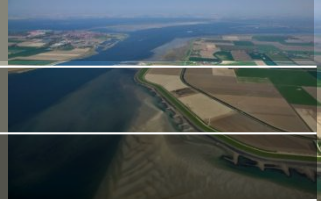
Deltares
Enabling Delta Life

Effective and multifunctional flood safety through Building with Nature

Mindert de Vries and Bregje van Wesenbeek

27 februari 2014

Mindert de Vries

Project coordinator of FAST

Senior specialist Eco-Engineering Deltares
Lector Building with Nature HZ Uni. Applied Sciences
Leading lector (Professor) of Delta Academy Applied Research Centre

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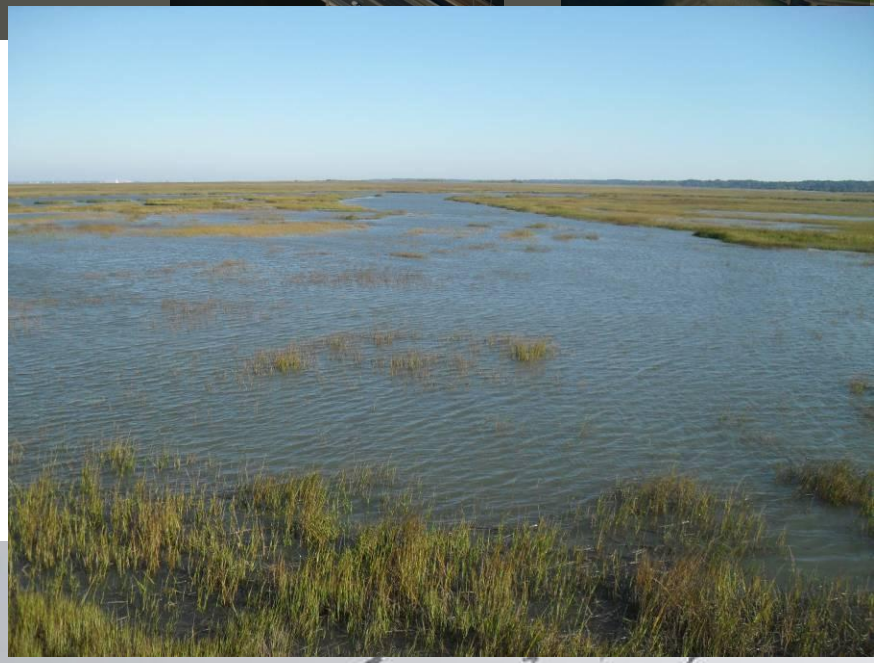
Ecosystemservices relevant for flood safety

- Wave dampening
- Reduction of windspeed
- Reduction of currents
- Stabilisation of sediment
- Increase of sedimentation
- Reduced erosion
- Water retention
- Creation of a physical barrier



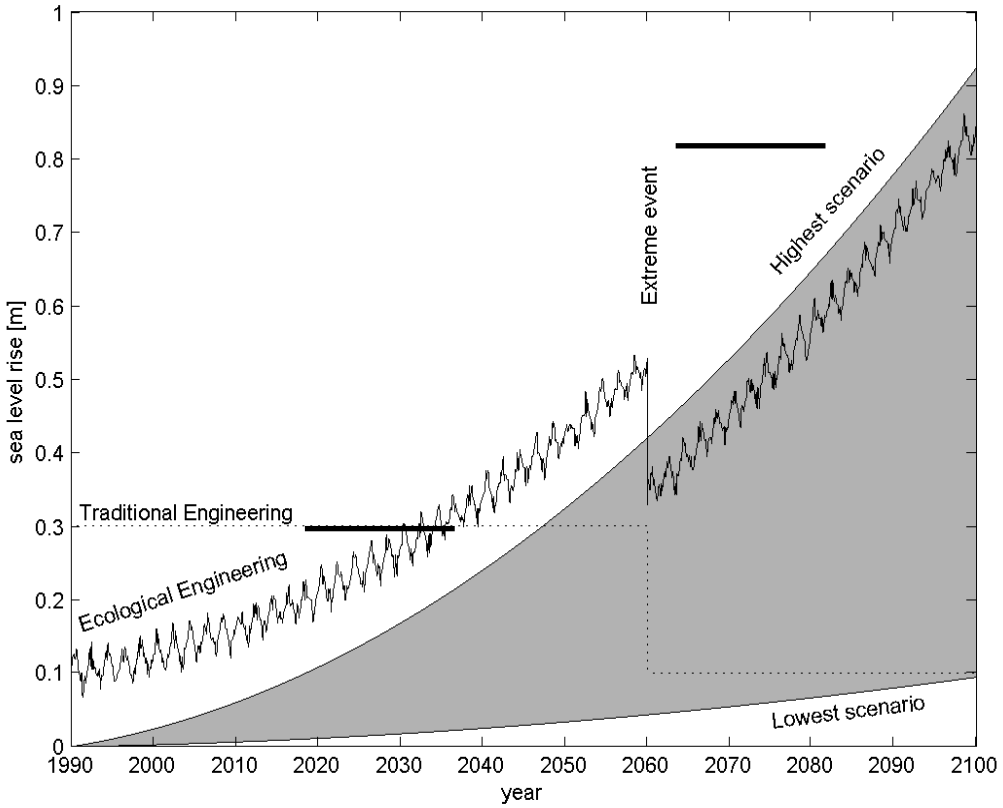
Why should we do ecosystem-based flood defense

Why should we make use of natural processes and ecosystem services in flood risk mitigation in combination with hard engineering?

1. Cost reduction
2. Reduces risk on failure
3. Adaptable

Adaptable

1. Self-sustaining and self-repairing
2. Accretes with rising water levels (peat or sediment)
3. Dampens waves independent on wave height



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Adaptable

1. Self-sustaining and resilient
2. Accretes with rising water levels (peat or sediment)
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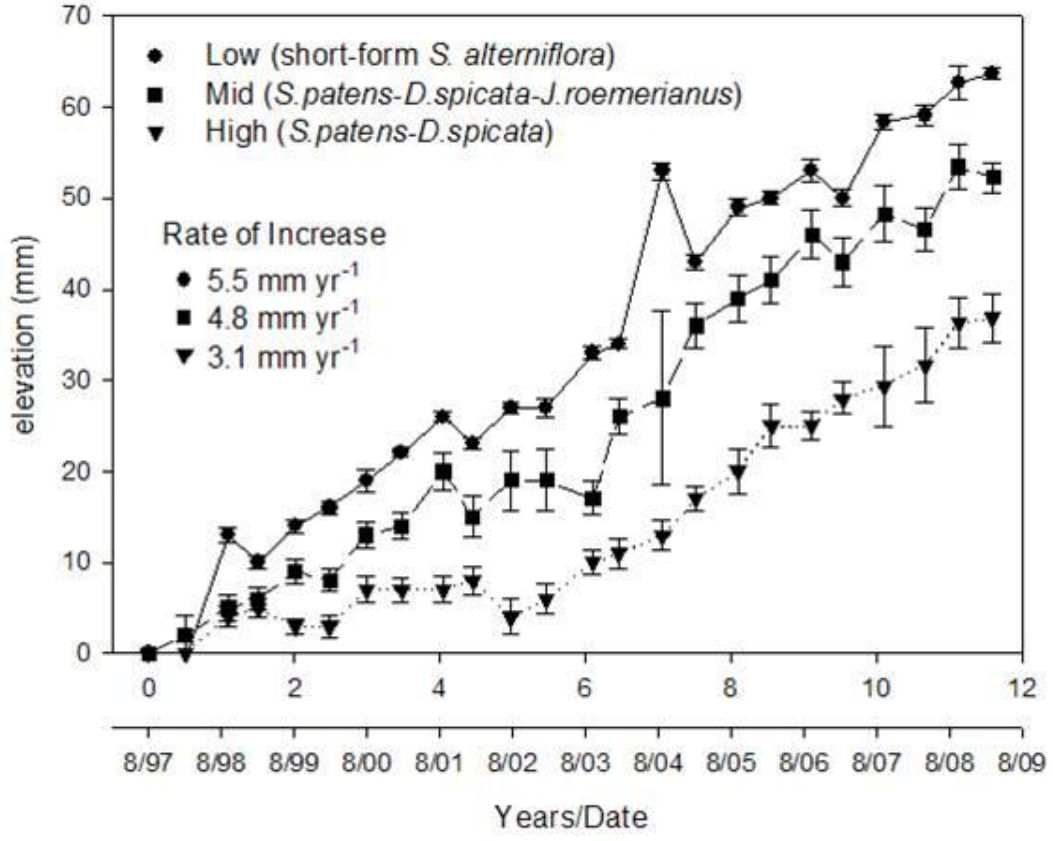

