 Phytoplankton analysis *(by Felipe Artigas)*
Tuesday – afternoon Chair: Roeland	10.45 - 12.15 Drifter measurements (going to the beach) 12.15 - 13.00 Lunch 13.00 - 14.00 Presentation working with instruments and ZM monitoring 14:00 - 16:00 Split in 3 groups: topo, bathy, dune lake 16:00 - 17:00 Process data on the beach

Wednesday

Wednesday – morning Chair: Anouk	**Data interpretation** •9:00 – 9:45 Introduction into data processing *(by Fedor Baart)* •9:45 – 10:30 MSFD - eutrophication *(by Anouk)* *Coffee break* •11:00 – 11:45 Example of SEACAMS project (Wales) on marine renewable energy *(Dave Mills (Bangor University))* •11:45 – 12:30 Exchange monitoring results of Tuesday by student groups
Wednesday – afternoon Chair: Genna	**Integration** of multidisciplinary data: *(whole afternoon by Genna)* •14.00 - 14.30 Introduction •14.30 - 15.15 Exercise integration of satellite data with google earth engine *Coffee break* •15:45 - 17:00 Hands-on exercise

Thursday

Thursday – morning Chair: Willem	Introduction to **data management**: •9:00 – 9:45 European data landscape - EMODNET •9:45 – 10:30 Data management and sharing - Gerben de Boer *Coffee break* •11:00 – 11:45 Archiving and publishing citable data - TUD •11:45 – 12:30 Portals for data dissemination - Willem
Thursday - afternoon Chair: Arjen	**Integration** of multidisciplinary data *(Arjen)* •14.00 - 14.45 Introduction on linking different types of data & disciplines •14.45 - 15.30 Integrated NatureCoast findings *(by postdocs)* *Coffee break* •16:00 - 17:00 Analysis of multidisciplinary data

Friday

Friday – Chair: Kees	•9:00 – 10:30 Analysis of multidisciplinary data (con't) *Coffee break* •11.00 - 11.45 Present results of analysis of multidisciplinary data •11:45 – 12:30 Wrap- up & evaluation (Kees) •Lunch ending at 14.00

Who are we?

- Anouk Blauw
- Kees den Heijer
- Arjen Luijendijk

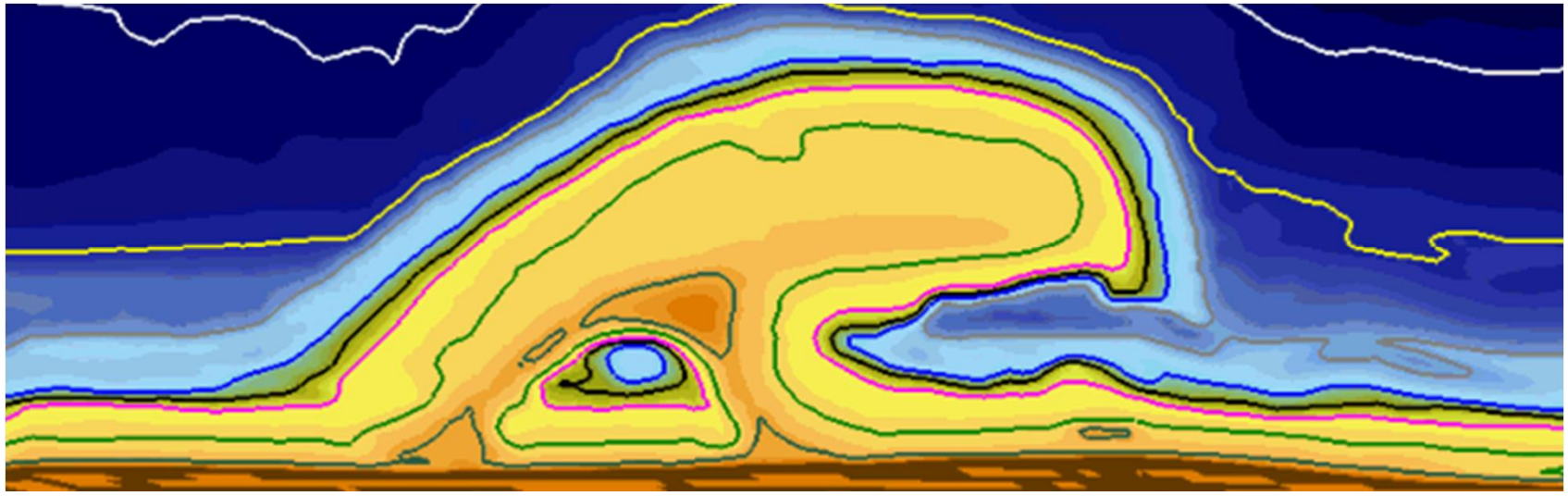
Monday

Monday – morning chair Arjen	•9:00 – 9:45 Welcome Introduction to course *(by Arjen), Intro Kees* •9:45 – 10:30 Introduction to JERICO-next *(by Anouk)* *Coffee break* •11:00 – 11:30 Introduction to NatureCoast *(by Arjen)* •11:30 – 12:15 Introduction to coastal observatories (ICON) *(by prof. Stefan Aarninkhof of Coastal Engineering of TU Delft)*
Monday – afternoon chair Arjen	•13.30 – 14:45 Students introduce themselves; 2 slides / 3 min pp *Coffee break* •15:15 - 16:00 Objectives of marine monitoring *(by Marcel Taal)* •16:00 - 17:00 Introduction into MSFD and monitoring *(by Theo Prins)*

Who am I?

- Arjen Luijendijk
- Deltares (2002) & TU Delft (2010)

- Background: Sr. Coastal Engineer at Deltares.
  - Coastal morphology modelling
  - International project experience
  - BwN - Holland Coast and Zandmotor.
  - Model coupling: subaerial and subaqueous

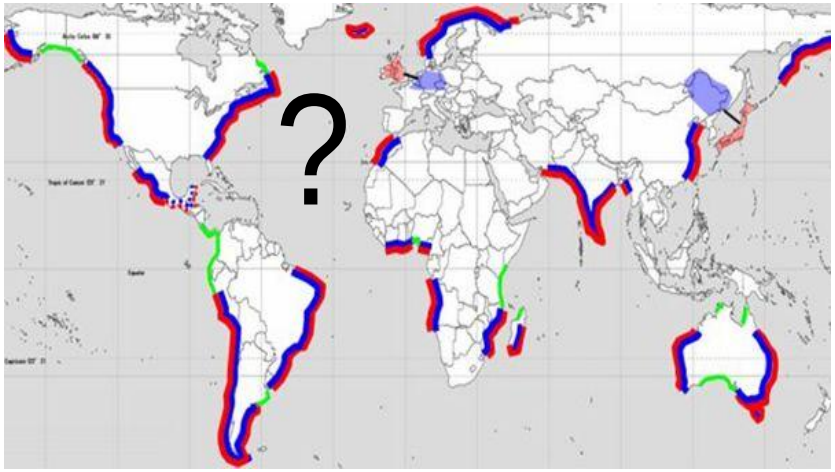


NatureCoast project

Title: Physical feasibility of mega-nourishment concepts worldwide

Postdoc - Physical system

- Identify promising locations worldwide
- Solutions in local context
- Explore export potential based on coastal dynamics using satellite images



PhD – Seamless modelling

- Coupling models for sandy solutions
- Promotor: Stive & Aarninkhof

Focus: Integrate multi-disciplinary knowledge and experience in exploring international opportunities

Deltares: facts and figures

- Legal form: not-for-profit organisation
- Approx. 800 fte
- Annual turnover of € 100 million
  - 50% government
  - 50% market
- Serves the public and private sector
- National (60%) and international activities (40%)
- Exact sciences, integrated with social sciences

Flood risk
Ecosystems and environmental quality
Water and subsoil resources
Delta infrastructure
Sustainable delta planning

Deltares

Deltares

Sand Engine

A nature-driven mega-nourishment

JERICO Summer school
19 – 24 June 2017

Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

EcoShape

provincie ZUID HOLLAND

Kansen voor West
G4P4

STW
Nieuwe technologie mogelijk maken

TU Delft

Deltares
Enabling Delta Life

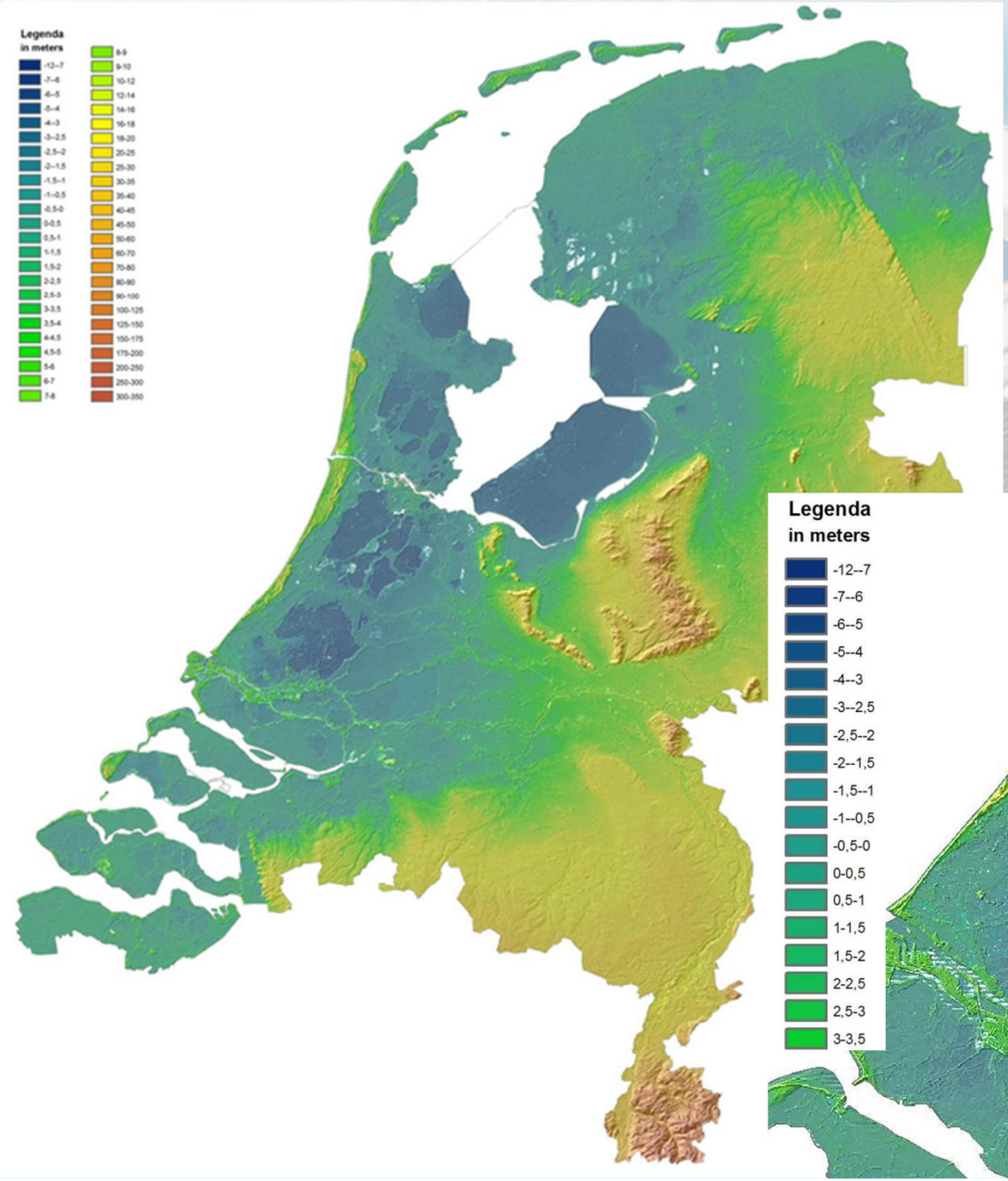
EcoShape

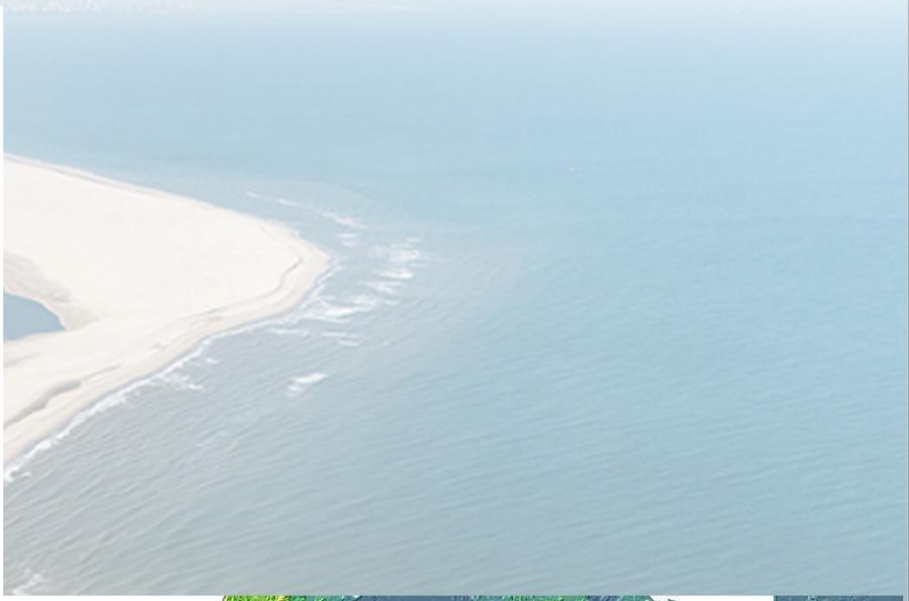
Arjen Luijendijk: arjen.luijendijk@deltares.nl

