Building safety with nature

Symposium March 27, Delft

TU Delft Delft University of Technology

NIOZ

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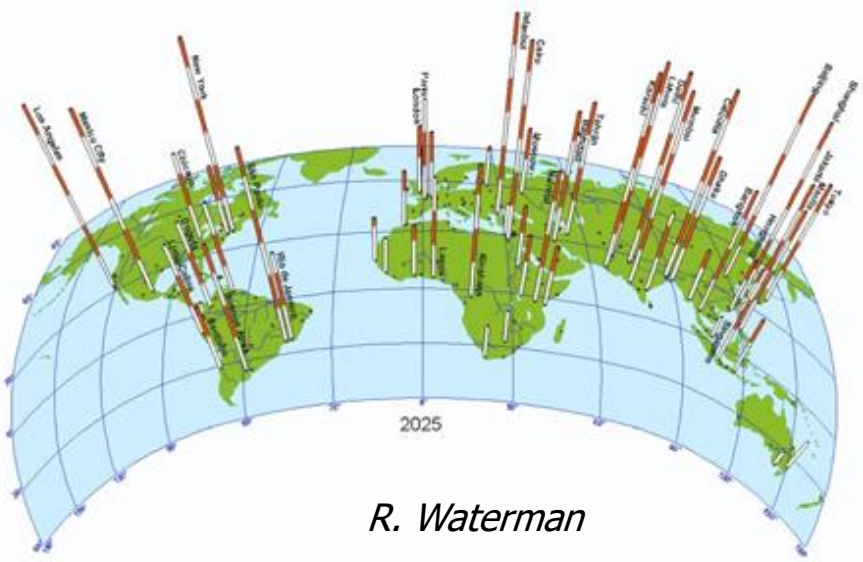
Global background

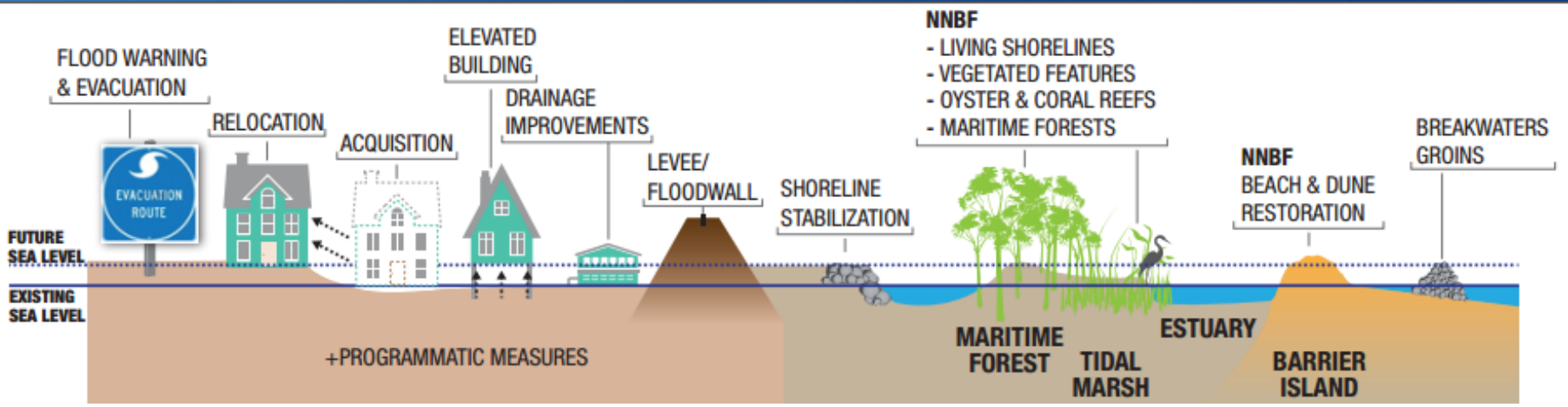
- Increasing coastal flood risks:
  - Rapid development
  - Sea level rise and subsidence
- Frequent floods in developed and developing countries
- From Building with Nature to Nature-based flood risk reduction