Blum 2011

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Adaptable

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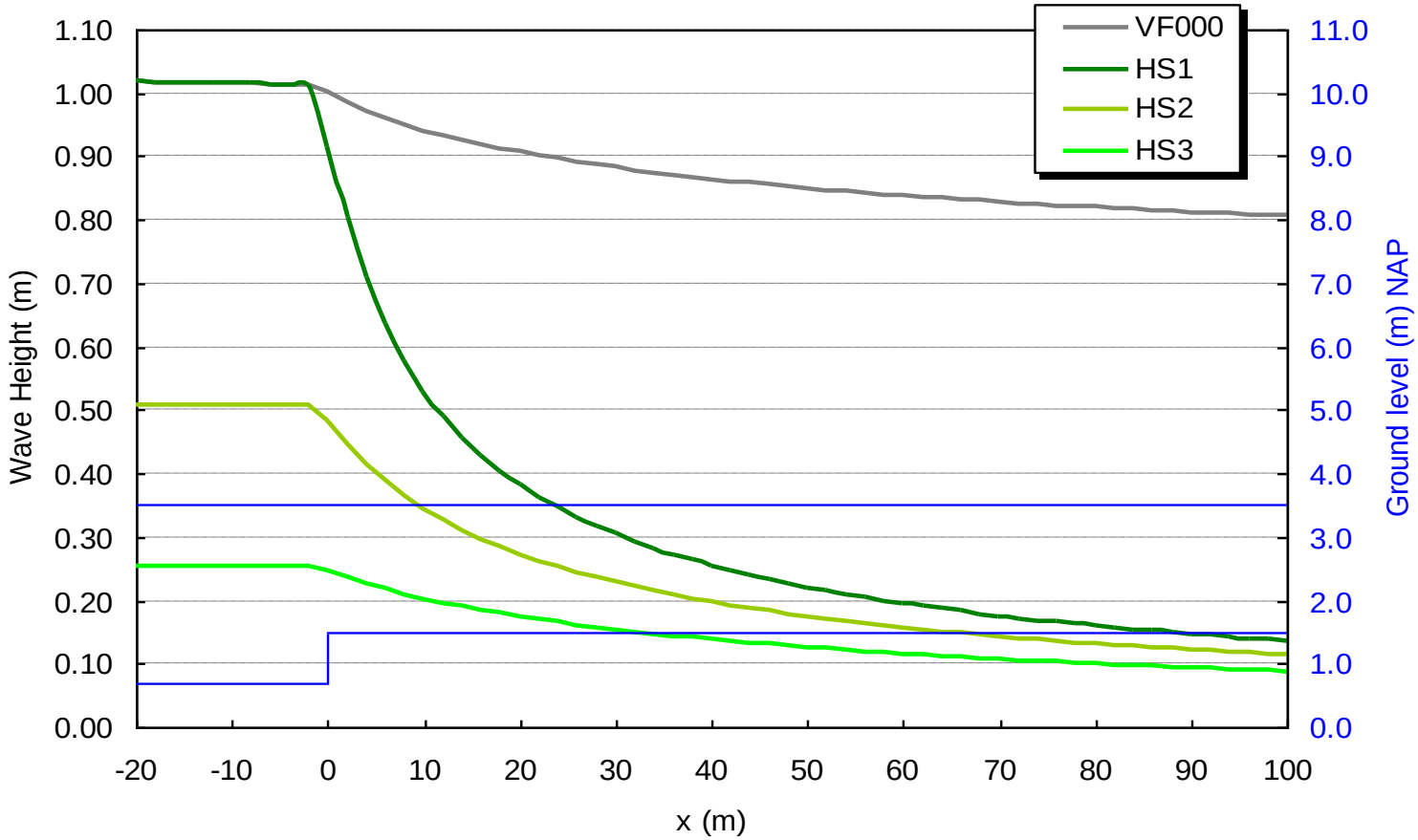
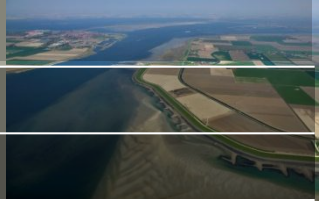
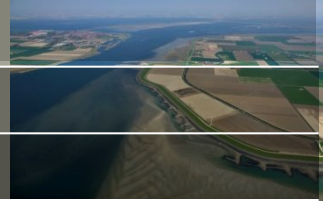


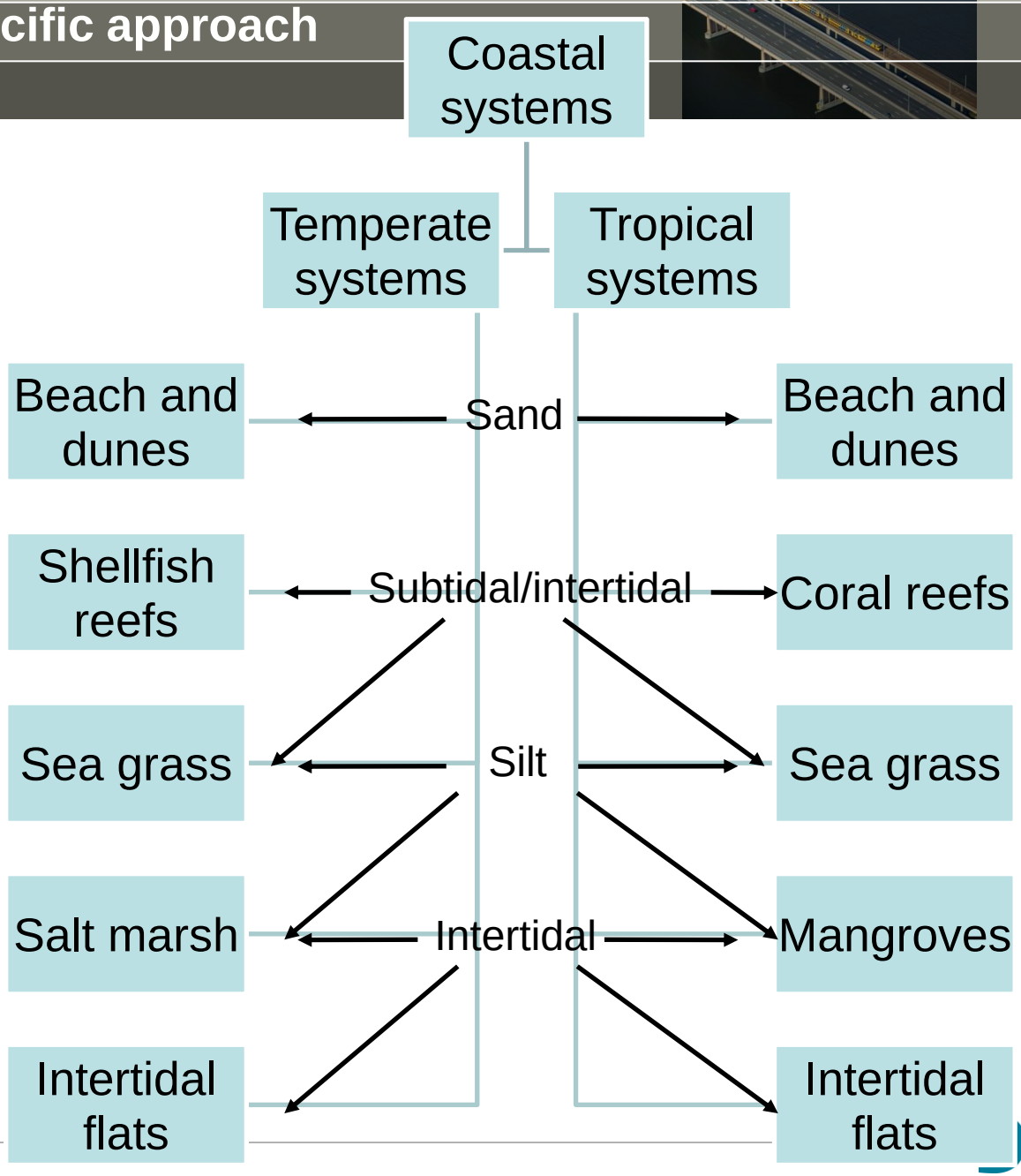
Additional benefits



- Nursery for fish and aquaculture species
- Food provisioning (fruits, waterfowl)
- Carbon fixation
- Firewood production
- Water purification
- Water retention
- Biodiversity
- Tourism & Recreation

System specific approach





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Coastal systems

- Coastal systems
  - Temperate systems
    - Beach and dunes
    - Shellfish reefs
    - Sea grass
    - Salt marsh
    - Intertidal flats