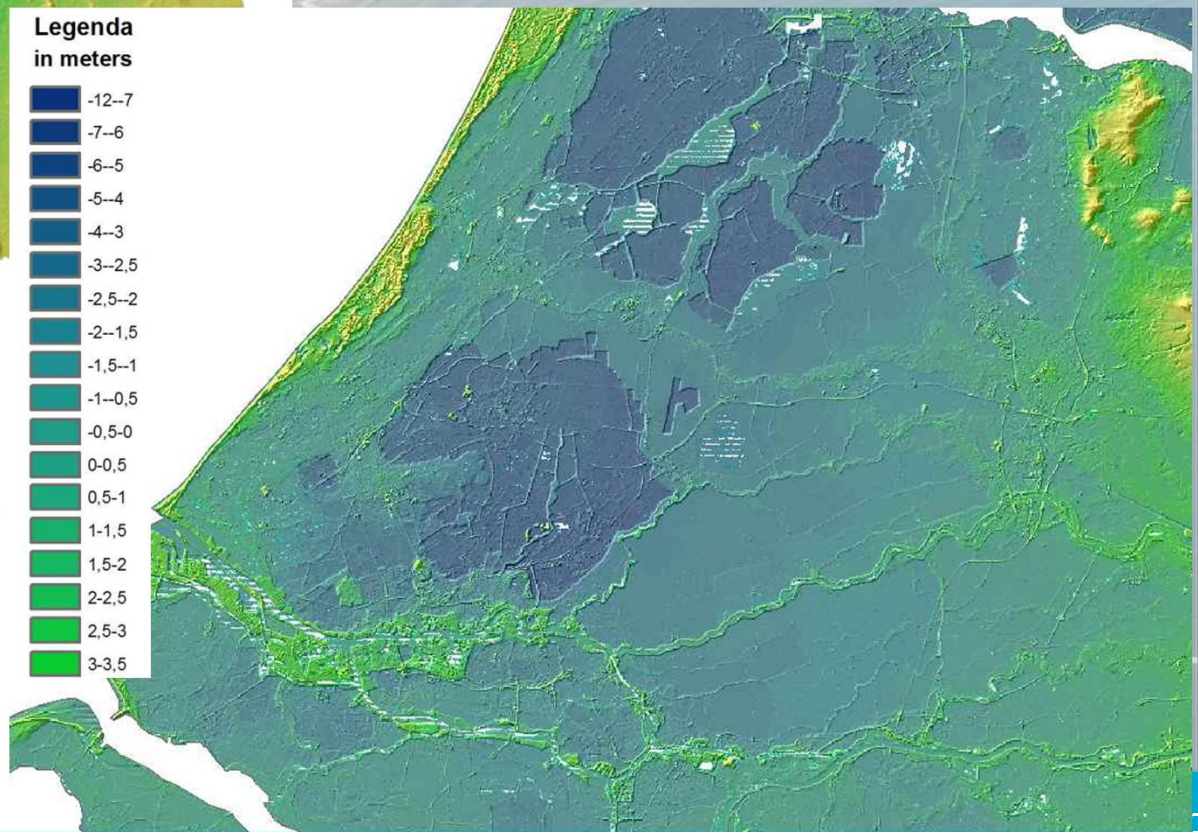
Outline

1. Introduction Dutch Coast
2. Design Sand Engine & construction
3. Monitoring
4. Knowledge development
5. Is it transferable?

1. Introduction Dutch Coast







Safety against flooding

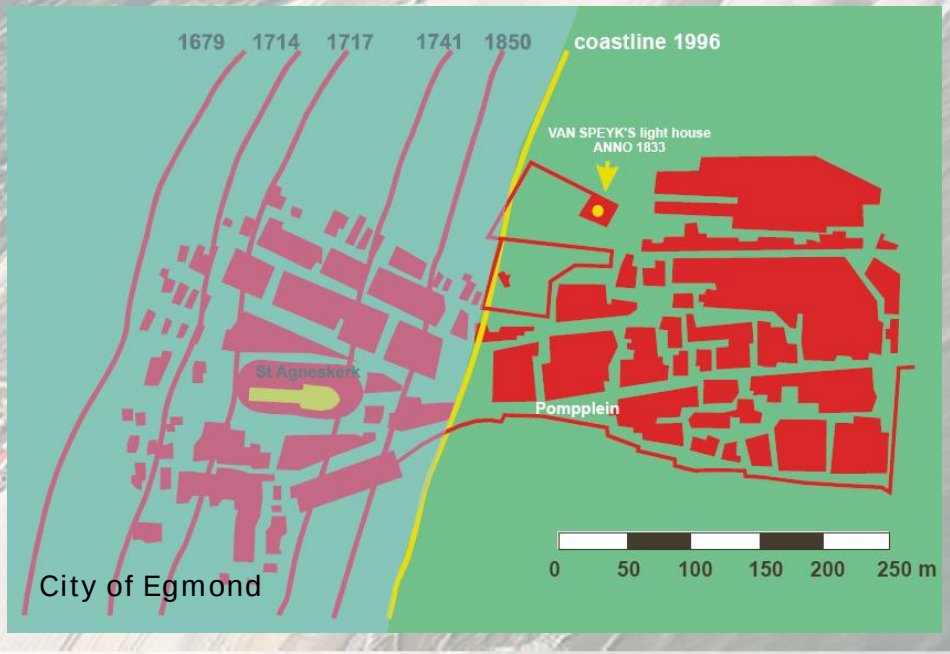
Natural dunes

Holland Coast: Policy context

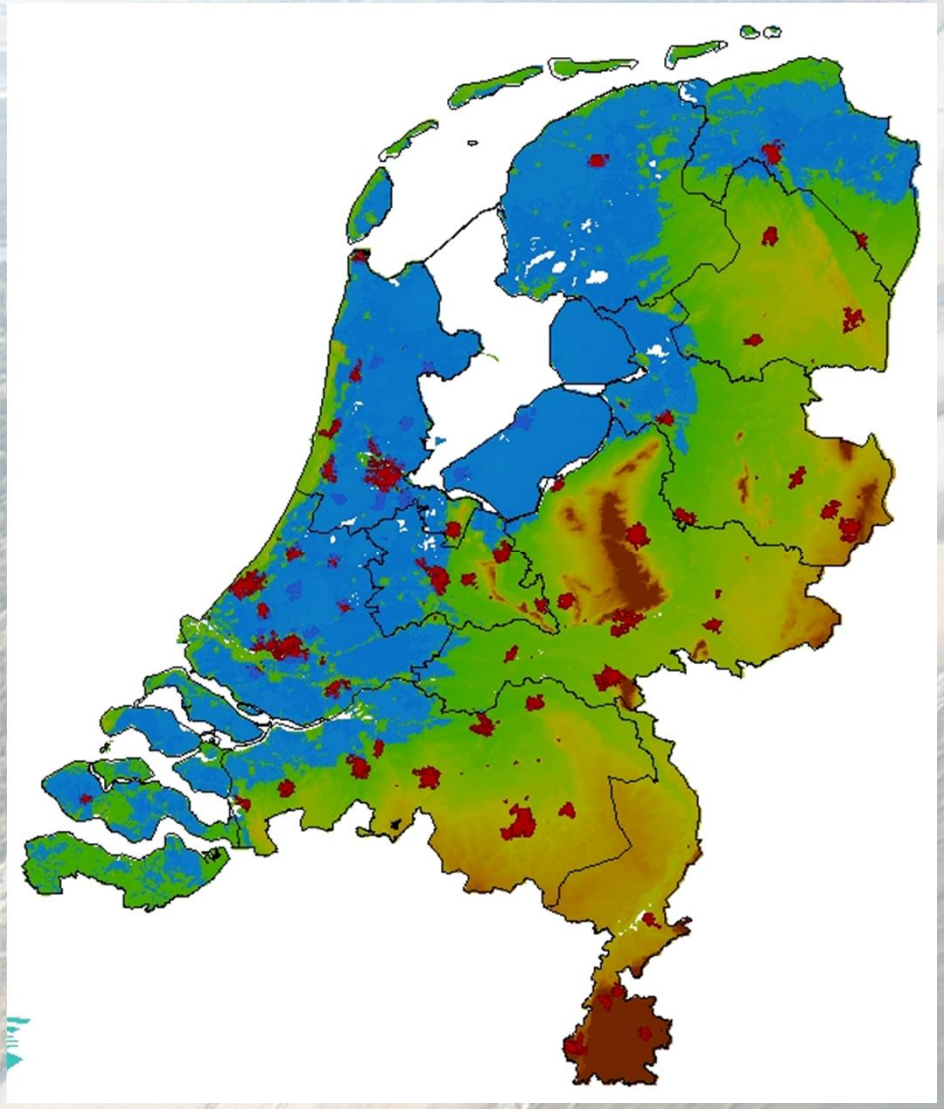
Shortage of natural sediment

Consequence: Structural erosion

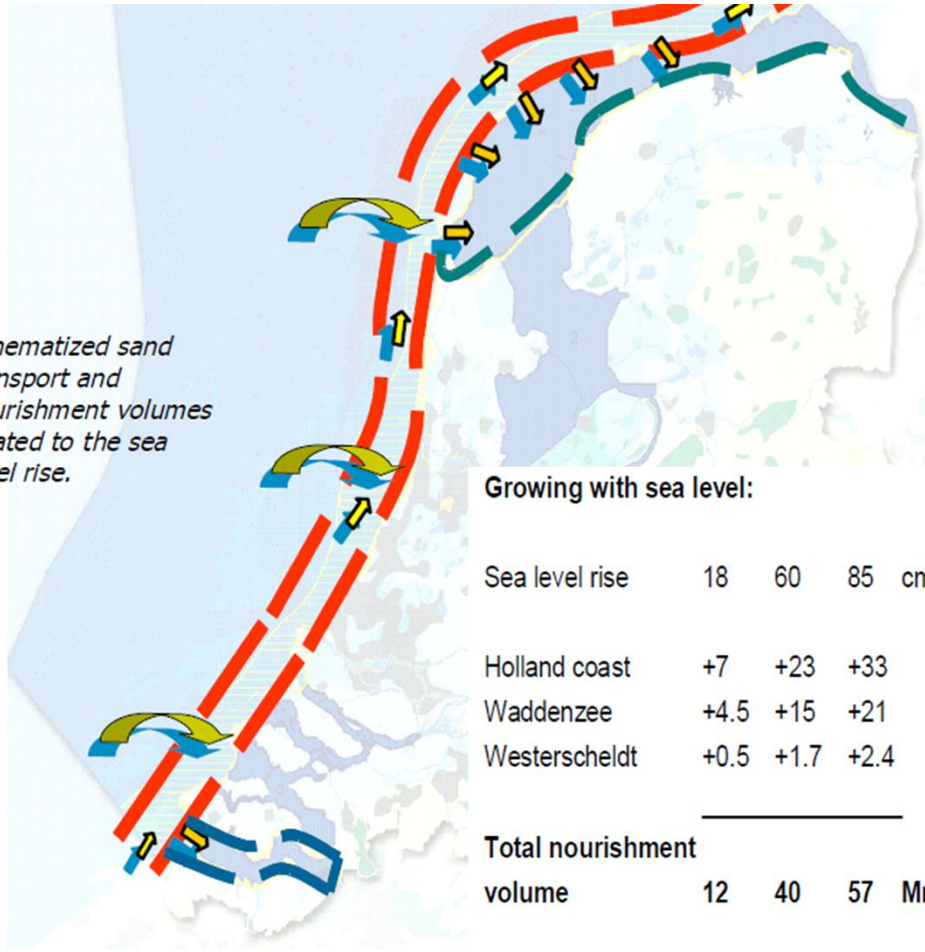
Solution: Nourishments (10-15 mln m3/yr)



Climate change - sea level rise



Upscaling nourishment volumes



Schematized sand transport and nourishment volumes related to the sea level rise.