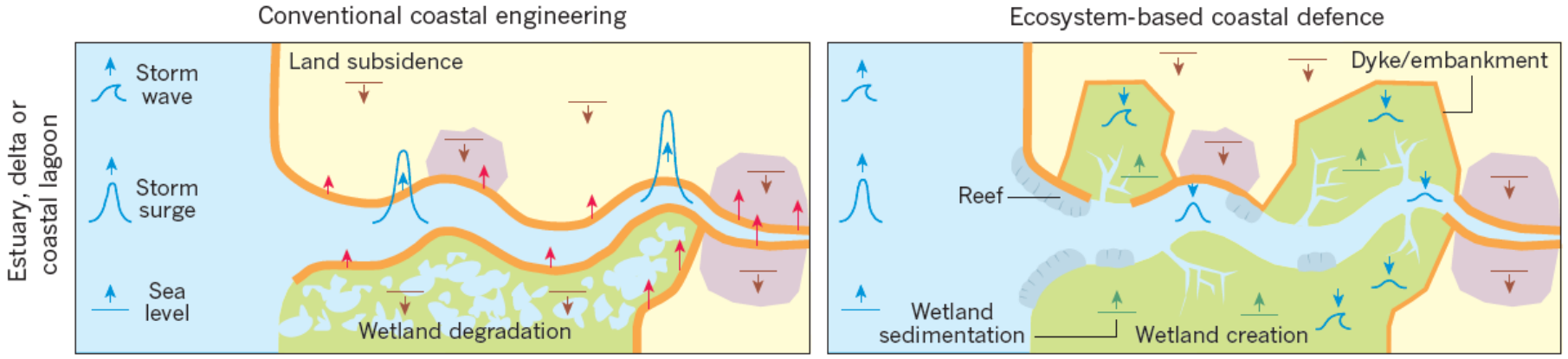
R. Waterman

Mekong, Bac Lieu, protective forest

Flood risk reduction concepts



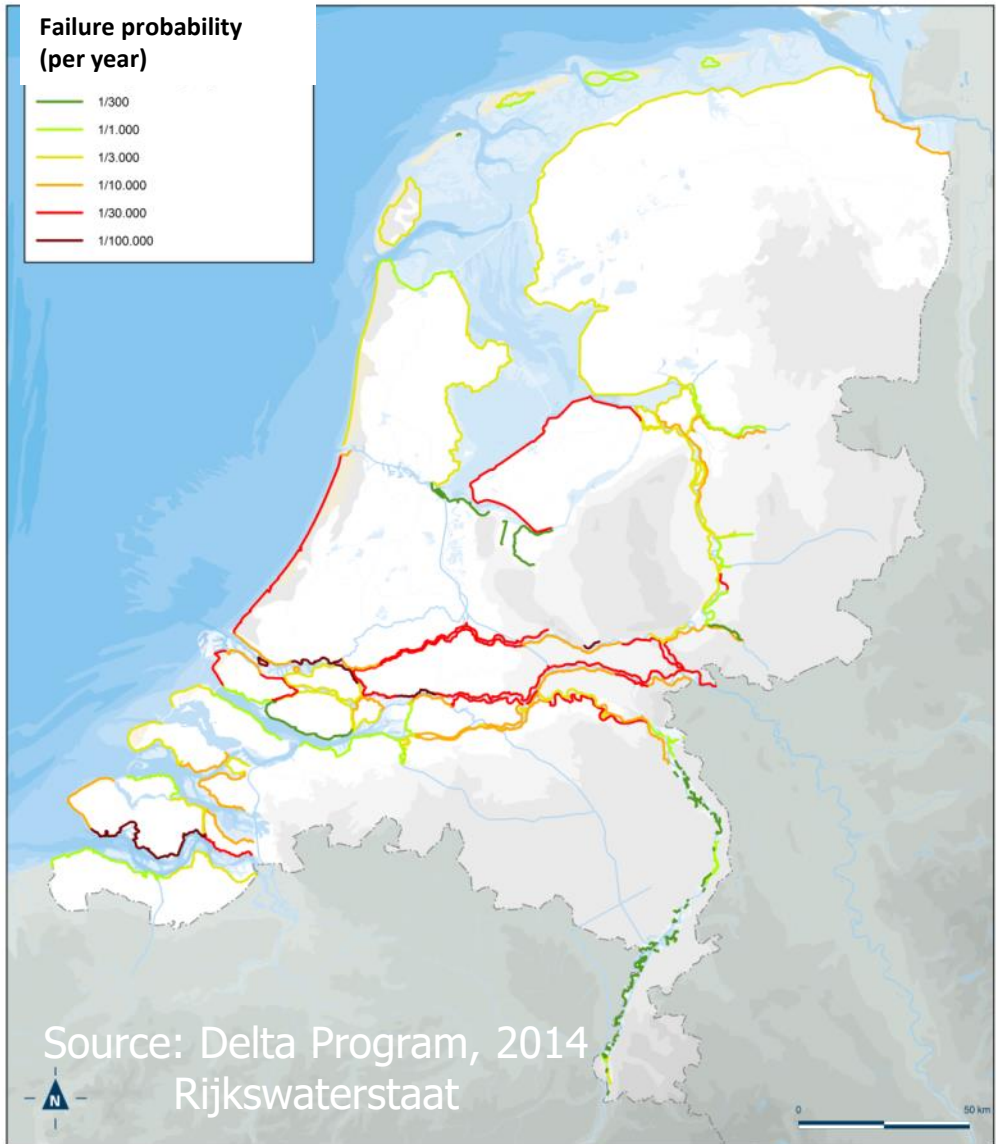
USACE, 2015

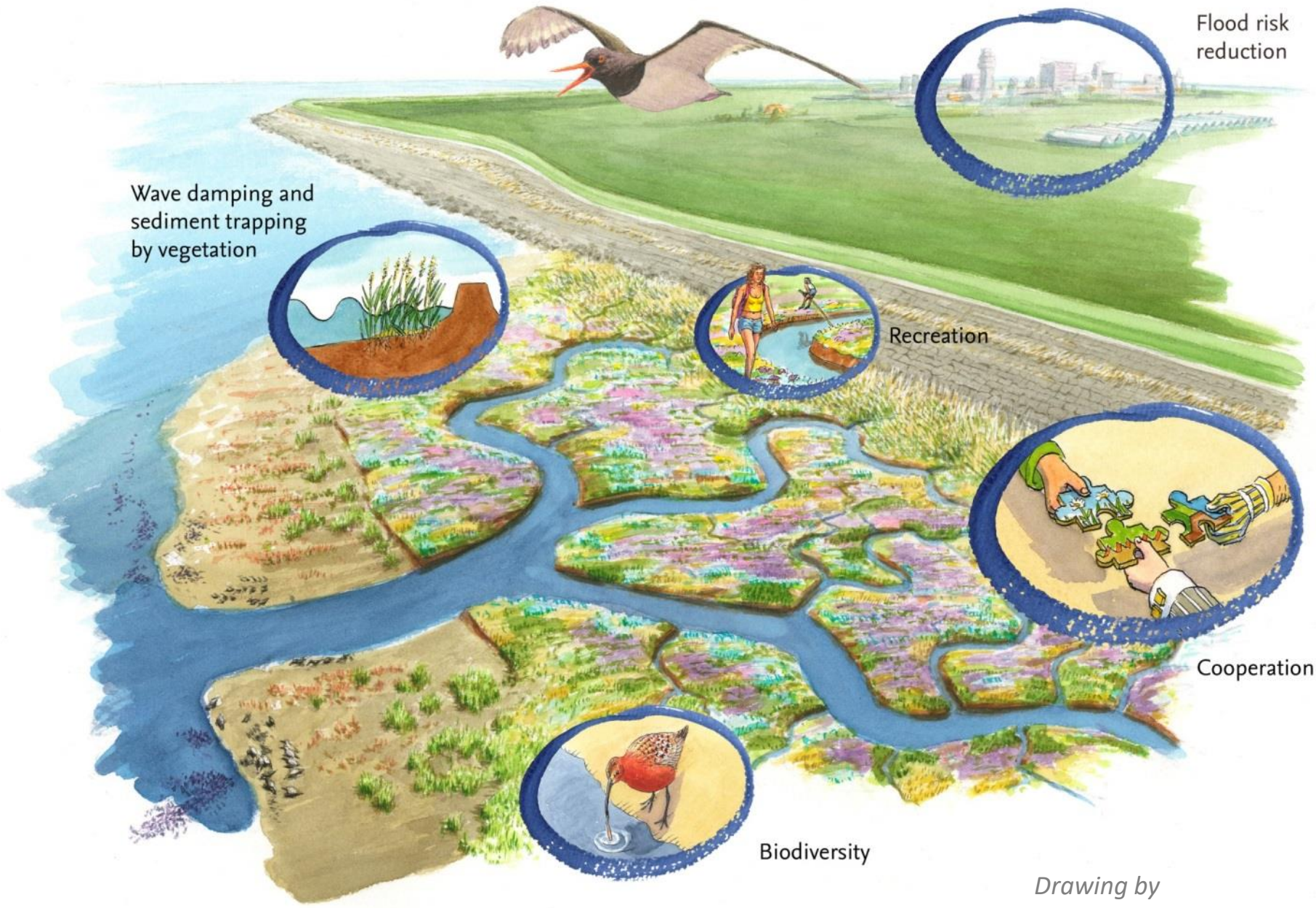


Temmerman et al. 2013

Background: Netherlands

- Dike reinforcements (HWBP)
- New safety standards as of 2017





Drawing by Jeroen Helmer & WWF

BE SAFE partners

Remaining challenges

- Flood risk reduction through BwN solutions
  - Effects on waves, failure mechanisms, breaches
- Hybrid solutions
- In various environments, e.g. mangrove
- Proven technology? Dealing with dynamics and uncertainties
- Organizational and management aspects