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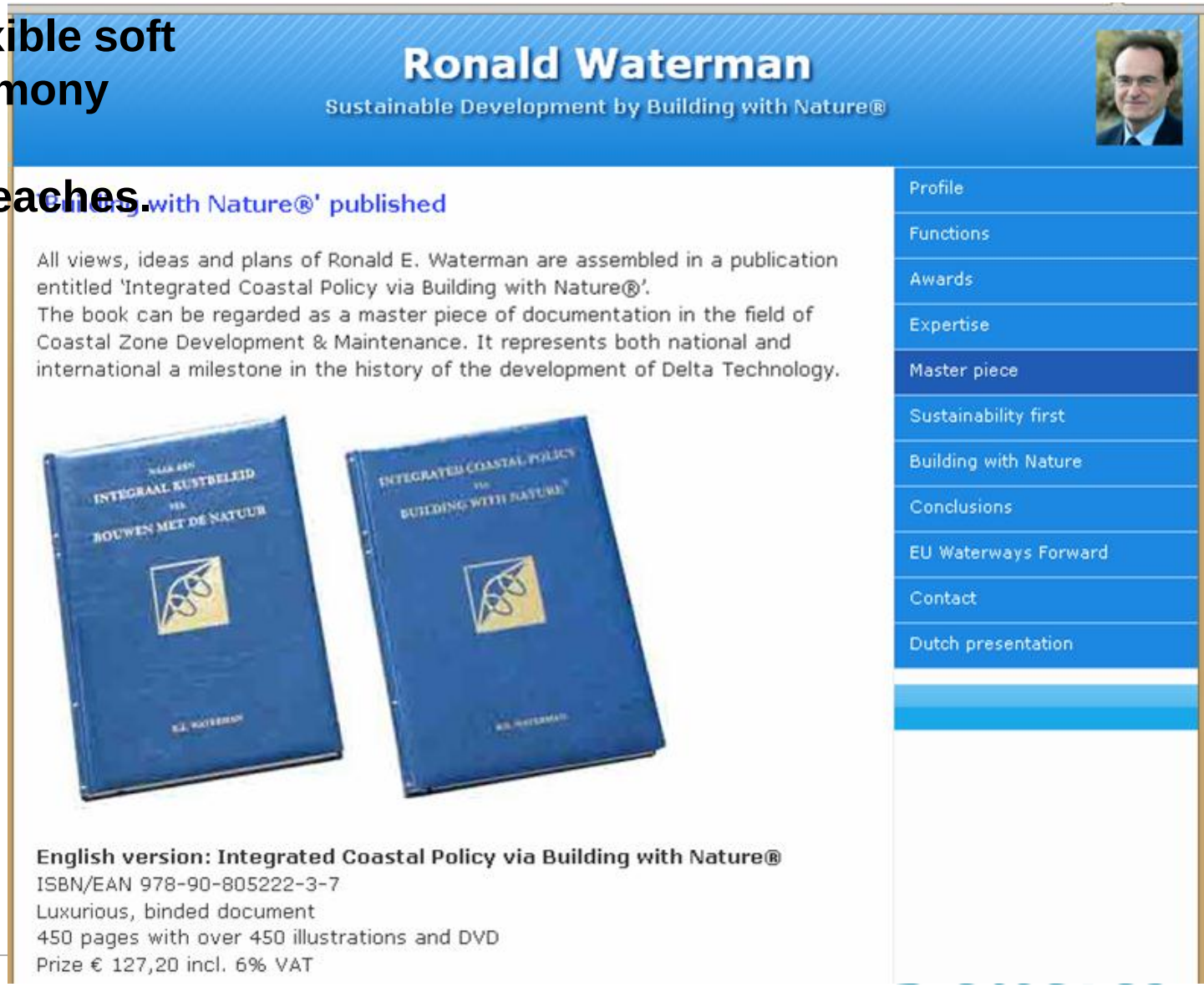
Principles of Building with Nature (R. Waterman)

Emphasis on flexible soft structures in harmony with the sea, like dunes and beaches.



Dutch historical 1000yr large scale land reclamation = stabilize mud coast by growing saltmarshes

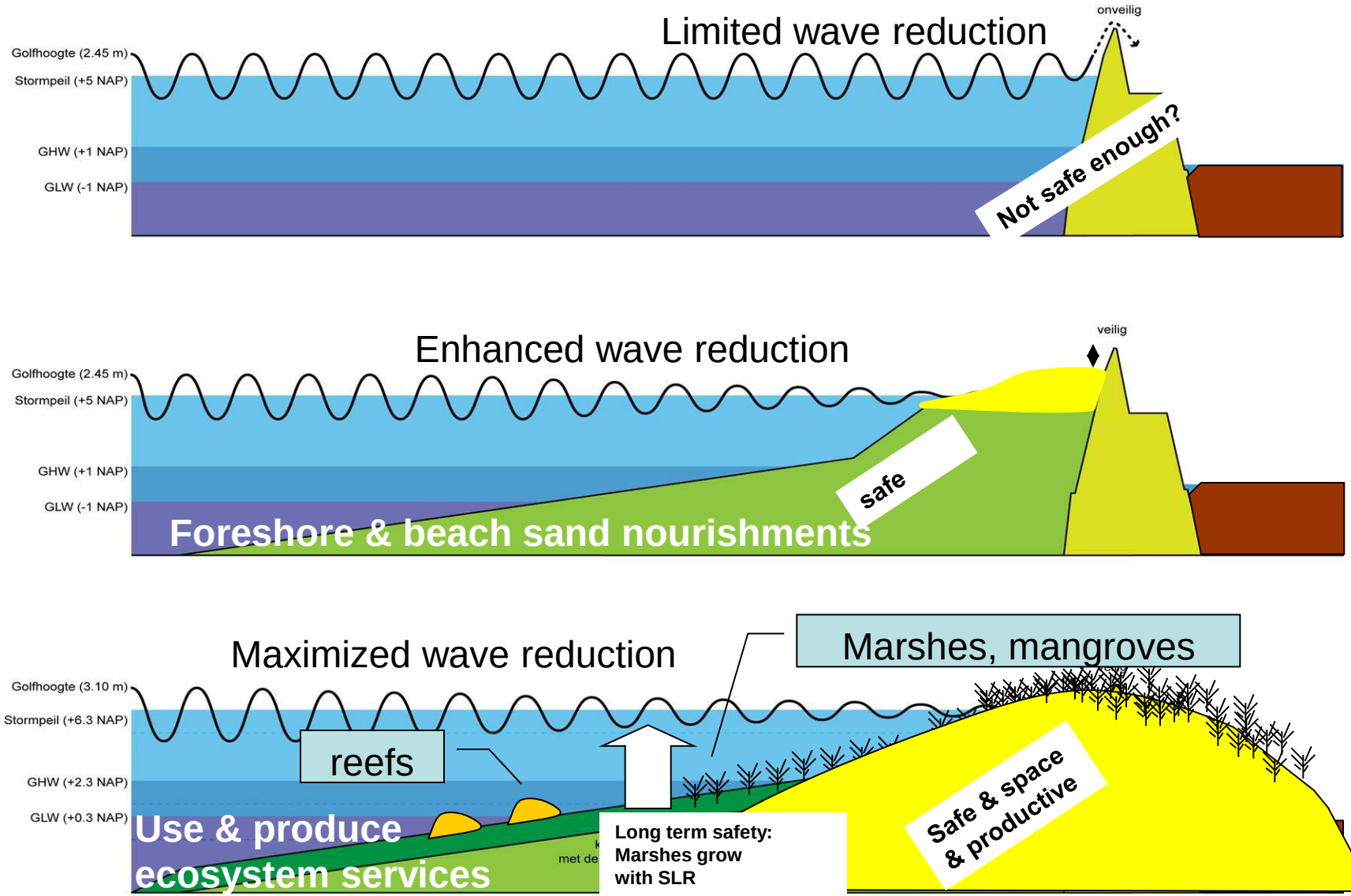
Frisian Wadden Sea coast

Effective low cost
low tech method
produces safety
& productive habitats
& more space

BWN stands on long term practical understanding of natural processes

100’s km Dutch sandy coast protected long term with dunes stabilized by vegetation

Traditional knowledge and BWN integrated to build safe soft eco levees by reef, marsh, dune, dike combinations



Situatie bij een superstorm, 1x per 10.000 jaar

BWN delivers continuum of concepts and applications

soft solutions

hard solutions

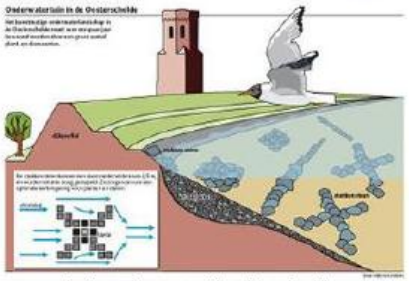
tidal

non-tidal

Galgeplaat
shoal nourishment

Delfland coast
Sand Engine

ES: oyster reefs
as shore protection



Eastern Scheldt
underwater garden

IJsselmeer
foreshore nourishment

Markermeer
eco-levee

Noordwaard: willow
forest foreshore

'rich levee'

focus on
ecosystem
functioning

focus on
infrastructure
development

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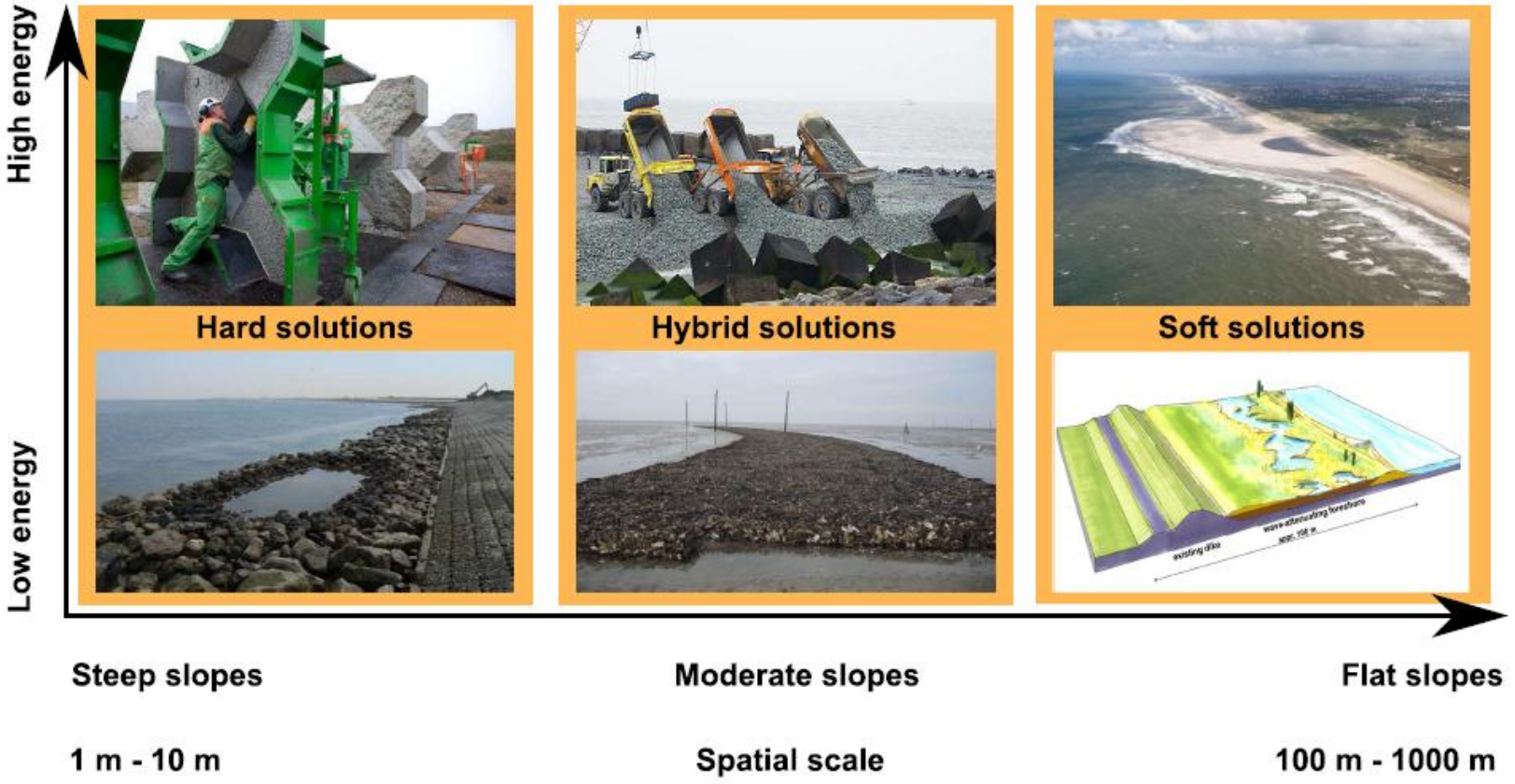