Growing with sea level:

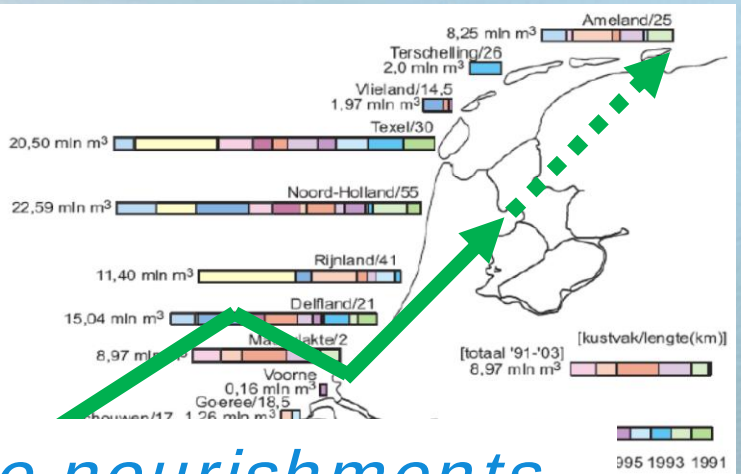
Sea level rise	18	60	85	cm/century
Holland coast	+7	+23	+33	
Waddenzee	+4.5	+15	+21	
Westerscheldt	+0.5	+1.7	+2.4	
Total nourishment volume	**12**	**40**	**57**	**Mm^3/year**

Increase in nourished volumes

Dynamic preservation of the 1990 coastline

Sand volumes:

- Since 1990: 6 mln m3/yr
- Since 2001: 12 mln m3/yr



Tendency towards larger-scale nourishments

Uncertainties on environmental effects

Need for space (nature & recreation)

Outline

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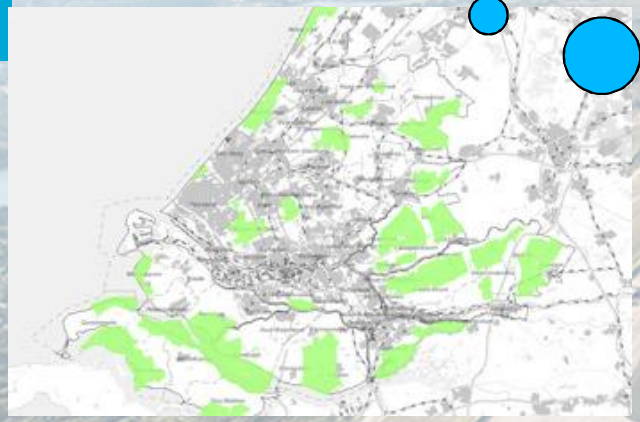
Delfland coast

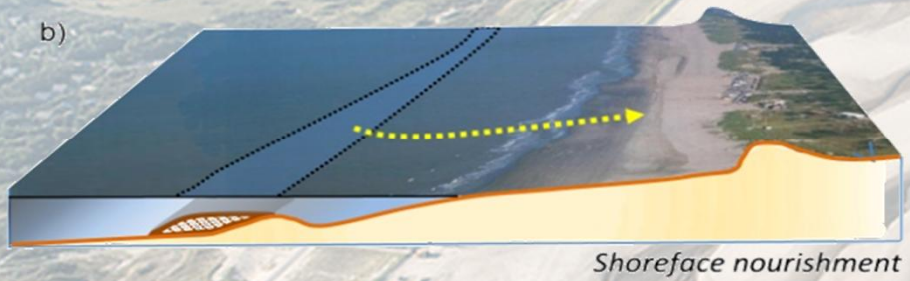
Challenge for Province

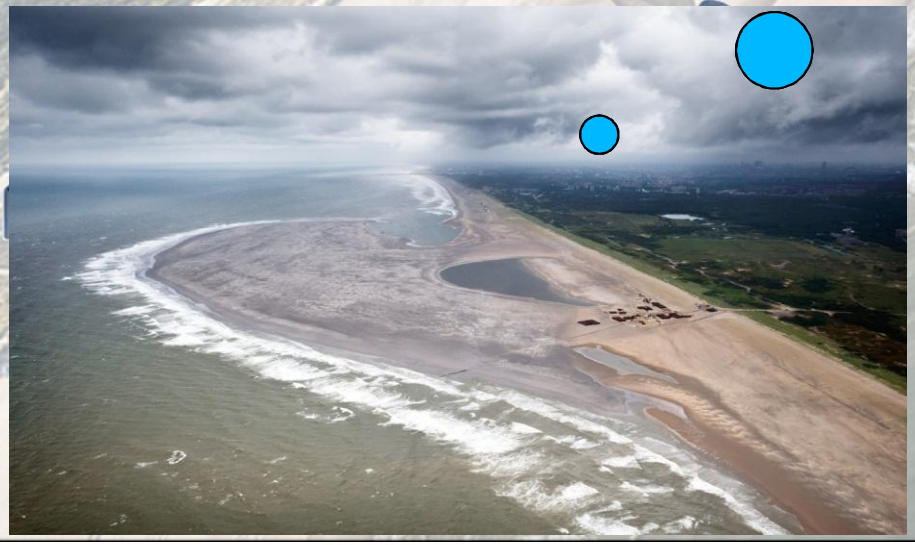
Shortage on natural recreation areas



How can ambitions by realised?

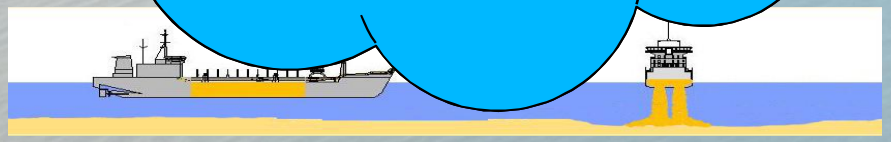
Challenge for Ministry of Public Works





- Tr

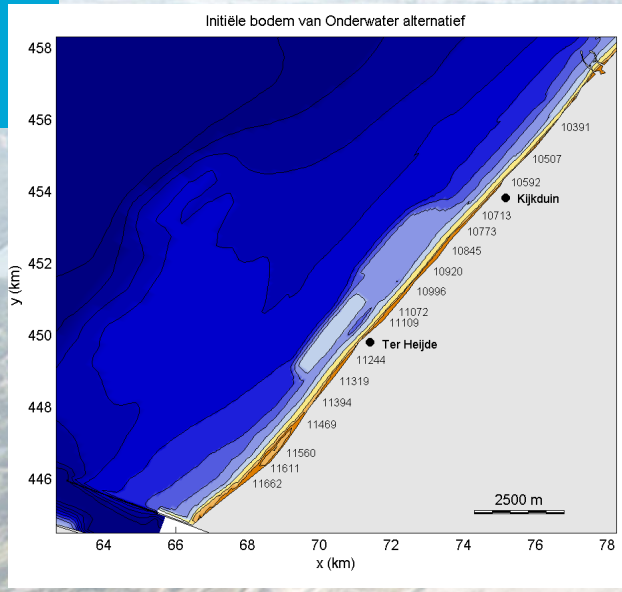
Let's try a pilot that combines the wishes of different stakeholders



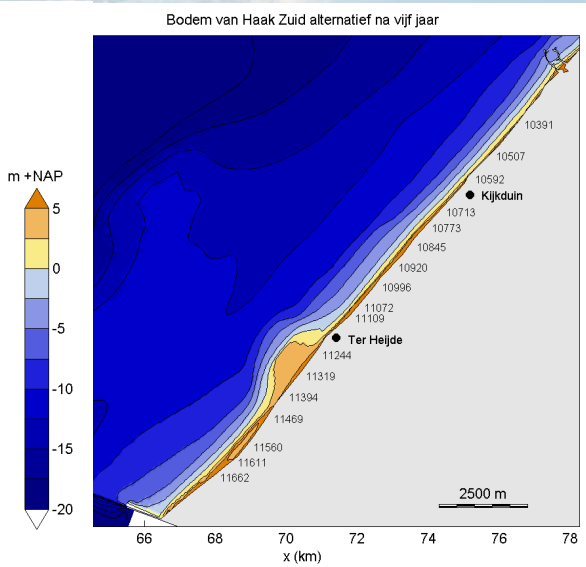
- Now experimenting with the Sand Engine!

Different designs

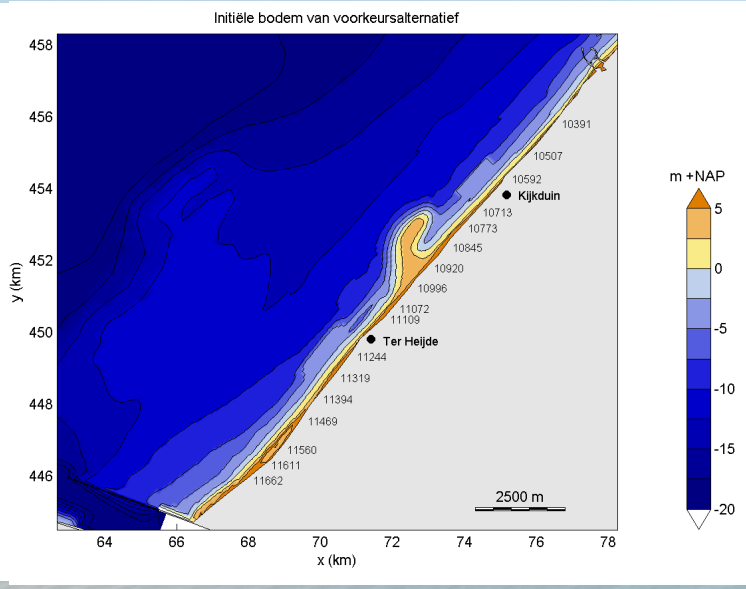
- submerged:



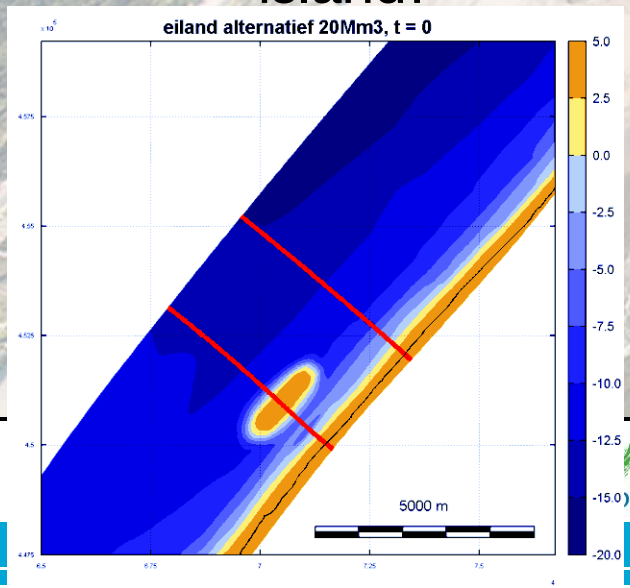
clock:

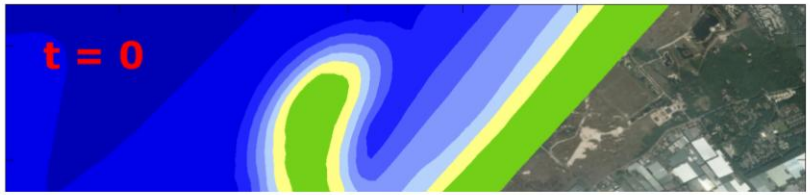


hook:



island:

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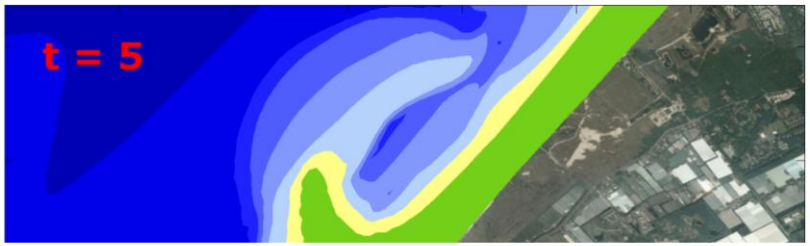
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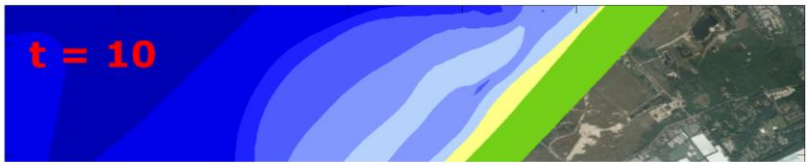
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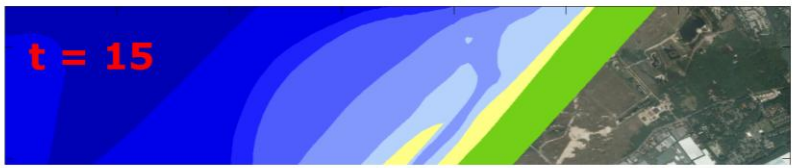
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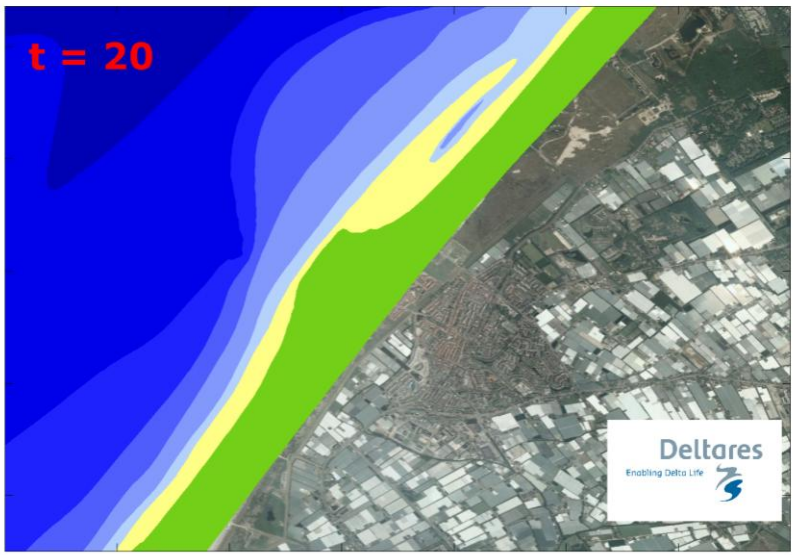
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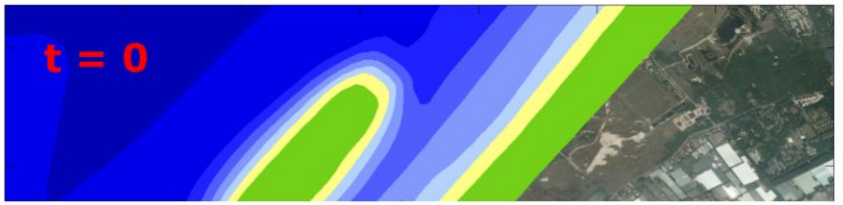
Deltares
Enabling Delta Life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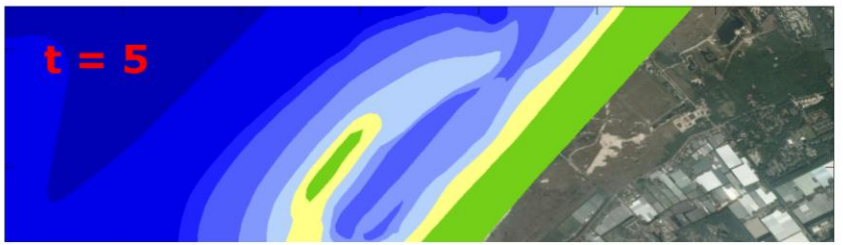
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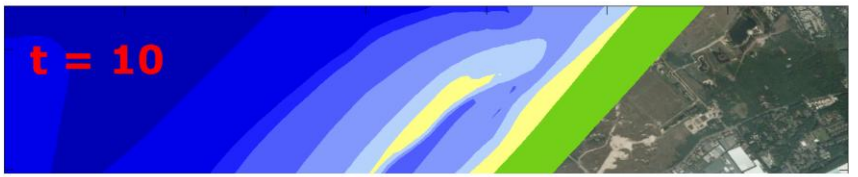
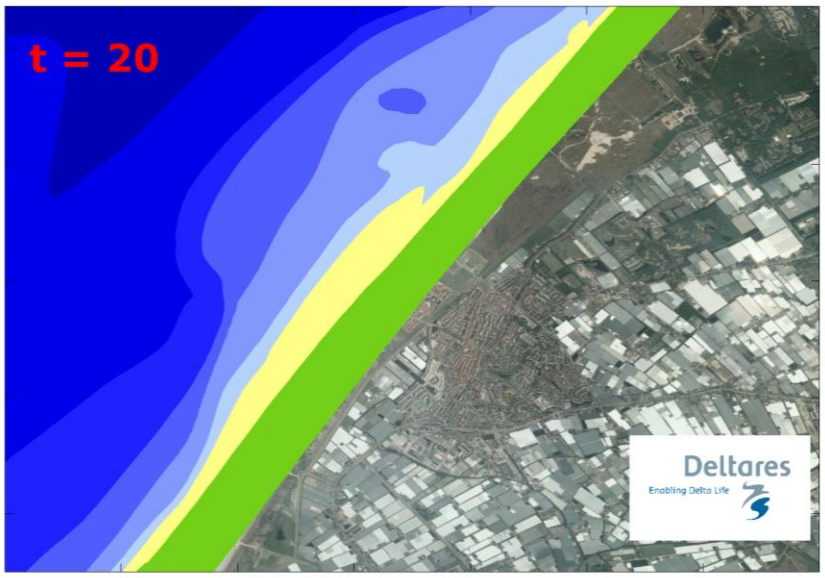

t = 10


t = 15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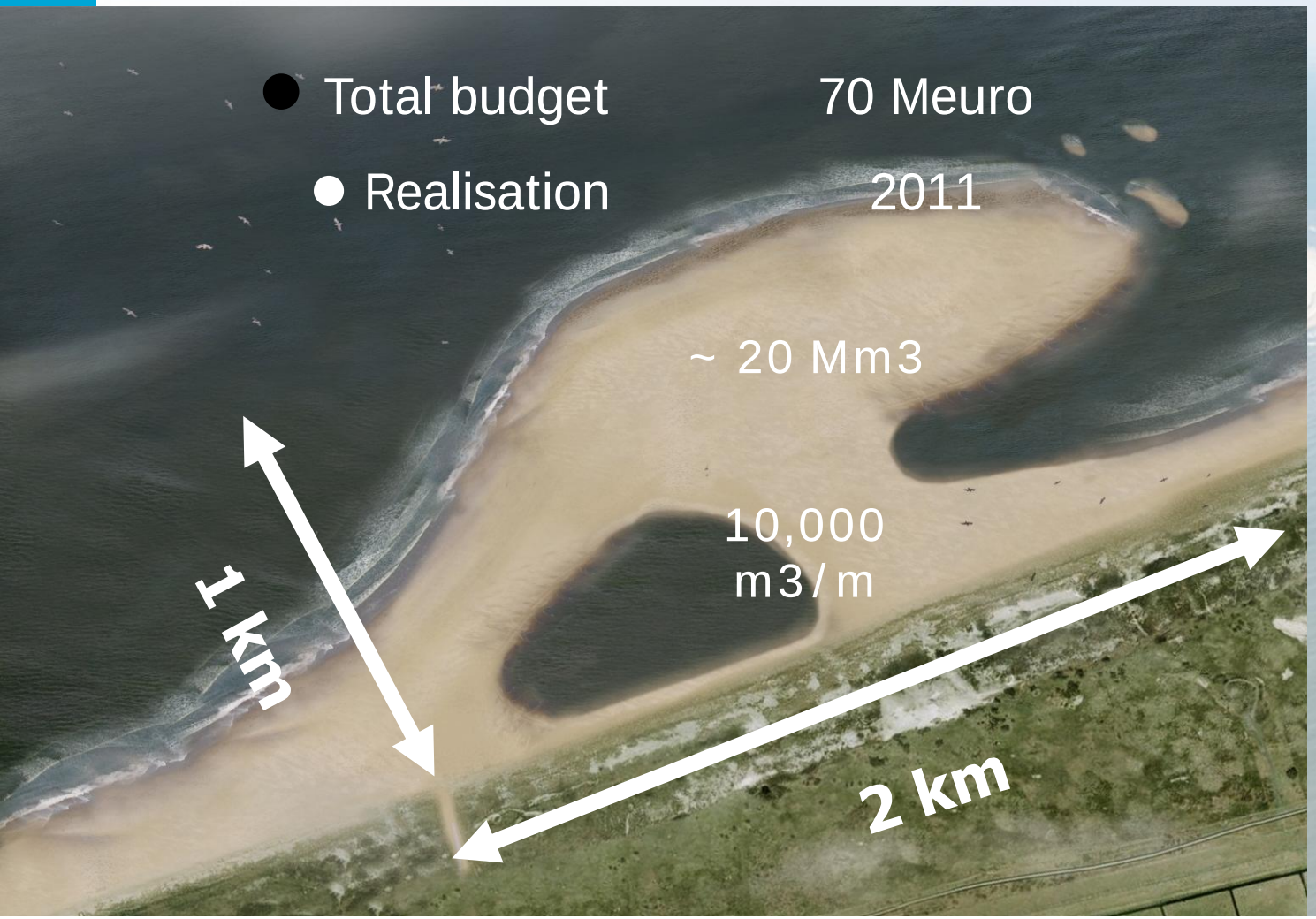
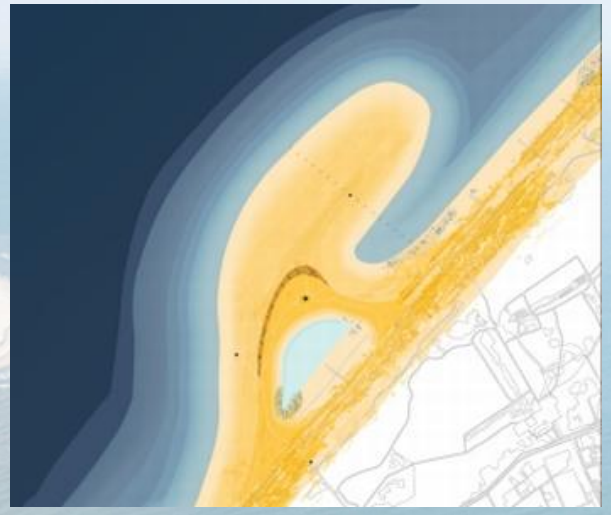
Deltares
Enabling Delta Life

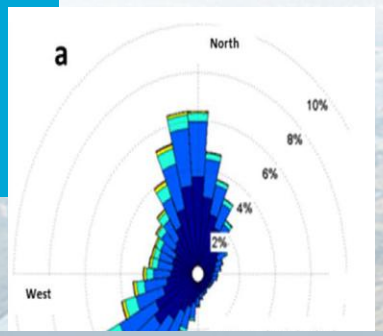
Pilot Zandmotor – final design





- Reduce frequency, upscaling of volumes
- Surplus of sand, distribution by tide, wind and waves