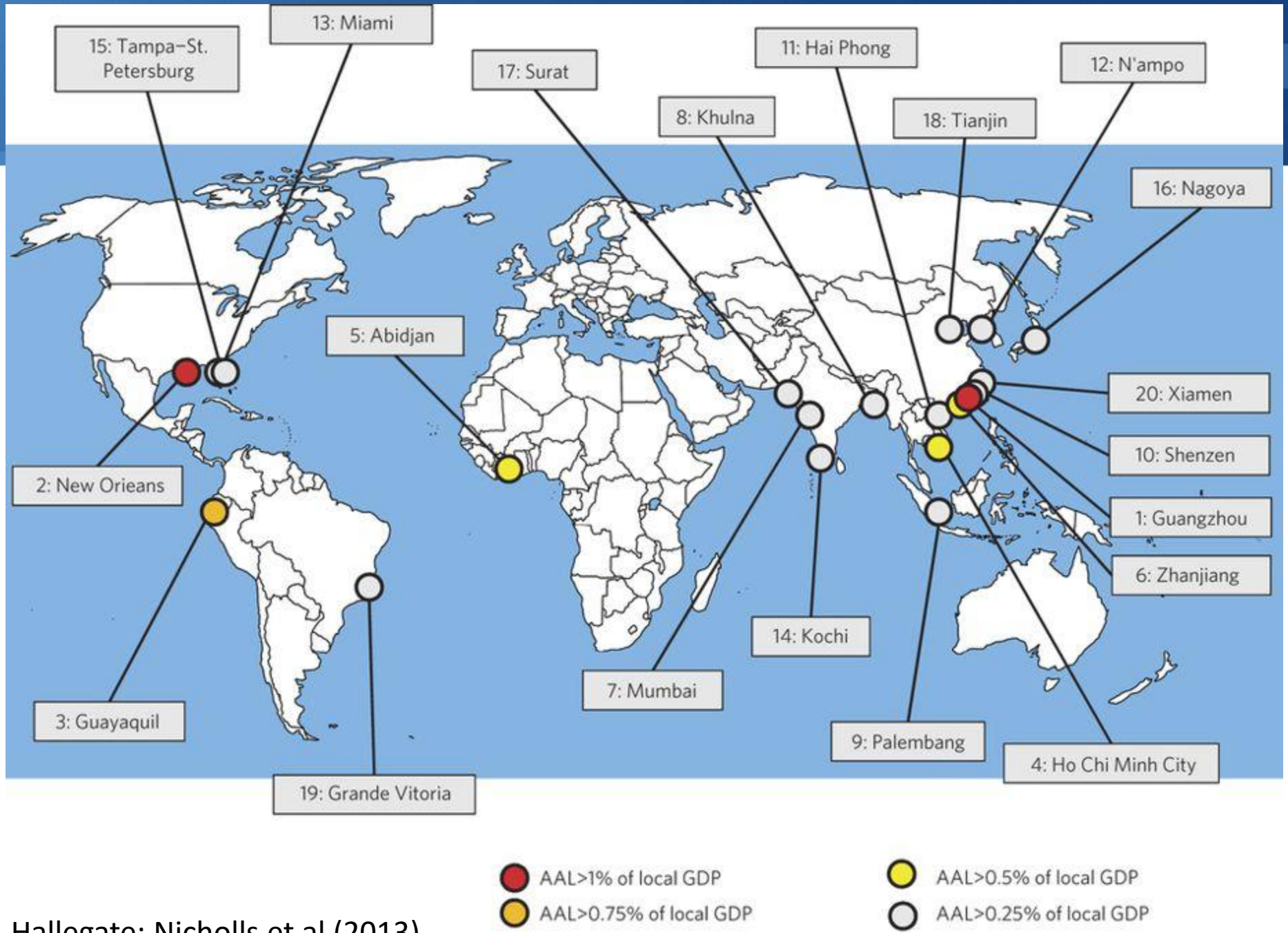
Program

- 13:00-13:30 Welcome and coffee
- 13:30-13:45 Introduction by **Bas Jonkman**, Professor of Integral Hydraulic Engineering, TU Delft
- 13:45-14:15 '*How managed realignment affects flood levels in the Scheldt estuary*' by **Stijn Temmerman**, Professor of Ecosystem Management, University of Antwerp
- 14:15-14:45 '*Ecosystem services and livelihoods in coastal Bangladesh*' by **Robert Nicholls**, Professor of Coastal Engineering, University of Southampton
- 14:45-15:15 Coffee break

Program (ctd)

- 15:15-16:00 Panel discussion: *'Advancing application of nature-based solutions for flood risk reduction'*, chaired by **Vincent Vuik**, TU Delft & HKV Consultants
  Panel members:
  - **Stefan Aarninkhof**, Professor of Coastal Engineering, TU Delft
  - **Niels Roode**, Project Manager of POV Voorlanden
  - **Bas Roels**, Senior advisor freshwater, WWF Netherlands