Figure 1: Range of potential BwN applications along the main axes of given bed slope and hydrodynamic energy. Of course factors like salinity and geo-climatic region also detemine potential solutions.

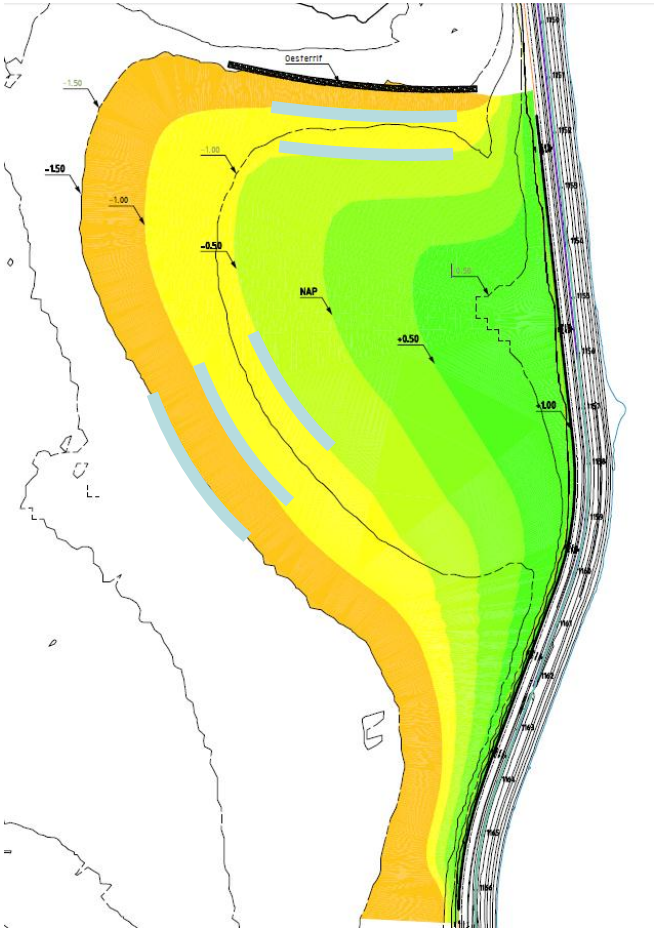
Hybrid Example: 2010, Ecoshape consortium: foreshore protection with oyster reef experiment

3x 200m x 20m

Reduce erosion of intertidal flats in Eastern Scheldt, maintain habitats and protect the dike

Safety buffer Oesterdam (implemented in 2013)

- Reduce erosion
- Promote aquaculture
- Promote nature



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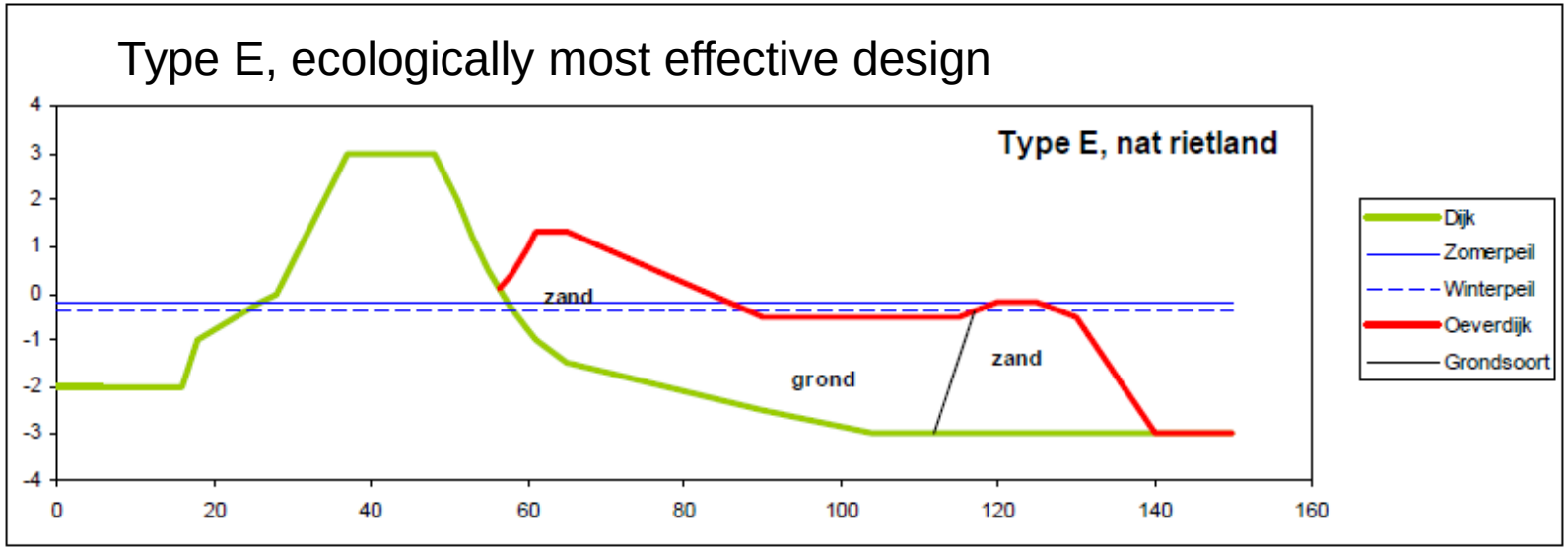
2011: Conceptual Design ‘Oeverdijk’

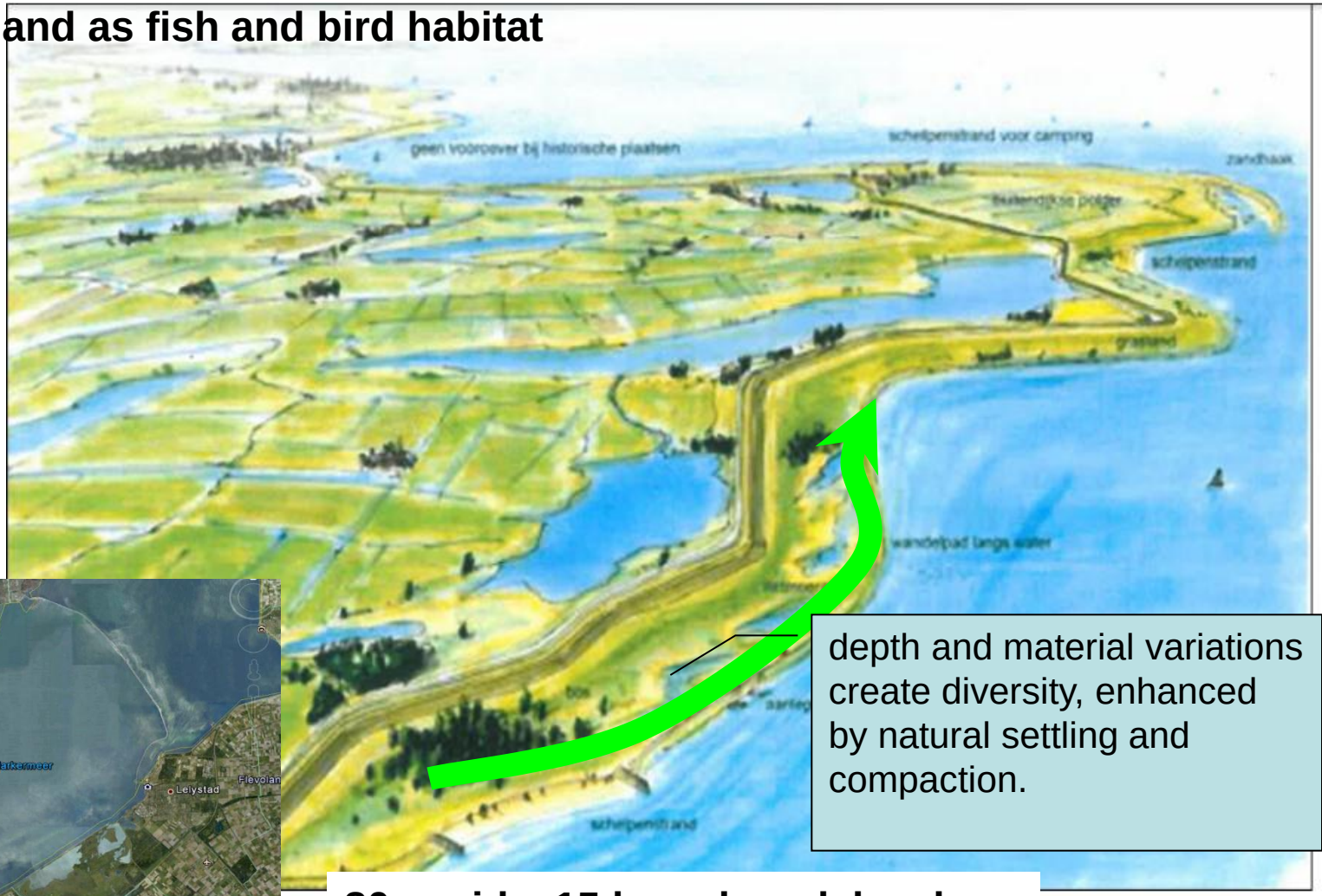
Door ARCADIS –DELTARES

- Aim1: replace weak dike section with safe and cheap solution
- Aim2: produce a natural solutions that delivers benefits to other functions.
- Construction: 2018