Sand mining



2011: 21,5 mln m^3

5 km

9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
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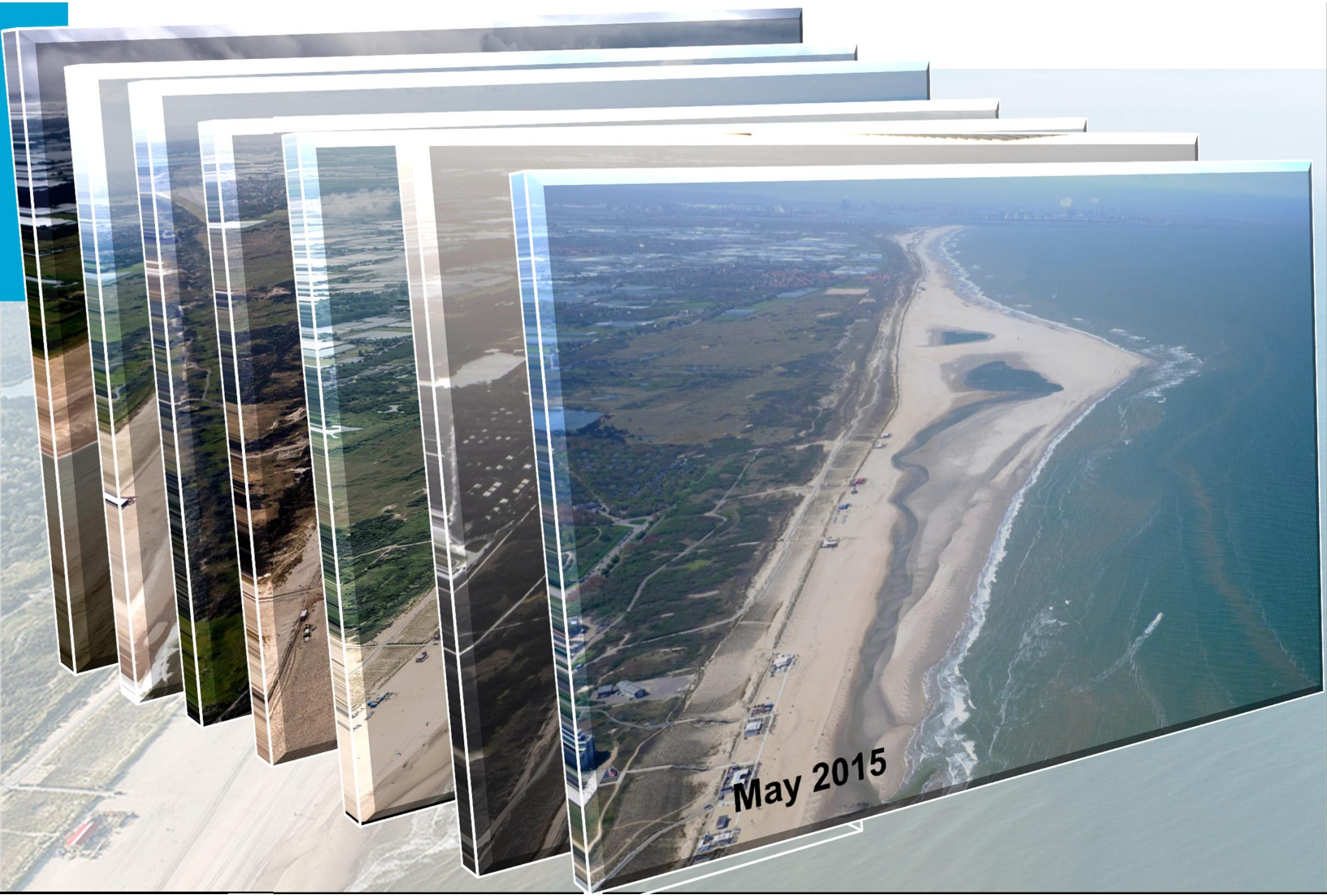
Construction

March 28th 2011

April 28th 2011

May 24th 2011

June 28th 2011



photos: Rijkswaterstaat; Joop van Houdt

Services of the Sand Motor

Ambitions Sand Engine

- enhanced safety against flooding
- cheaper per m3 compared to traditional nourishments
  - (but: costs brought forward → interest!)
- longer period between consecutive nourishments
- ecologically interesting intermediate stages
  - beach lagoons, juvenile dunes, pioneer vegetation
- recreation potential
- wider dune area
  - increased freshwater reserve

Outline

1. Introduction Dutch Coast
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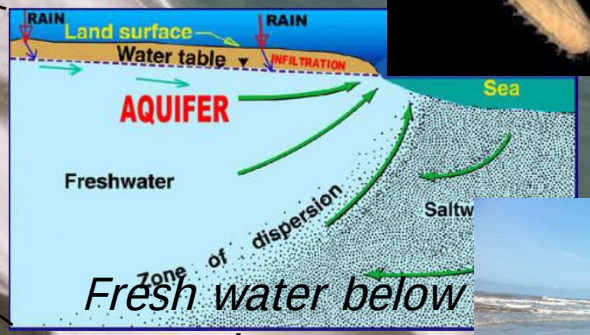
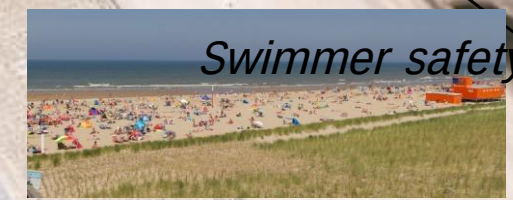
5. Is it transferable?

‘Living lab’ for studying different processes & species

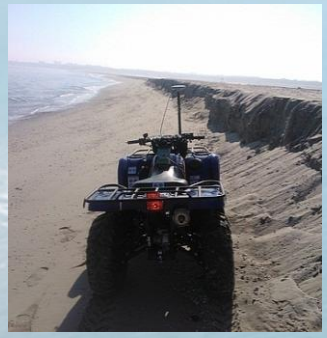




Extensive monitoring campaign…

BEACH



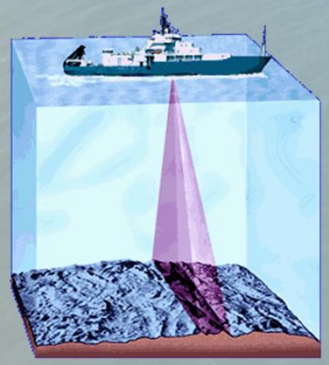



SURF



LS





Extensive monitoring campaign…

Macrobenthos:

Fish

Birds

Sea mammals

Vegetation

Insects



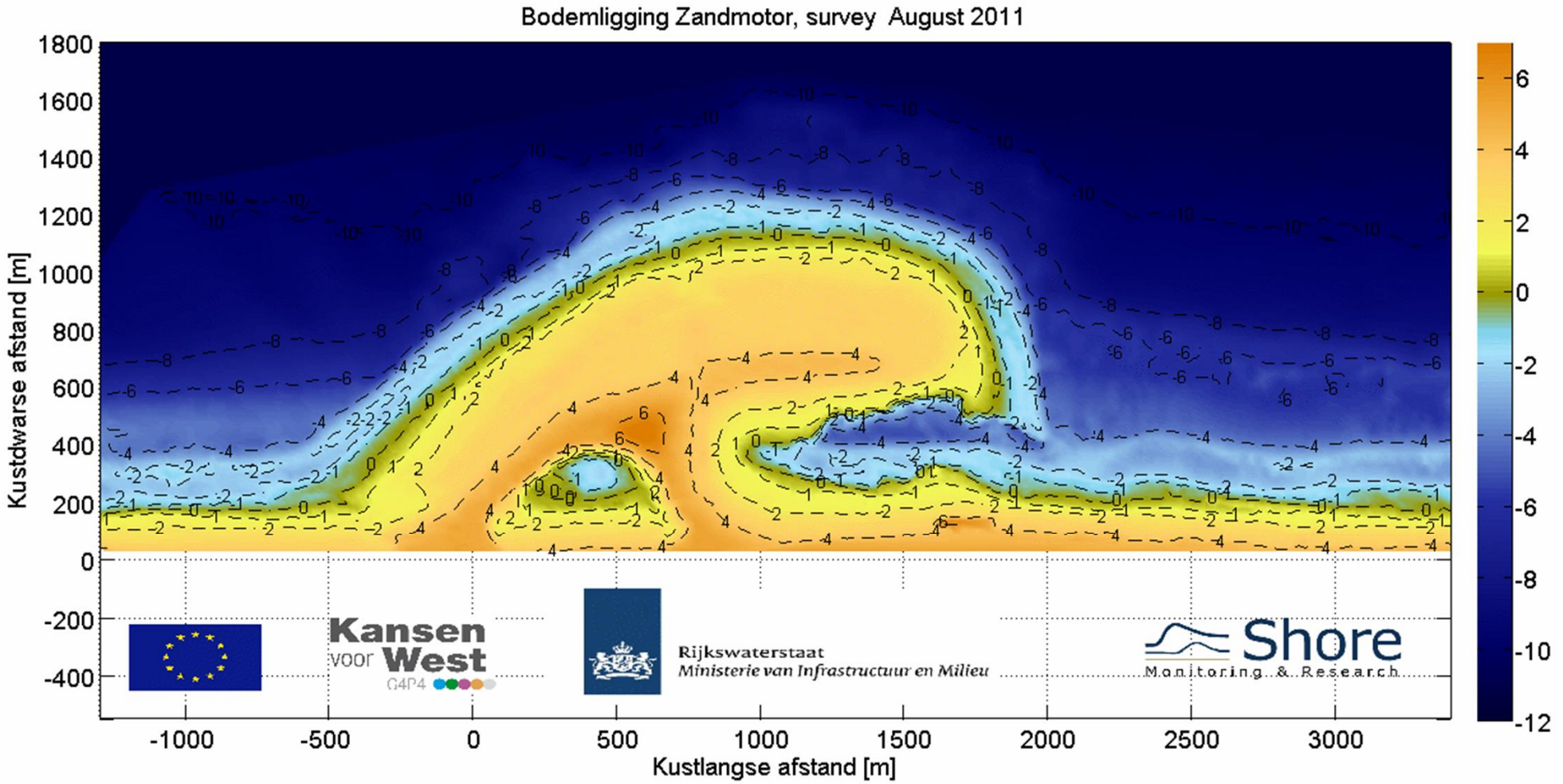




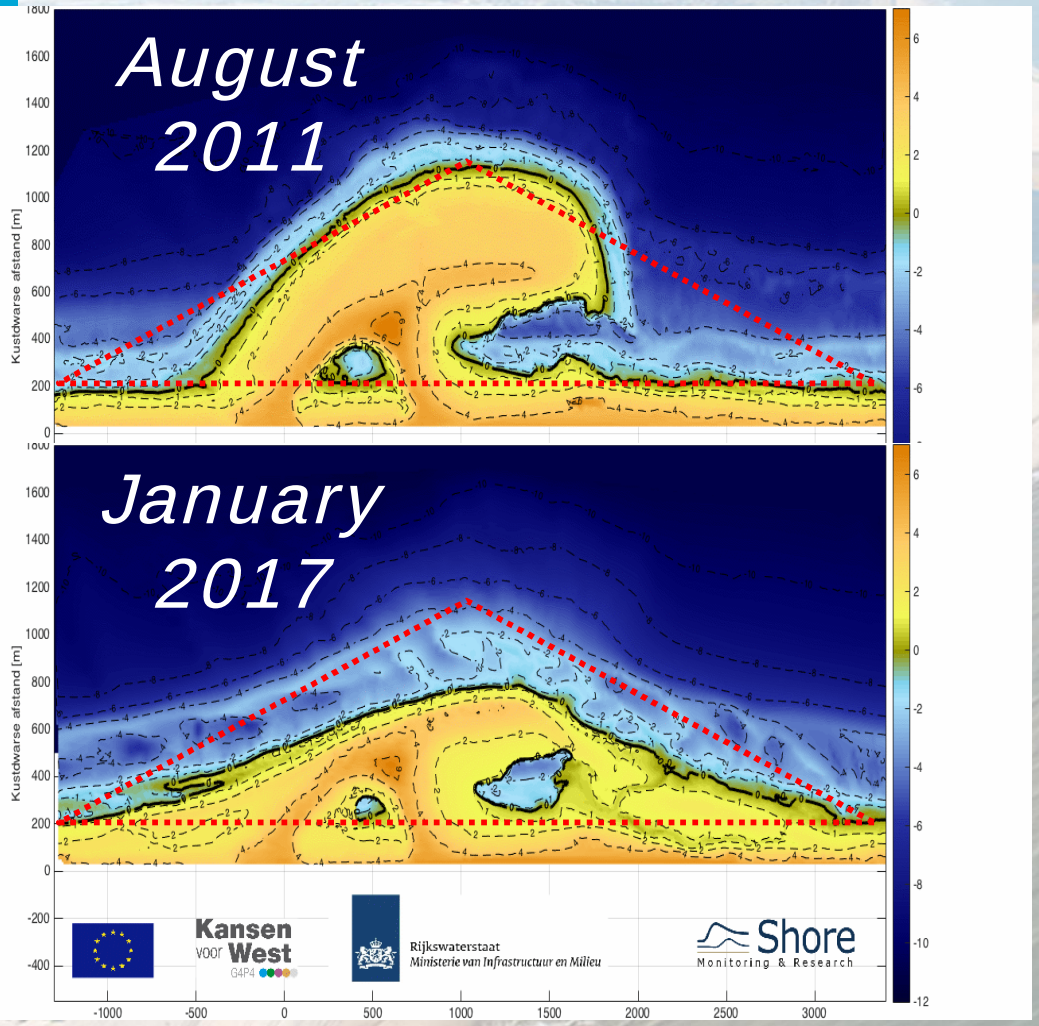




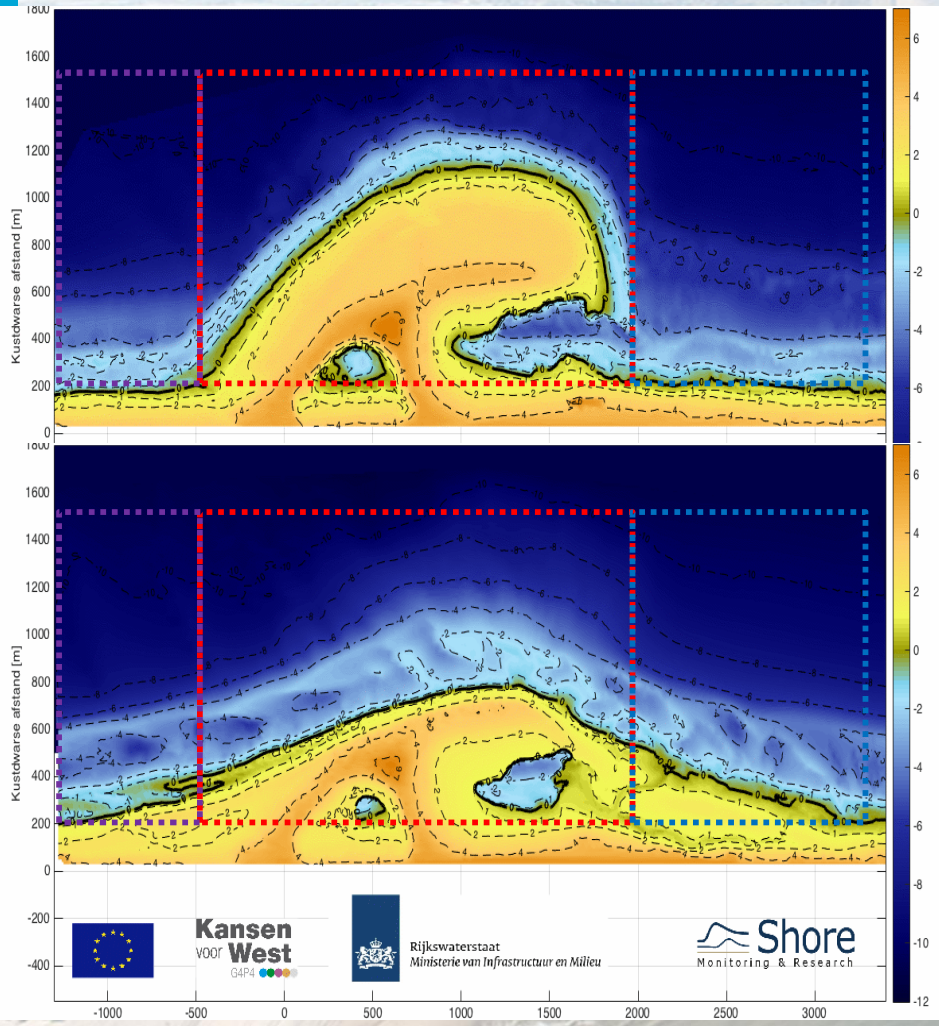
Evolution morphology

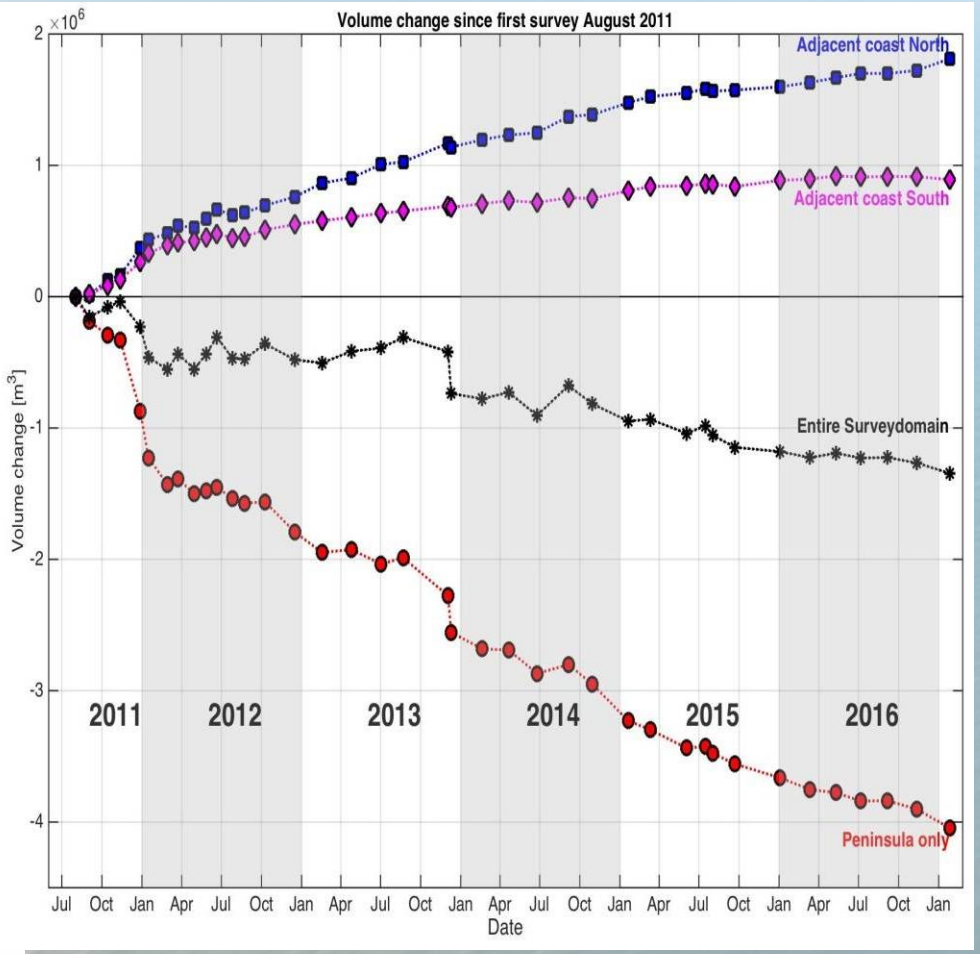


Evolution and volume changes



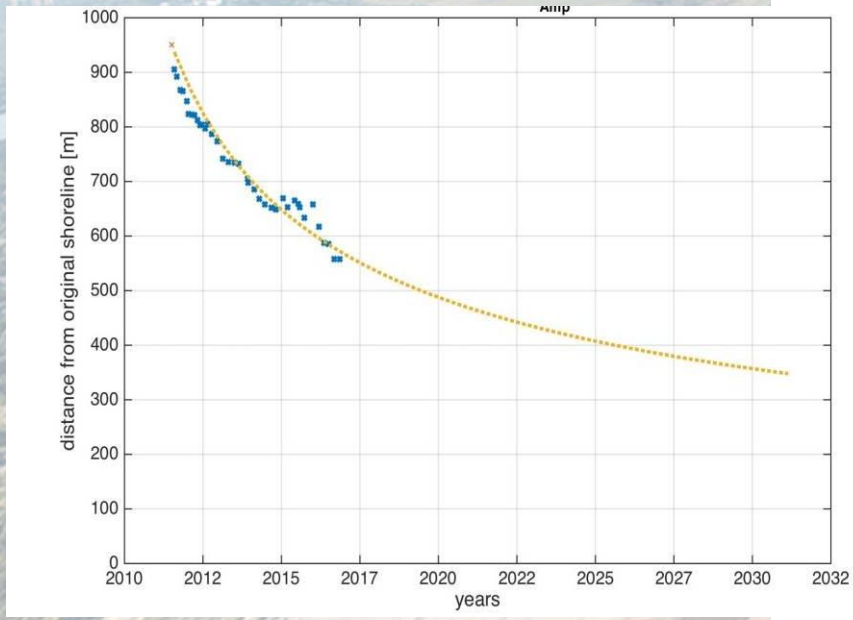
Evolution and volume changes



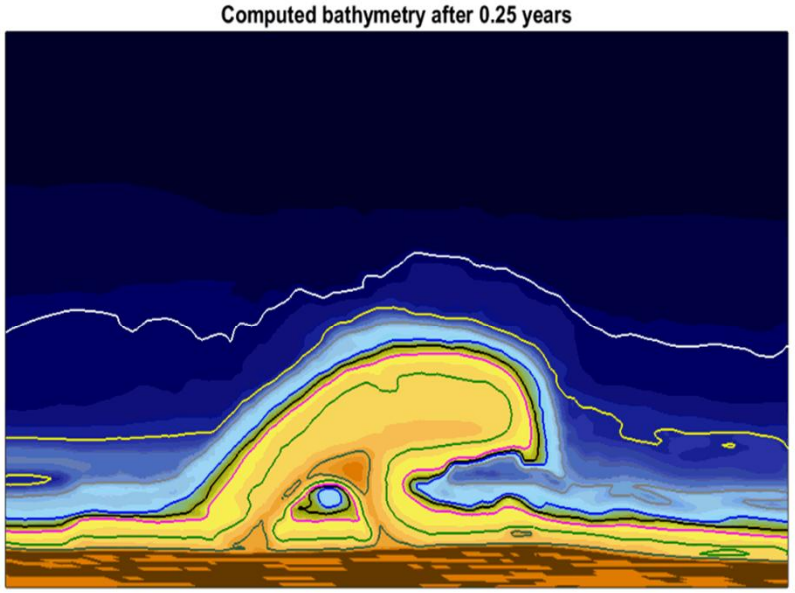


How will it evolve?

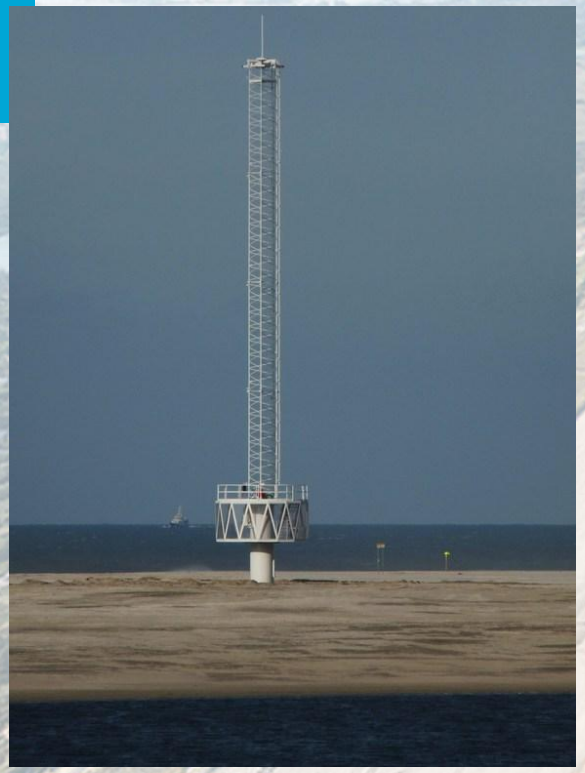
Using a fit function



Using a process-based model



Monitoring: Argus video



Observations: Recreation and Nature

Outline

1. Introduction Dutch Coast
2. Design Sand Engine & construction
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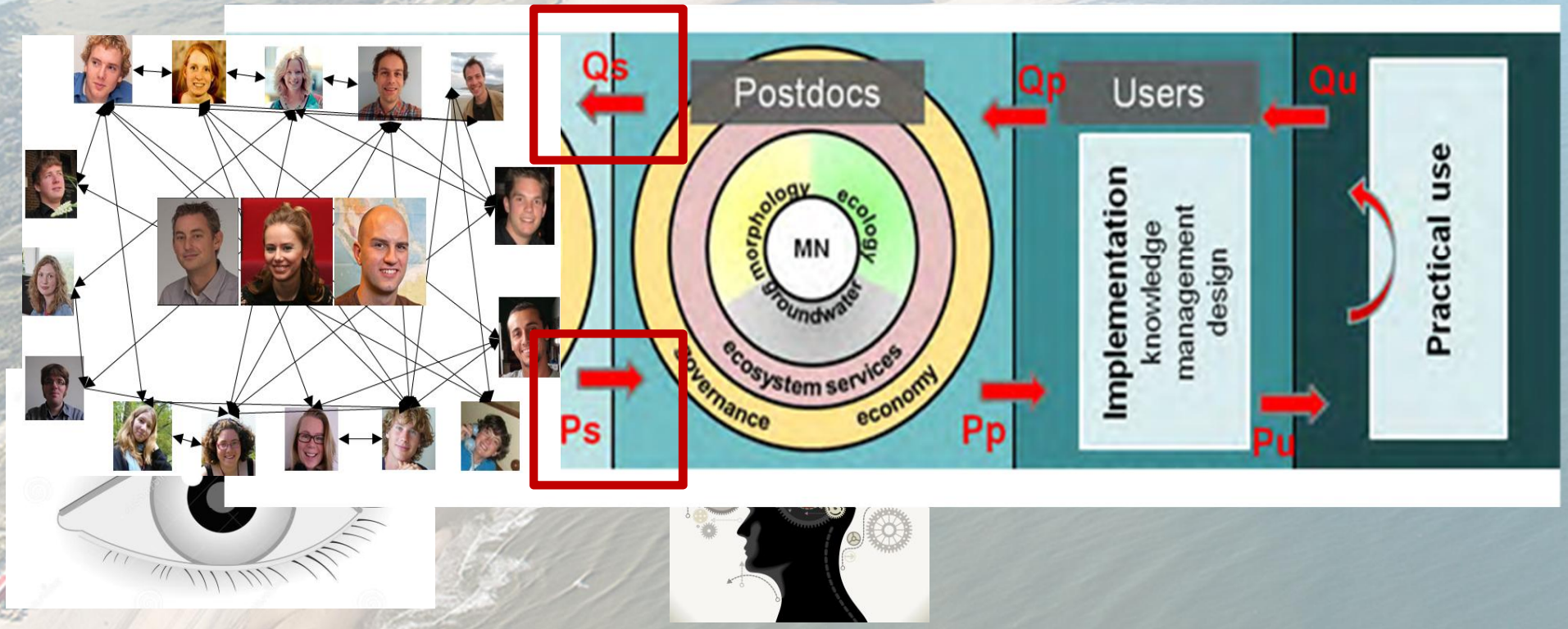
4. Knowledge development
5. Is it transferable?