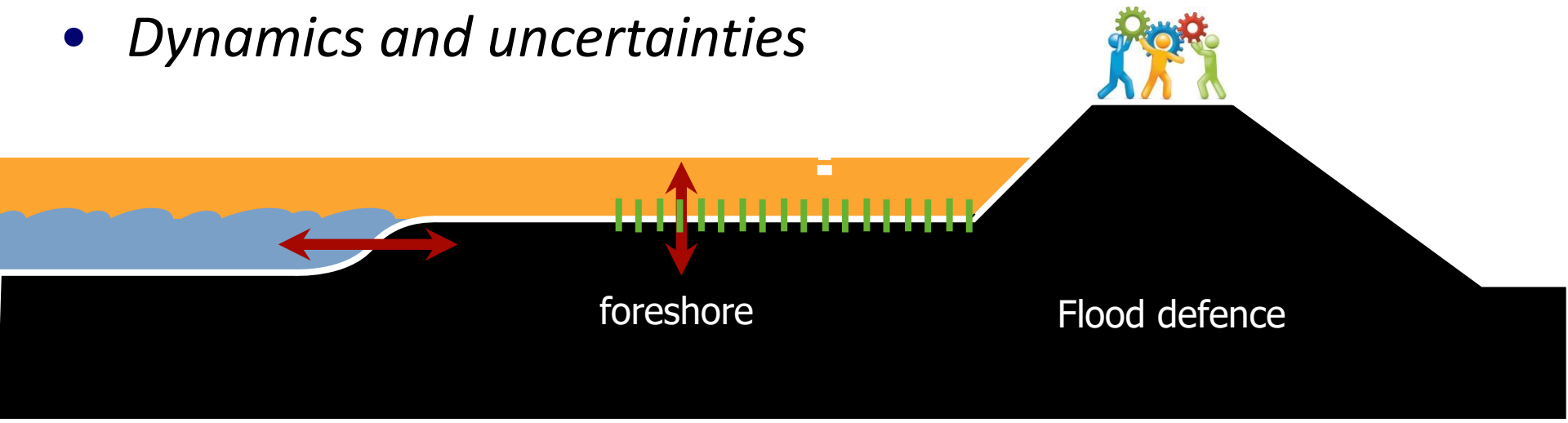
  (Panel discussion will be in Dutch)
- 16:00-16:30 Closure and drinks



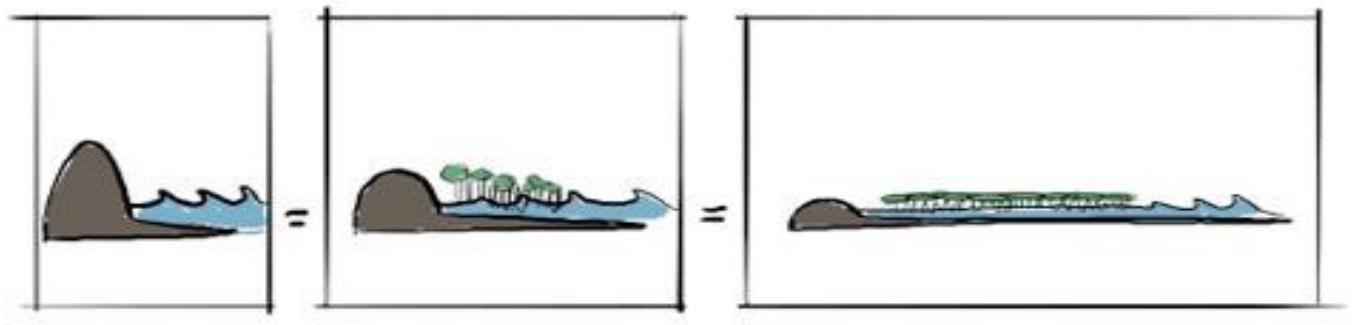
Hallegate; Nicholls et al (2013)