Soft Example: 2010, Waterboard, RWS, Deltares: completely soft green solution replaces existing dike

Nature development with longshore connectivity and regional relevance for recreation and as fish and bird habitat



depth and material variations create diversity, enhanced by natural settling and compaction.

Amsterdam

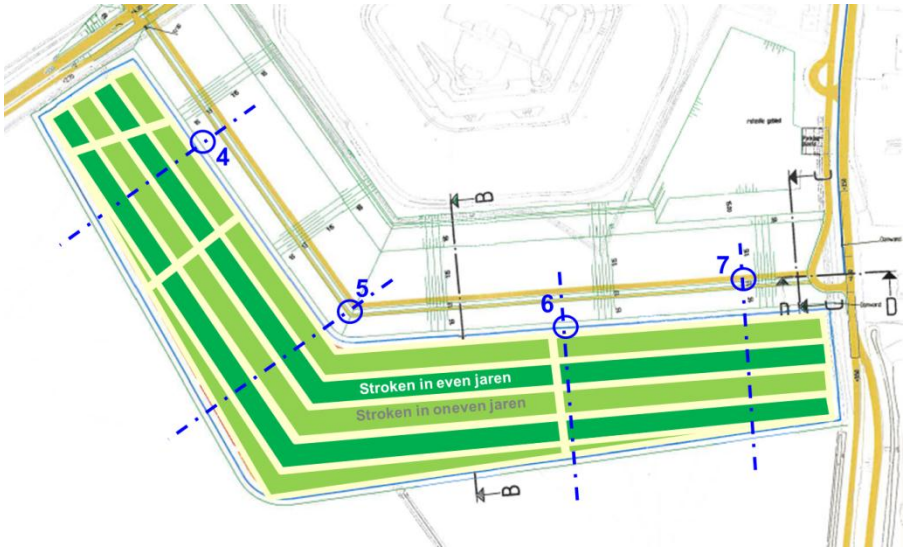
80m wide, 15 km, along lake shore
Final technical design phase

Forest-Dike combination near Werkendam

- Aim: reduce waterlevel at peak discharge at city of Gorinchem
- Need to build new dike as part of dike-ring. Klaar in 2015.
- Design of cheap hybrid solution with a low as possible crest heigth.
- Maintain legally required safety level

Build a wave reducing forest

- A willow tree forest is introduced



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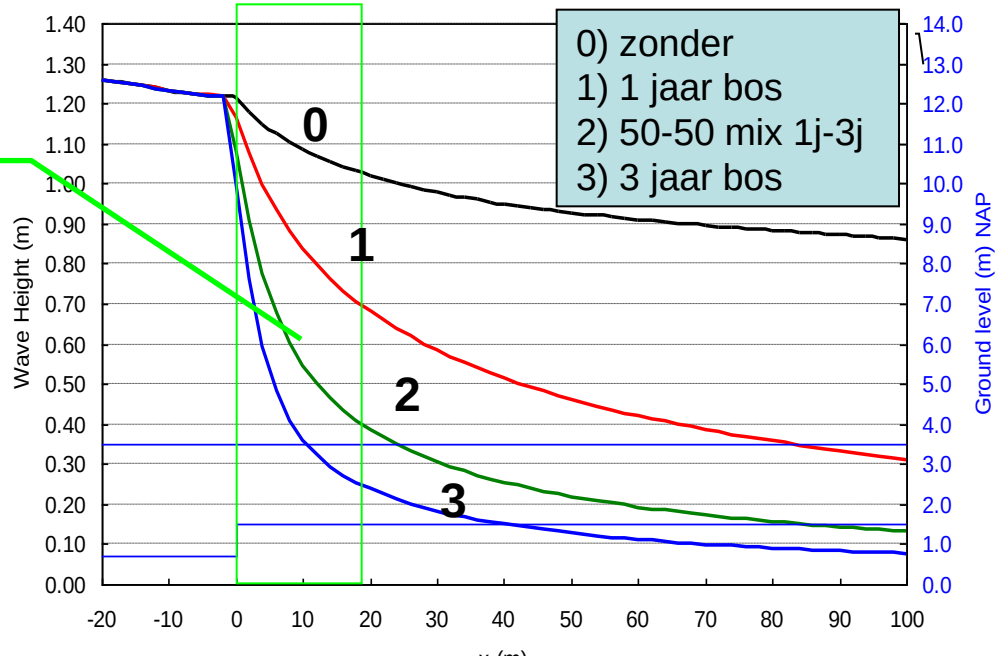
twee jarige wilgetenen

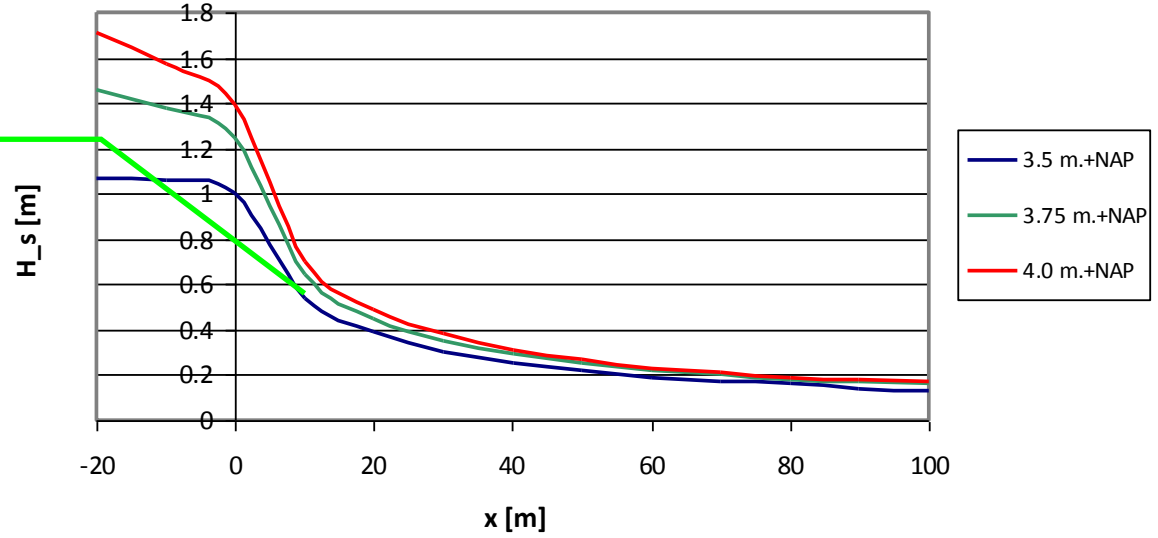
8 jaar oud griend, twee jaarlijks gemaaid

Willows reduce waves, predicted by SWAN-VEG WAVE model

70%-80% reductie van golfhoogte in wilgenbos in eerste 20 m (2 en 3)



Golfreductie is ongevoelig voor stijgende waterhoogte



Hybrid Example: 2009 RfR programme Noordwaard Wavereducing forest- soft dike combi 'Werkendam'