NatureCoast

- STW project of 5.5 mln euro
- Interdisciplinary science project
- 6 universities, 15 PhD researchers
- Strong involvement of end-users

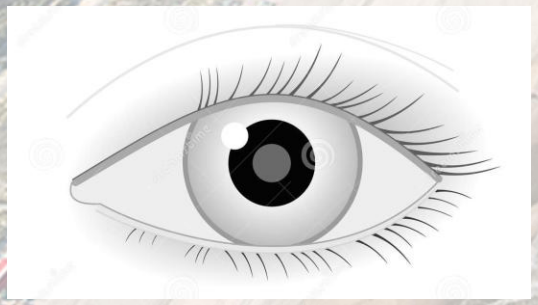


NatureCoast

- STW project of 5.5 mln euro
- Interdisciplinary science project
- 6 universities, 15 PhD researchers
- Strong involvement of end-users

- Create generic understanding of Sand Engine evolution in order to develop innovative sandy strategies worldwide

Monitor → Understand → Create



Interdisciplinary research

- Coastal Safety
- Dune formation
- Hydrology and geochemistry
- Marine ecology
- Terrestrial ecology
- Governance

End-users


Deltares
Enabling Delta Life
Boskalis
Van Oord
IMARES
WAGENINGEN UR
Deltaprogramma
Rijkswaterstaat
Ministerie van Verkeer en Waterstaat
provincie ZUID HOLLAND
Royal HaskoningDHV
Enhancing Society Together
Witteveen + Bos
ARCADIS
dunea
DUIN & WATER
Hoogheemraadschap van Delfland
Hoogheemraadschap van Rijnland
bosschap
bedrijfschap voor bos en natuur
Natuurmonumenten
NORTEK B.V.
NWP
Netherlands Water Partnership
REDDINGSBRIGADE Nederland
Provincie Noord-Holland
PWN
SVASEK HYDRAULICS
COASTAL, HARBOUR AND RIVER CONSULTANTS
Unie van Waterschappen

The roles of the postdocs

- Integration
  - Phd days, field campaigns, writing week
- Utilization
  - Collaborate with end-users, design workshops, sandy strategies
- Dissemination
  - End user meetings, media, excursions, this symposium, related programs & projects

Arjen Luijendijk
TU Delft & Deltares
Postdoc on Physical feasibility worldwide

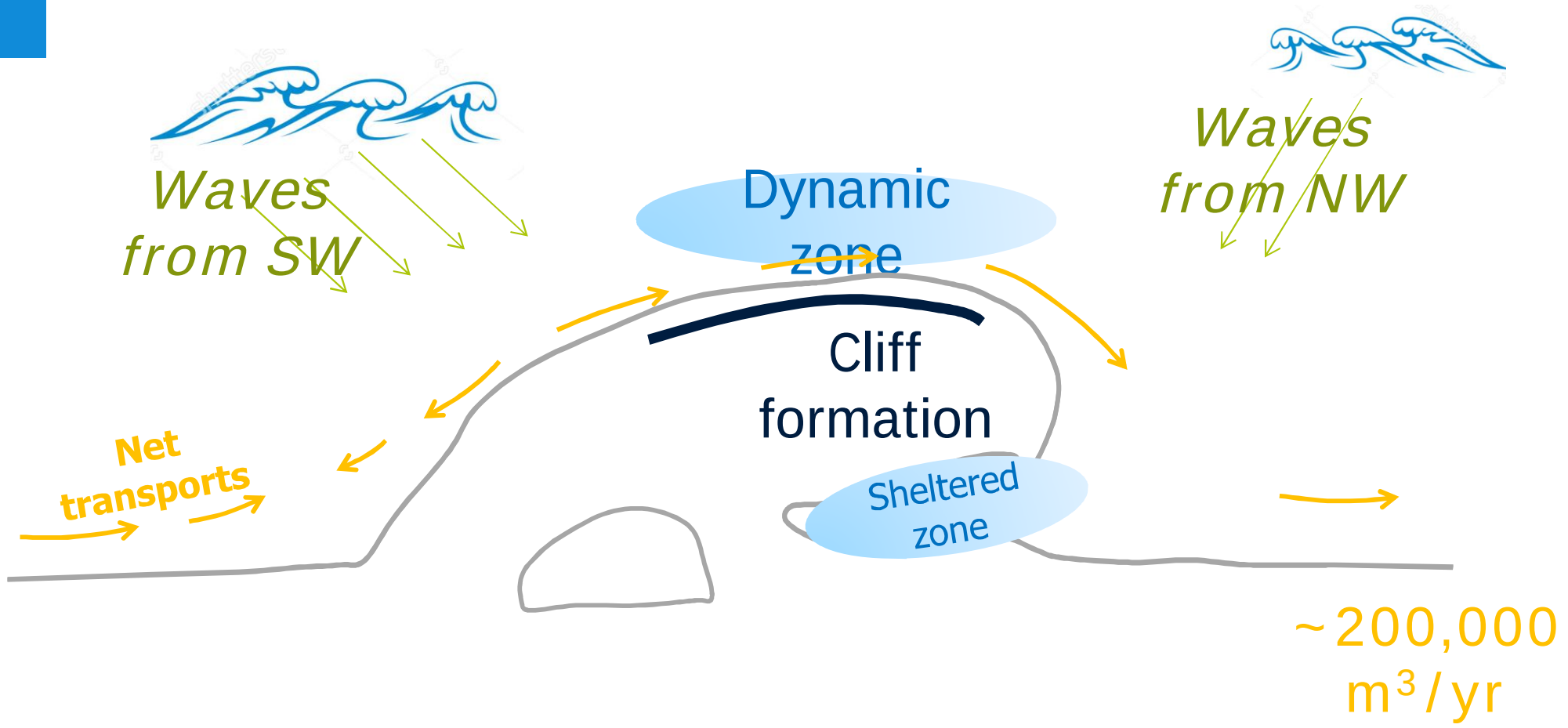
Vera Vikolainen
University of Twente
Post-doc on Governance