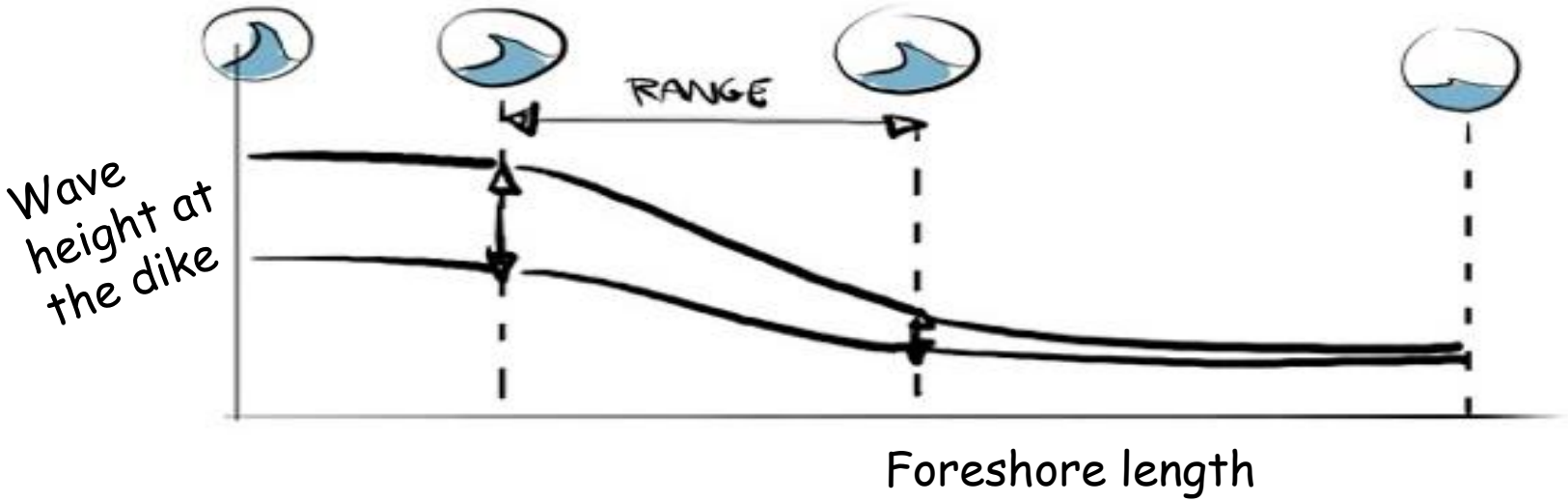
BE-SAFE objectives

- Develop new methods to assess how (much) vegetated foreshores contribute to flood risk reduction
- Enable design and implementation
- *Dynamics and uncertainties*

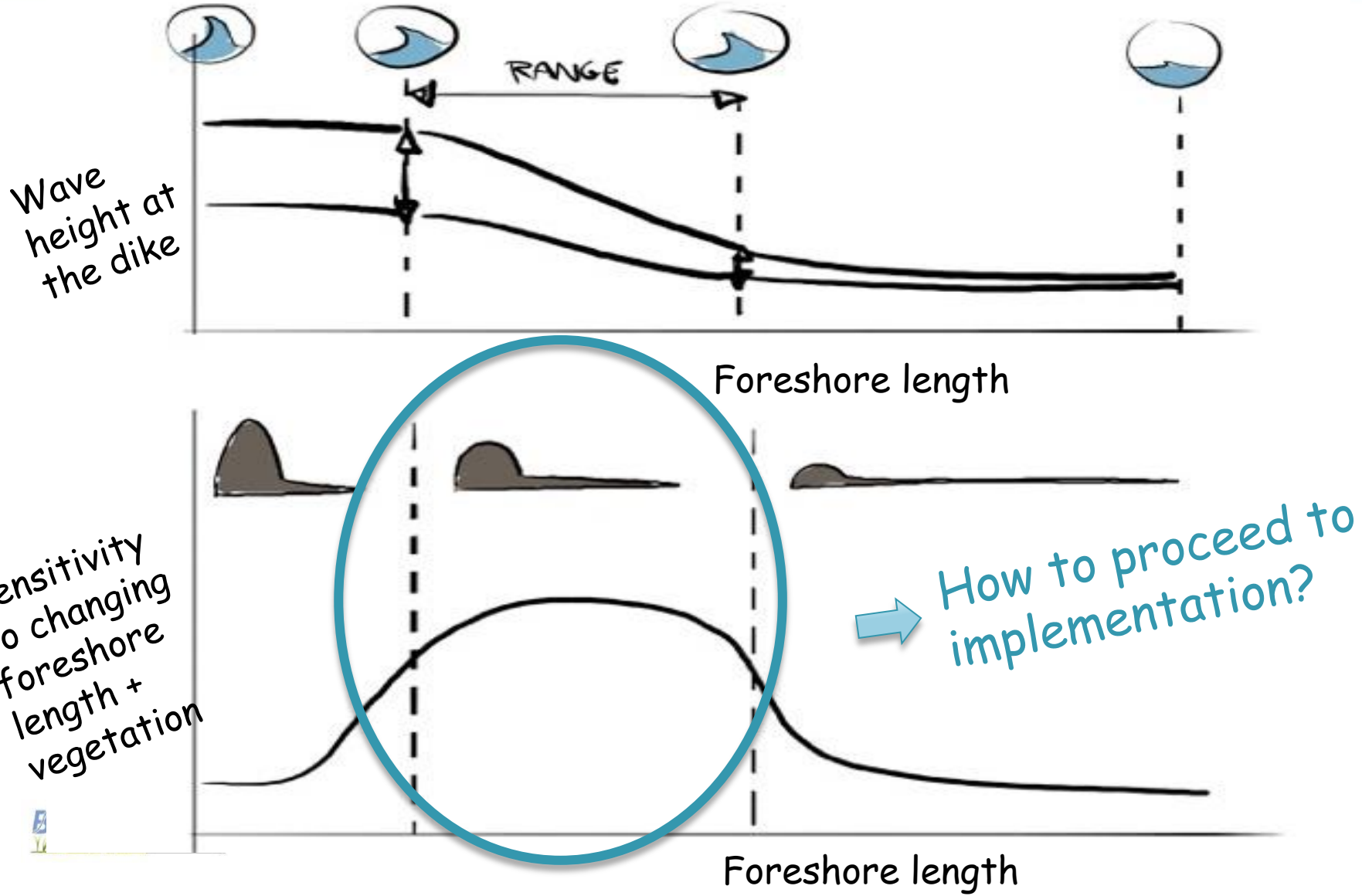


Towards implementation?