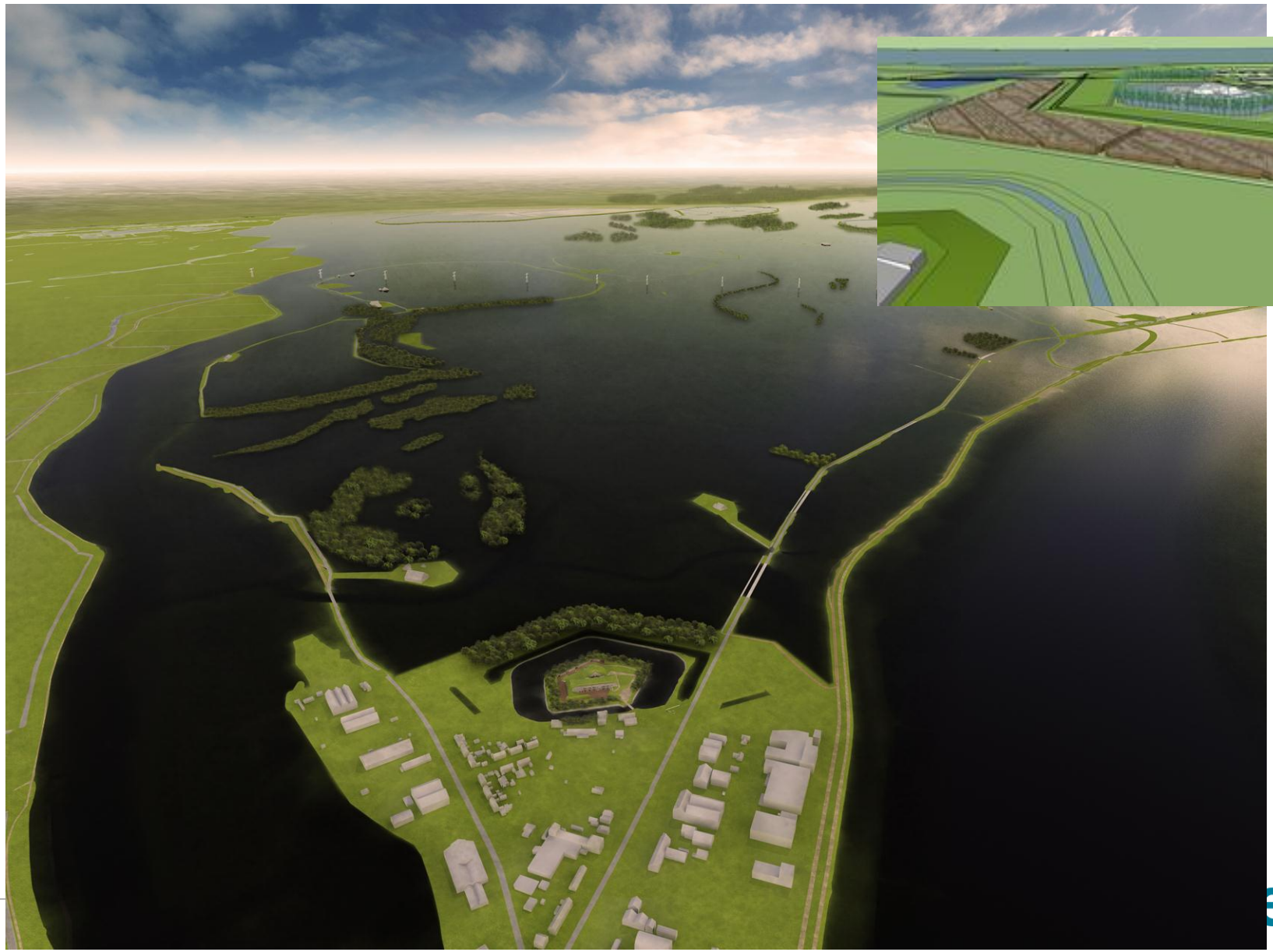
Clay dike
will be lower than
traditional design

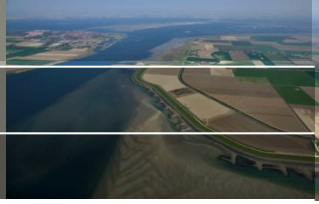
100m wide

Wave reducing
willow-tree plantations
Low cost low tech

- >70% reduction of wave height in healthy willow forest
- Deltares/RWS design achieves required 1/2000 safety standards and is <u>now under construction</u>.

Artist impression: hybrid dike near Werkendam





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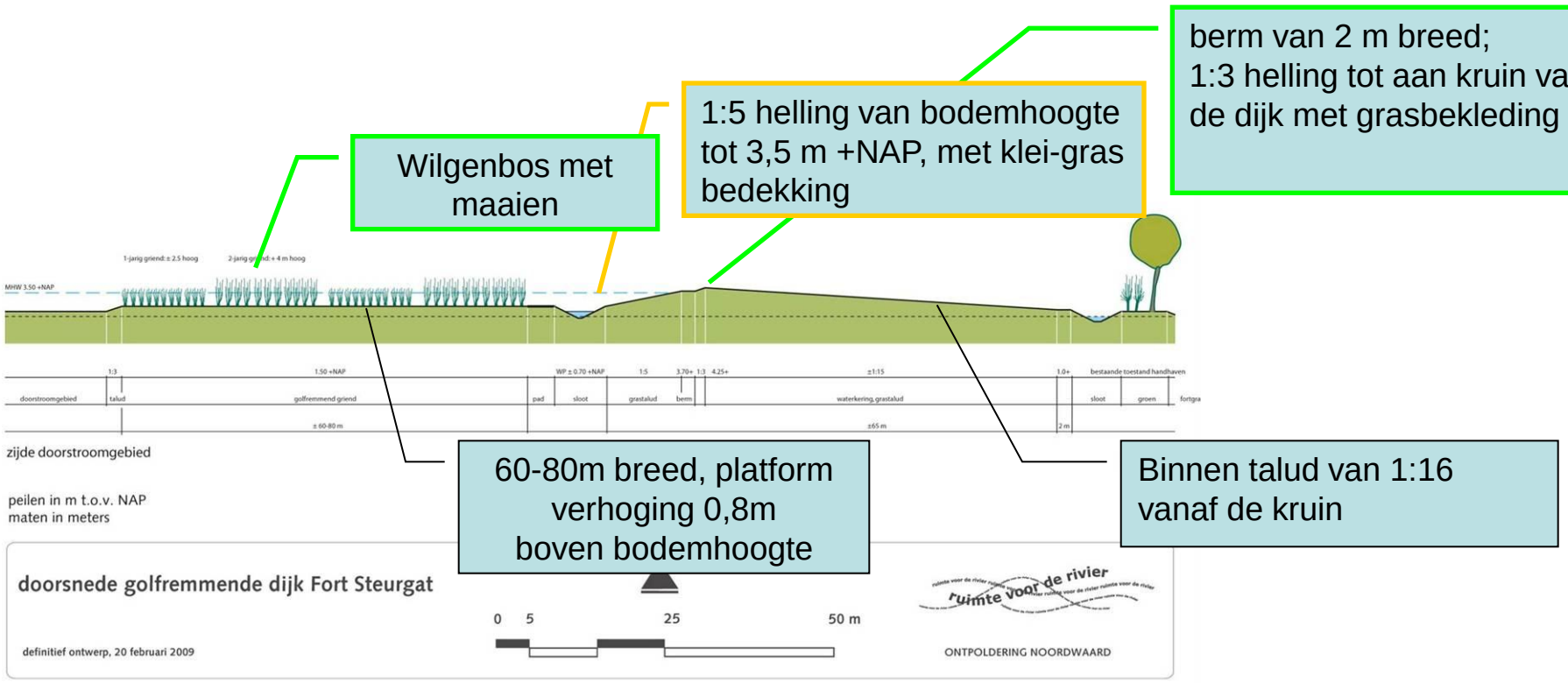
Technical design of forest-dike combi



Hybrid dike replaces traditional design

Crest height reduced with 0.7m. Completely soft design of slope

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Monitoring….

- Regular yearly monitoring
  - growth/health/density
  - Stability of the slopes
- Check status @ extreme conditions:
  - Storm events
  - Ice cover/flows
  - Fire
  - Diseases

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Maintenance is crucial

- Use adequate measures for heath issues
    - Chemicals, cutting
- Regular cutting is part of healthy forest management:
    1. *After storm season*
    2. *Half of forest each year (or two years)*
    3. *Use slow growing species*
    4. *Replace old trees (they will die after about 30-40years)*

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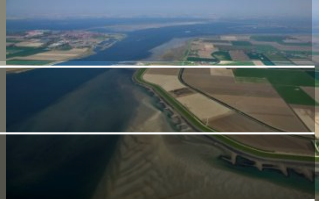
Benefits en cost



- Lower dike
- No hard cover needed
- Added natural and landscape values
- Robust design (climateproof, flexible w.r.t . boundary conditions)

- Saved 1500 Eur/m in construction cost)
- Maintenance 2 Eur/m/y higher (forest, Eur1.500/ha)

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Our minister of transport and environment is supportive

26-04-2013 **Werken met de natuur**

Minister Schultz wil ‘werken met de natuur’. “Eeuwenlang hebben we de natuur met dammen en dijken proberen in te perken. Maar we kunnen de oplossing niet alleen blijven zoeken in het ophogen of verbreden van dijken. Ik wil bouwen mét de natuur.

Melanie Schultz: 'Mijn beeld is dat bouwen mét de natuur je veel beter beschermt dan de technische oplossingen die tegen de natuur ingaan.' Volkskrant 26 januari 2013

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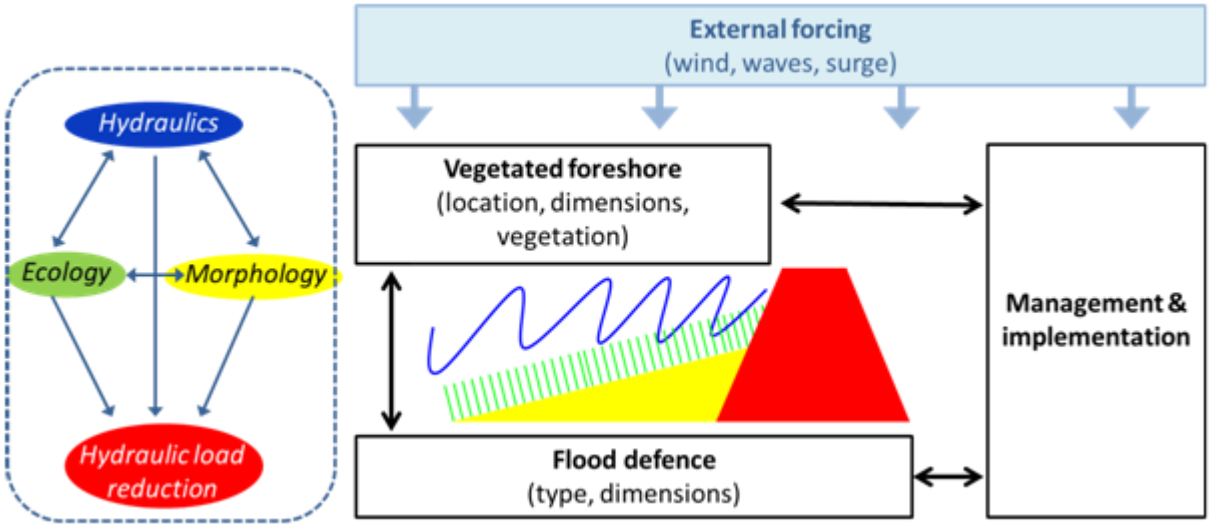
Stability of saltmarshes: filling gaps in Hydralab 3 (2012-2013)