Alexander van Oudenhoven
CML, Leiden University
Post-doc on Ecosystem services

Zandmotor features

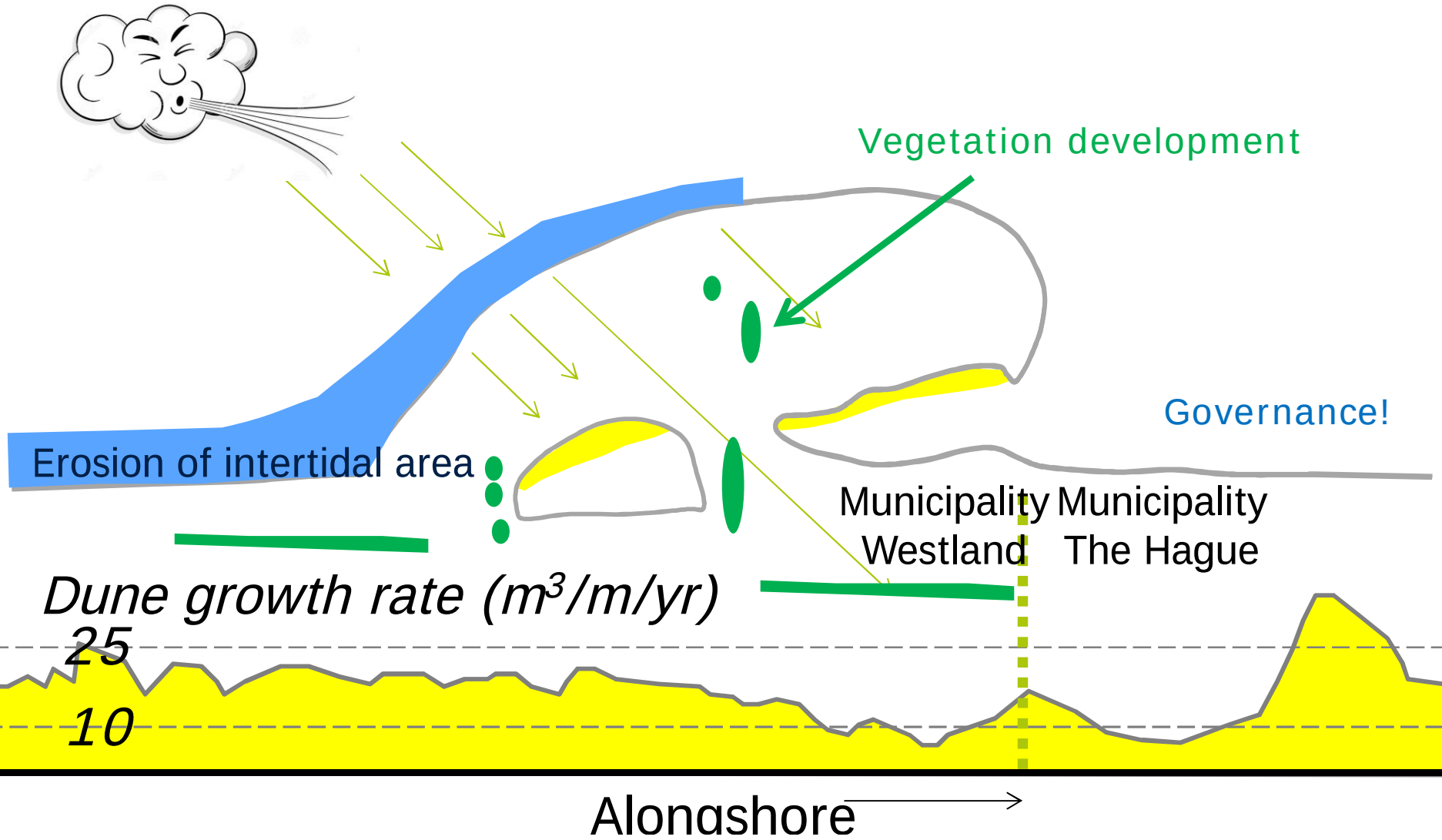
Understanding its behaviour

Forcing type: Waves Wind Tide



Understanding its behaviour

Forcing type: Waves Wind Tide



Understanding its behaviour

Forcing type: Waves Wind Tide

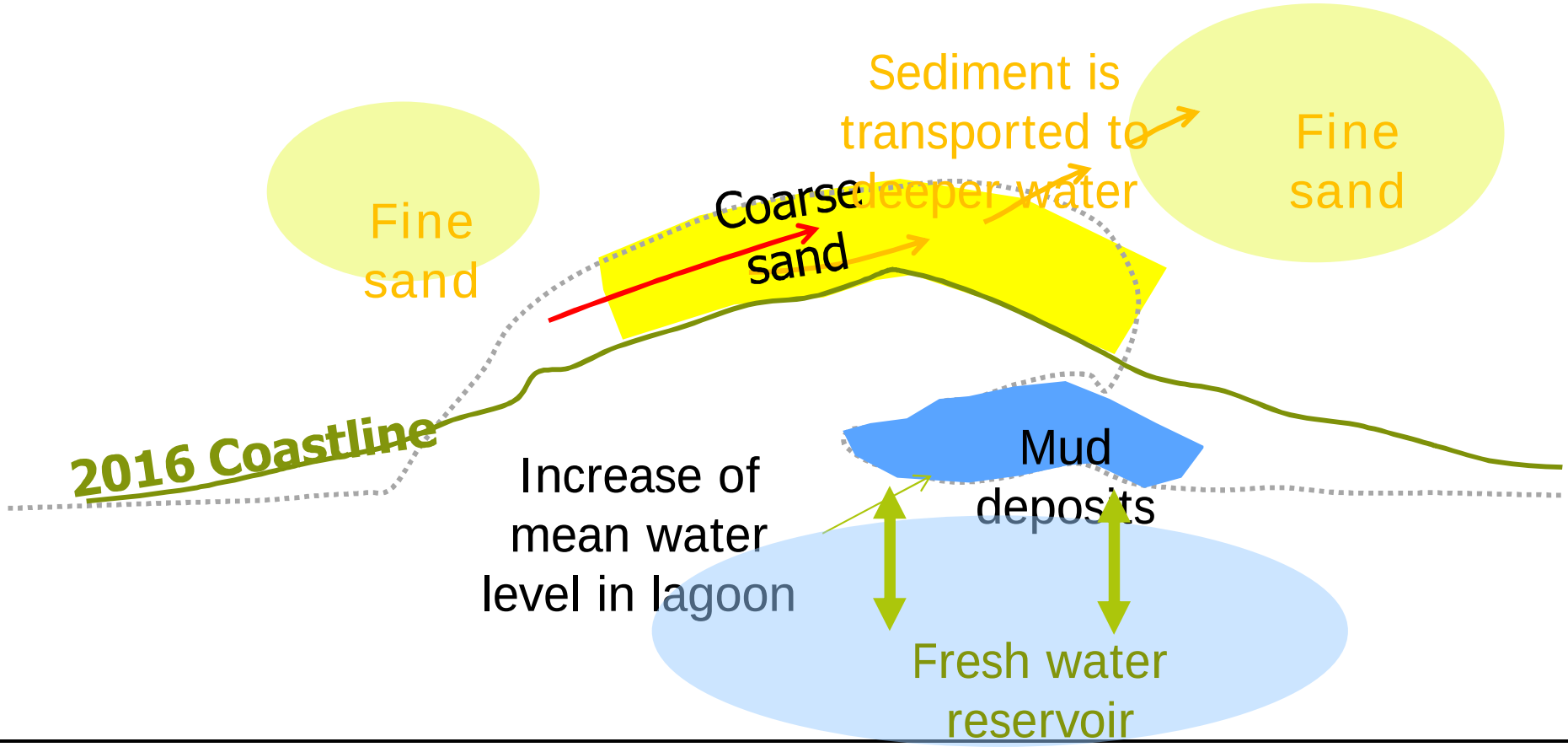
t
deeper water

Tidal currents

2016 Coastline

Understanding its behaviour

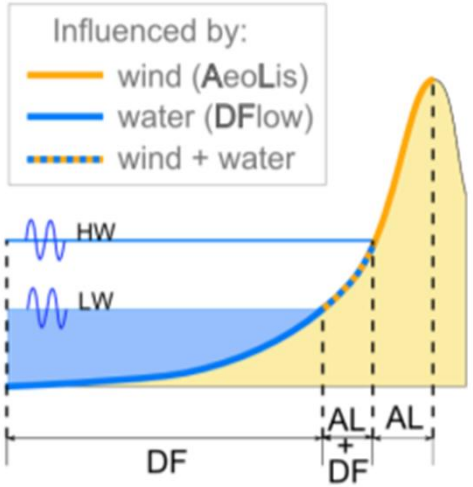
Forcing type: Waves Wind Tide

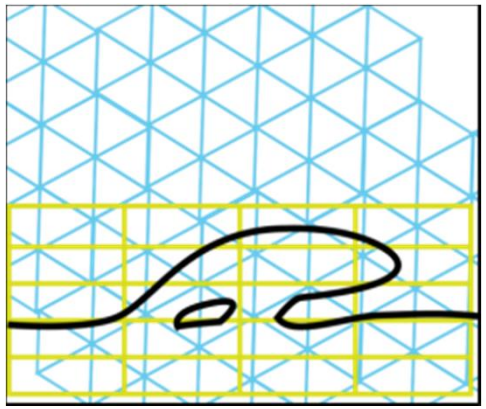


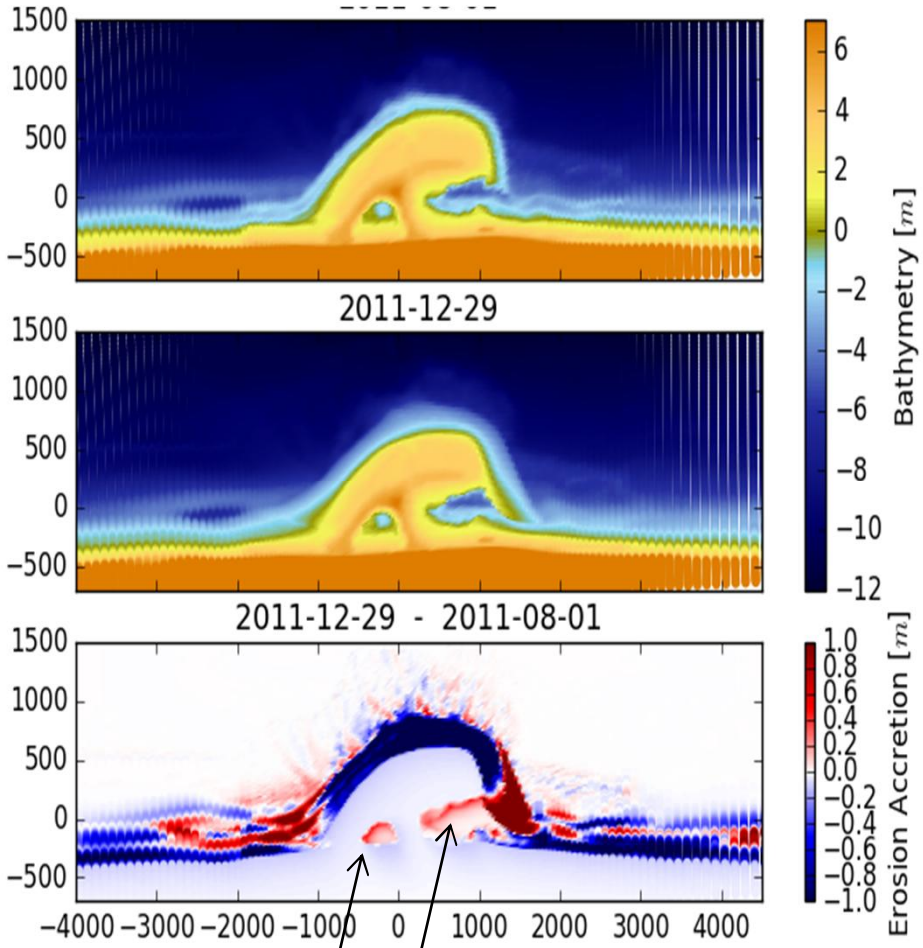
Integrated morphodynamic model

for the dry beach and subaerial

- Intertidal area is resolved by Delft3D and AeoLiS model
- Deposition of dune lake and lagoon is now incorporated in the morphological simulation.







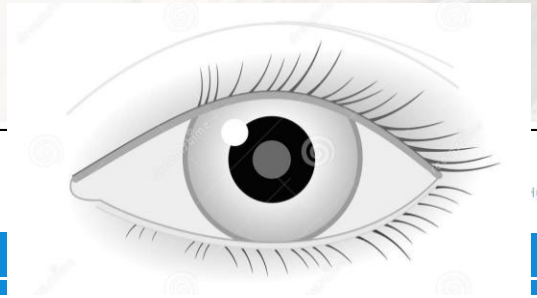
Arjen Luijendijk, Bas Hoonhout, Rufus Velhorst and Sierd de Vries, Coastal Dynamics, 2017

Nature Coast
BUILDING WITH NATURE

Outline

1. Introduction Dutch Coast
2. Design Sand Engine & construction
3. Monitoring
4. Knowledge development
5. Is this concept transferable?

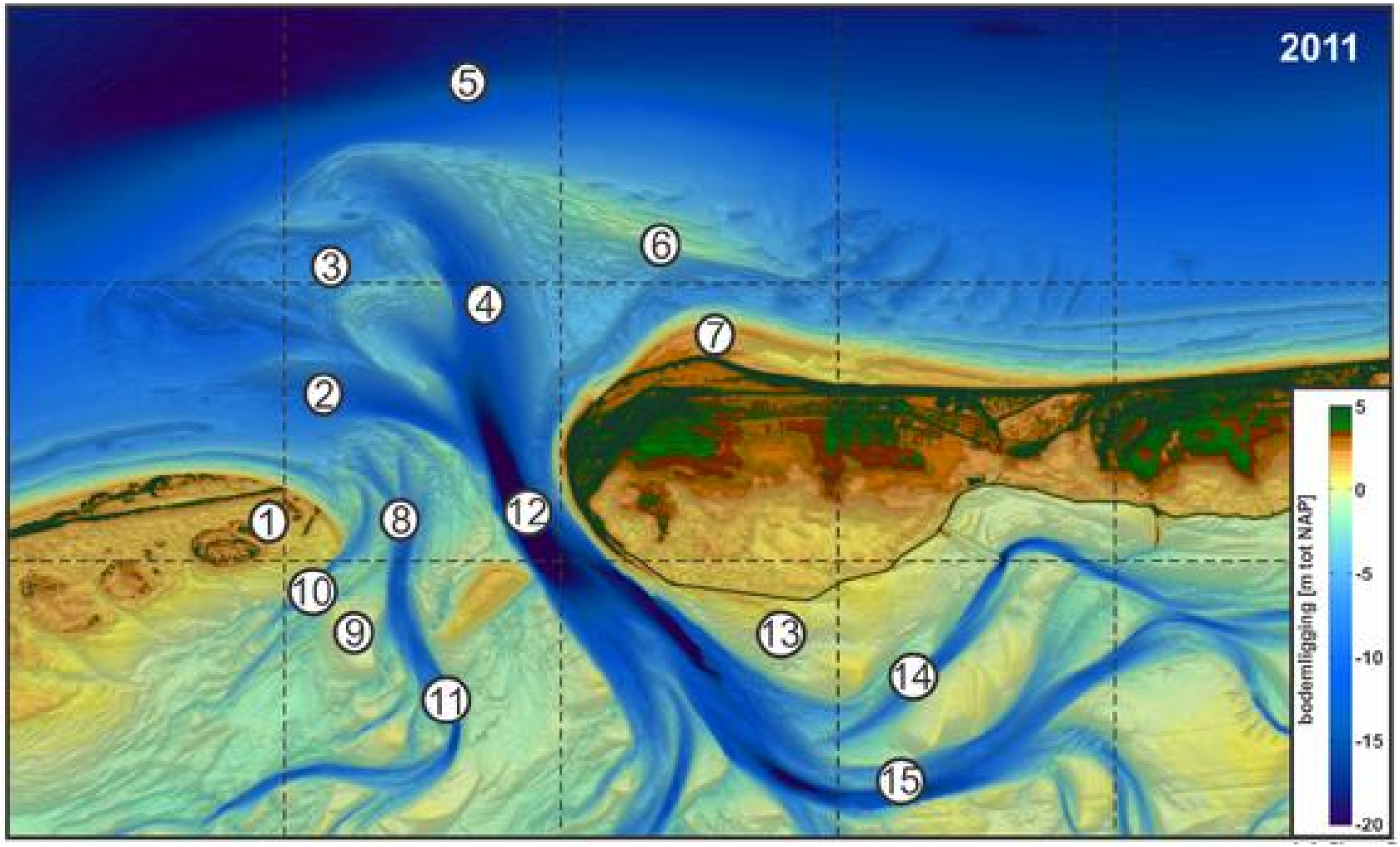
Monitor



Understand

Create

Next Sand Motor in the Wadden Sea?



We can not copy-paste the Sand Engine

- The Sand Engine Delfland is an optimal solution for the Delfland Coast.

- The start point for comparable solutions should be the context of a local coast having its own:
  1. ambitions
  2. governance context
  3. environment
  4. eco-system services

- Don’t copy-paste but instead:
  - Integrate experience from the Sand Engine in innovative Sandy Strategies
  - Sand Engine concept is tranferable, not Sand Engine Delfland