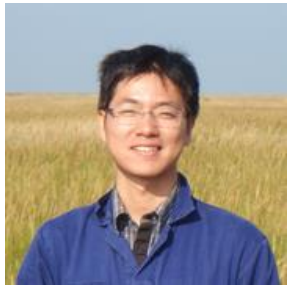




Towards implementation?



BE SAFE Project and team (2014-2019)



Ecology

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Safety

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Bio-geomorphology

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Implementation

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Implementation case: Koehool

- HWBP project, in exploration phase
- Vegetated foreshores are in front of the dike *and* on the agenda
- Wetterskip Fryslan, nature organizations and Rijkswaterstaat involved
- Project is part of the POV Waddenzeedijken
- Potential link with mudmotor (to be explored)

Implementation case

BE SAFE investigations (Jan-Dec 2017):

- Role of foreshores in safety assessment and dike design
- Additional benefits of vegetation
- Goals for ecology (biodiversity) vs safety (wave attenuation)
- Stakeholder interactions: dike managers, foreshore owner, nature conservancy, … (apply game theory)

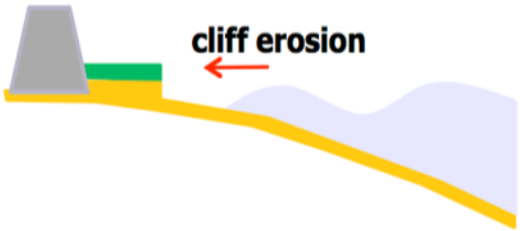
maptable

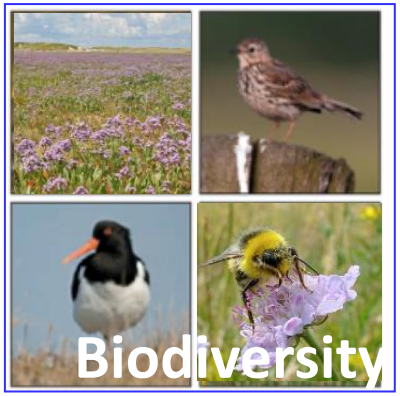
A bit more on the sub-projects

Ecology

Focus: *Long-term marsh dynamics* & *compatibility of ecosystem services*

Lateral erosion & Lateral expansion

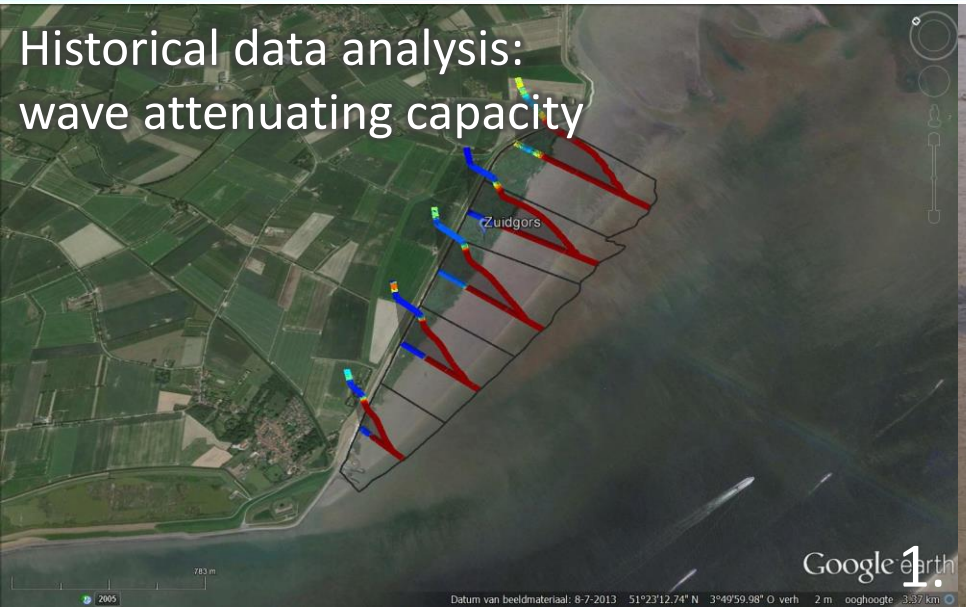




Root biomass can greatly decrease erosion resistance of the marsh edge (Zhu et al., prep.)