NWO project BE-SAFE (2014-2017)

- Focus on dynamic development of foreshore in time
- We aim to develop new methods to assess how, and how much vegetated foreshores can contribute to flood risk reduction. This requires integration of knowledge from ecology, biogeomorphology, hydraulic engineering, and governance



NIOZ, TUD, UT, HKV, Deltares
End users: RWS, NGO's, Waterboards

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FAST

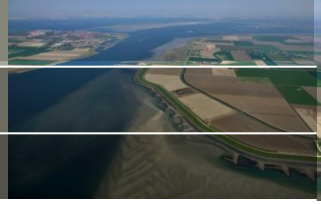
FORESHORE ASSESSMENT
USING SPACE TECHNOLOGY

FAST
Foreshore Assessment using Space Technology

EU 7th Framework Programme SPACE

'Stimulating development of downstream services and service evaluation'

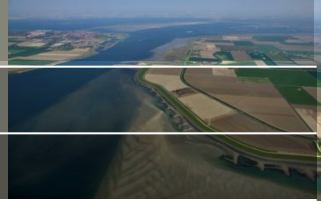
FAST Challenge



Challenge: foreshores are currently not included in water safety assessments and in levee design but can be effective building blocks for safety.

Aim: to develop a new GMES/Copernicus downstream service by developing products based on Sentinel data to gain spatial information on foreshore and floodplain characteristics, such as morphology, sediment characteristics and vegetation properties.

FAST Steps WP3-4



- EO data collection of foreshore characteristics
- On site ground truthing in 4 study areas
- Setup general relationships between foreshore and flood risk mitigation properties will be derived and implemented in a GIS based software package.
- Create software that calculates effects of foreshores and floodplains on hydraulic and bed conditions.
- Translate effects into to potential reduction in levee width and crest height.

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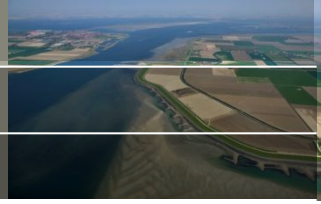
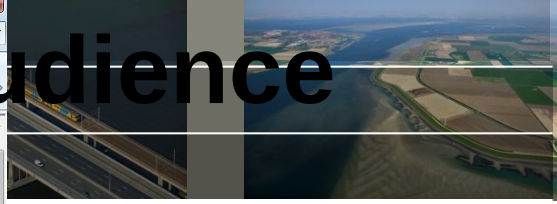
FAST Steps WP5-6-7



- Develop software in close contact with end-user groups to ensure commercial uptake and long-term continuation of services.
- Provide tool for integrating levee-landscape interaction into cost efficient and safe flood risk management strategies.
- Provide business case and disseminate the results

Dissemination to a wide audience



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European Study on Dike Upgrades Kicks Off (The Netherla

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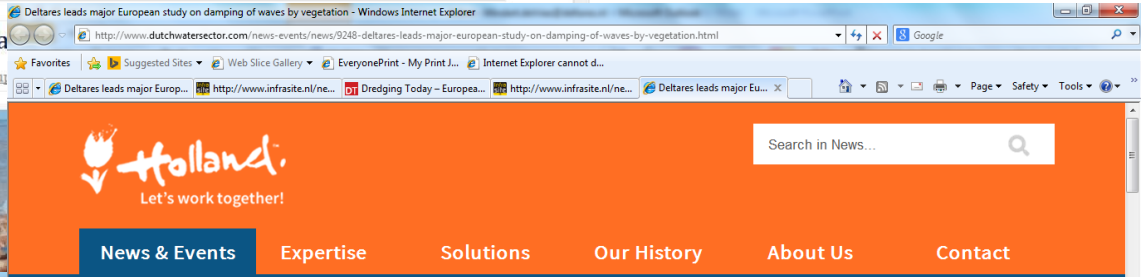
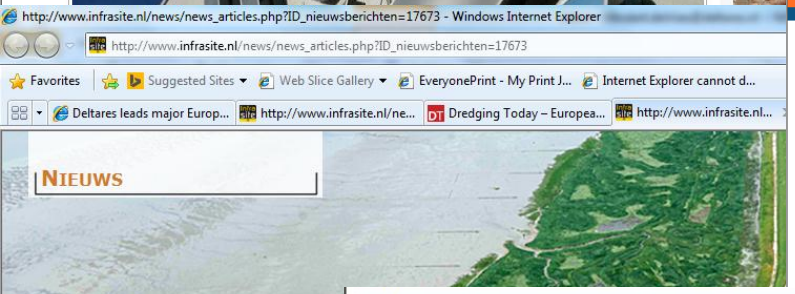
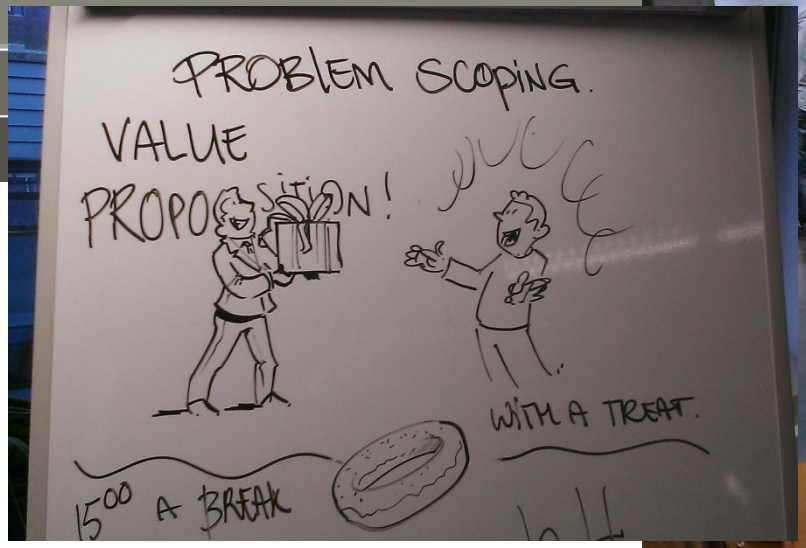
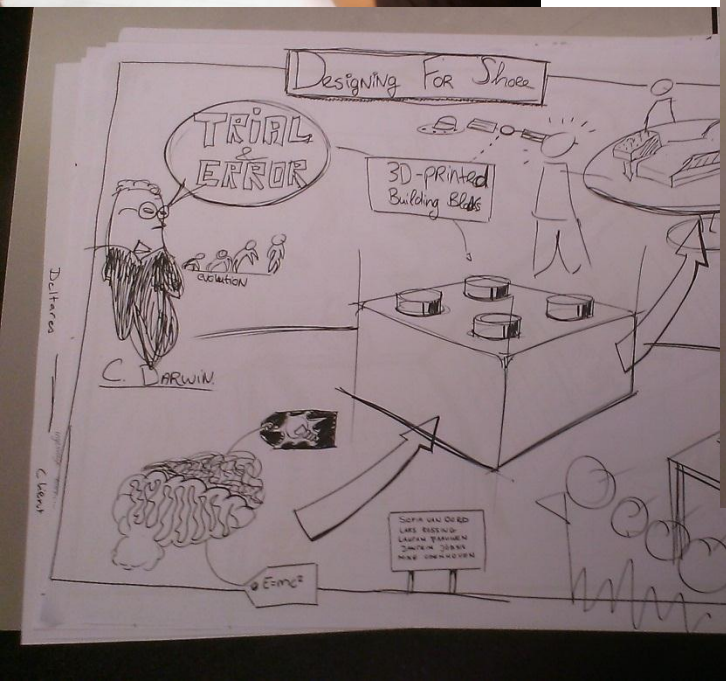
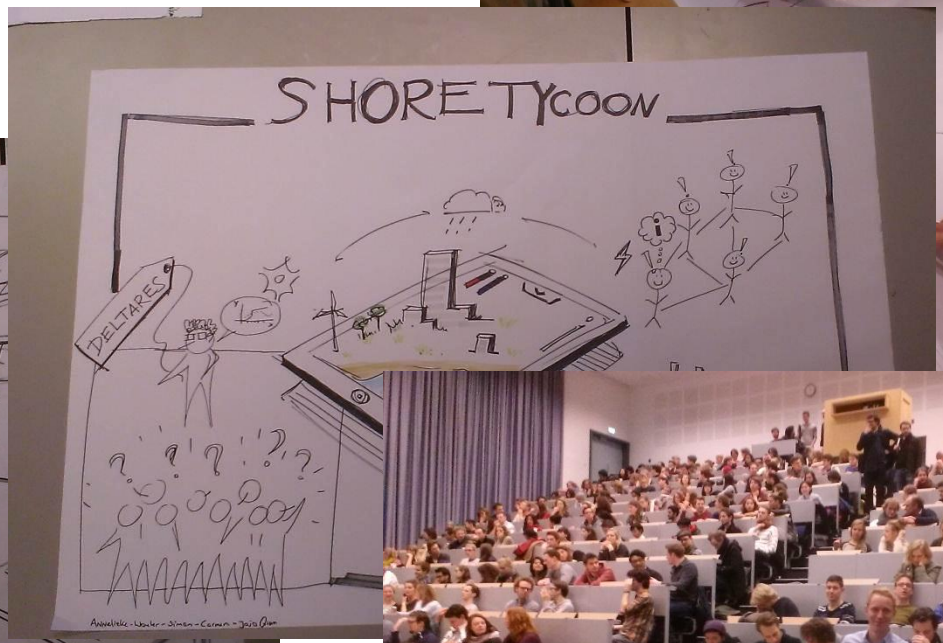




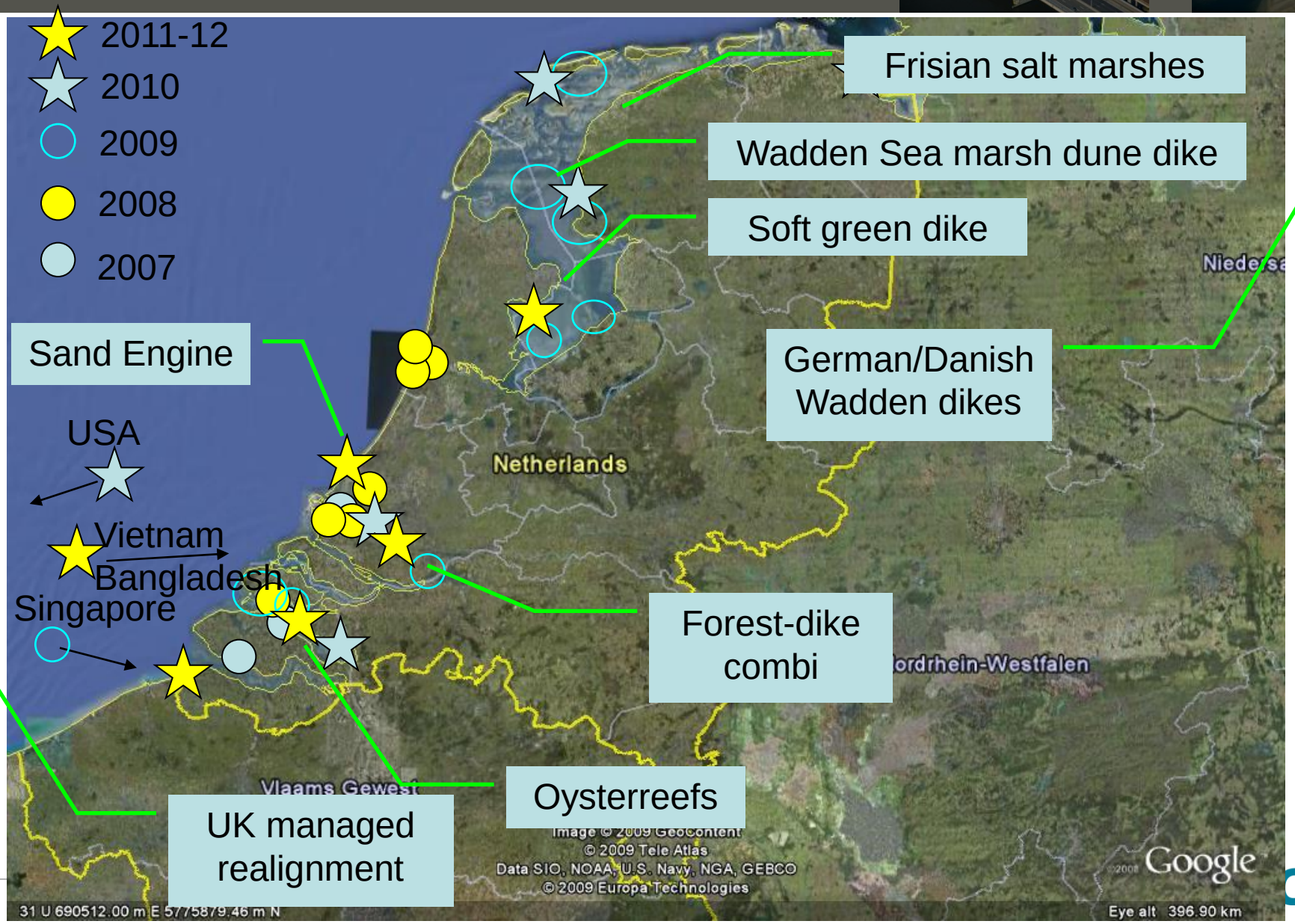

PROBLEM SCOPING.
VALUE
PROPOSITION!
WITH A TREAT.
15:00 A BREAK


Designing For Shore
TRIAL & ERROR
3D-printed Building Blocks
C. DARWIN
Deltares


SHORETYCOON
DELTARES


SHORETYCOON

Building with Nature projects overview



BW(L)N related publications, until now…

Borsje, B.W., B. K. van Wesenbeeck, F. Dekker, P. Paalvast, T. J. Bouma, M. M. van Katwijk, M. B. de Vries, **2011**. How ecological engineering can serve in coastal protection. Ecological Engineering, V37: 113–122.

Bouma, T.J., M. B. De Vries, E. Low, G. Peralta, I. C. Tanczos, J. Van De Koppel and P. M. J. Herman, 2005. Trade-Offs Related To Ecosystem Engineering: A Case Study On Stiffness Of Emerging Macrophytes. Ecology, 86(8), 2005, pp. 2187–2199

Leeuwen, B. van, D.C.M. Augustijn, B.K. van Wesenbeeck, S.J.M.H Hulscher, M.B. de Vries, 2009. Modeling the influence of a young mussel bed on fine sediment dynamics on an intertidal flat in the Wadden Sea. Ecological Engineering.

Paalvast, B. K. van Wesenbeeck, G. van der Velde, M. B. de Vries, **2012**. Pole and pontoon hulas: An effective way of ecological engineering to increase productivity and biodiversity in the hard-substrate environment of the port of Rotterdam. Ecological Engineering V44: 199–209

Slobbe, E. van, H.J. de Vriend, S. Aarninkhof, K. Lulofs, M. de Vries, P. Dircke, **2012**. Building with Nature: in search of resilient storm surge protection strategies. Accepted for publication as 'note to the editor' in Natural Hazards special issue in on storm surges.

Temmerman, S., T. J. Bouma, G. Govers, Z. B. Wang, M. B. De Vries, and P. M. J. Herman (2005), Impact of vegetation on flow routing and sedimentation patterns: Three-dimensional modeling for a tidal marsh, J. Geophys. Res., 110, F04019.

Temmerman, S., T.J. Bouma, J. Van de Koppel, D. Van der Wal, M.B. De Vries and P.M.J. Herman, 2007. Vegetation causes channel erosion in a tidal landscape. Geology, V35 (7): 631–634, (2007).

Temmerman, Stijn, Mindert B. De Vries, Tjeerd J. Bouma, **2012**. Coastal marsh die-off and reduced attenuation of coastal floods: A model analysis. Global and Planetary Change 92–93 (2012) 267–274P.

Cooperation is the key to progress and success

2009-2013
Ecoshape scientists – practitioners consortium, Building with Nature (BwN)

2013-2018
progress from 'Show that it works' to 'Make it happen!'

Cooperation is the key to progress and success

ecoshape.nl

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EcoShape

Welcome to 'Building with Nature'

Building with Nature aims to utilize natural processes and provide opportunities for nature while realising hydraulic infrastructure. Design guidelines on how to make this happen in practice are the main end product of the Building with Nature innovation programme. The work is carried out by the EcoShape consortium, that consists of private parties, government organisations and research institutes.

Latest news: Building with Nature Book

Ecoshape tweets

RT @friesheinis: Mooi artikel in @cobouwredactie over succes Building with Nature @EcoShapeBwN. Zie ook http://t.co/IT18AzSK #topsectorwater

7 dagen geleden

EcoShape shows it is

Innovative hydraulic engineering through 'Building with Nature' works

Read more »

DOWNLOAD BwN BOOK (pdf)

During the EcoShape Lustrum Conference, Huib de Vriend presented the Building with Nature Book.

Feel free to download a digital copy (pdf) here

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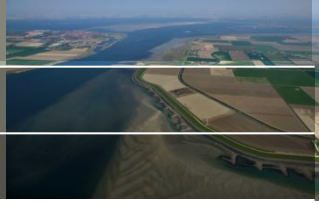
Homework for each week



- We will setup a wiki page that contains the information presented in each lecture
- The wiki page will be setup in a fixed format
- It needs to contain the following chapters (if relevant) :
  - Summary
  - Description of the issue that is solved
  - Aim of the project at hand
  - Definition of ecosystem
  - History and location of the problem
  - Relation to legislation and government planning
  - Principles of the solutions
  - Design/description of solutions
  - Techniques of implementation/construction
  - Costing of works
  - Monitoring techniques
  - Maintenance
  - Relation to BWN principles
  - Benefits to nature and other functions
  - A list and definition of concepts (with photos)

Prepare a presentation on a BWN publication

- Summary
- Description of the issue that is solved
- Aim of the project/publication at hand
- Principles of the solutions proposed or implemented
- Design/description of solutions
- Benefits to nature and other functions

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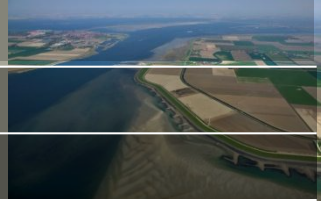
Questions?



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