Biogeomorphology

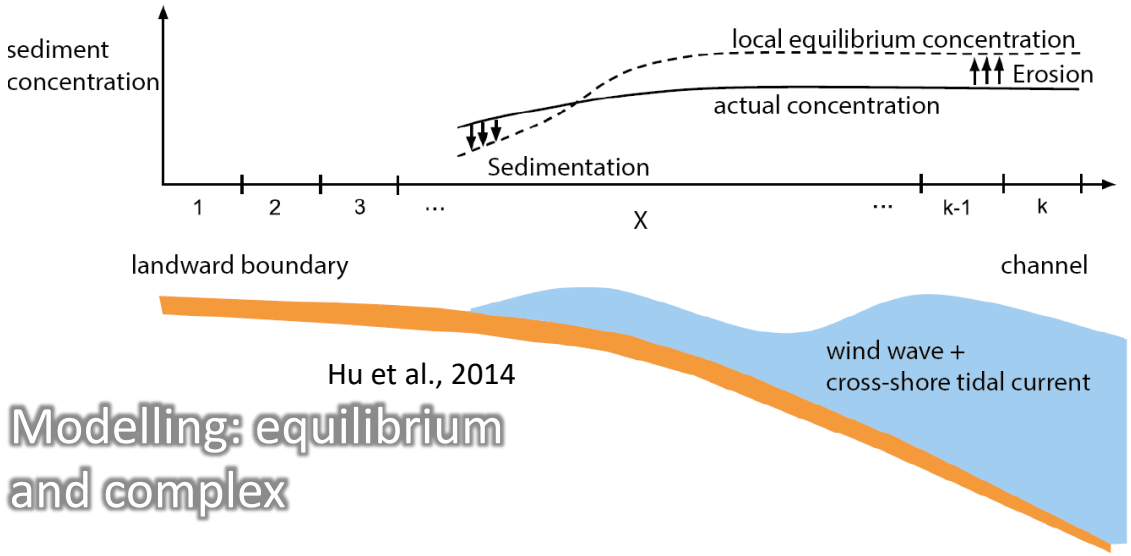
Historical data analysis:
wave attenuating capacity



1.

Fieldwork: morphodynamics
vegetation edge

2.



Hu et al., 2014

Modelling: equilibrium
and complex

Safety

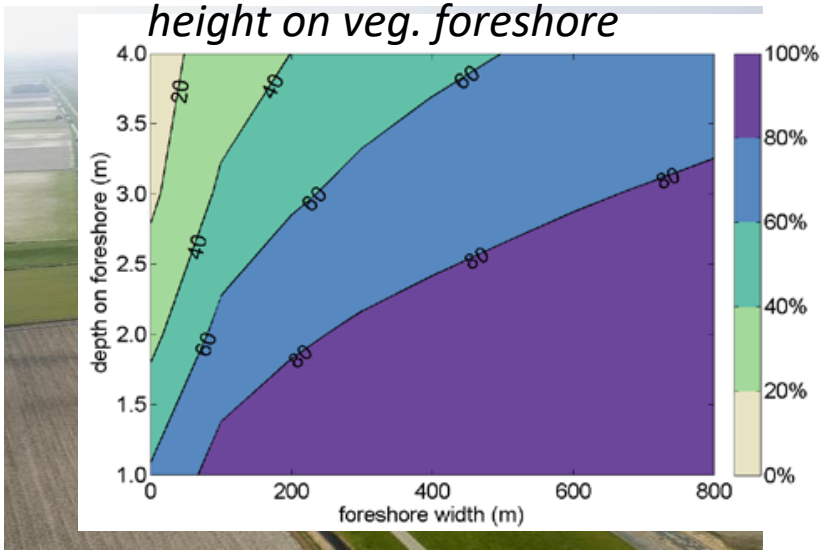
Approach

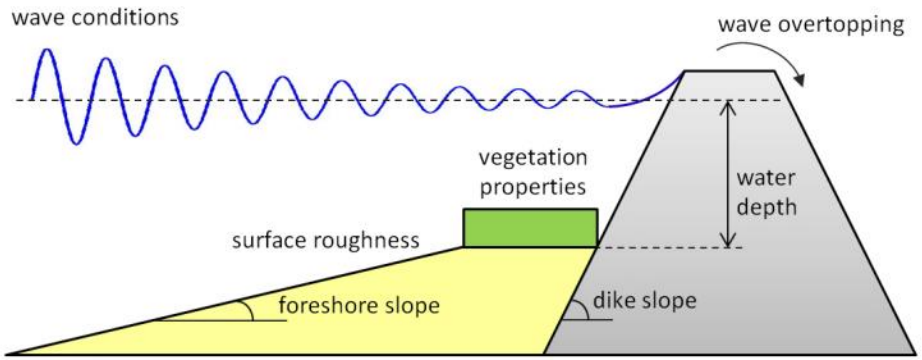
- Field measurements (waves, vegetation)
- Numerical modelling
- Uncertainty quantification

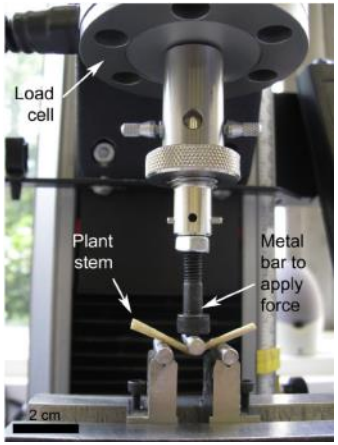
Insights:

- Effect of foreshore + vegetation on:
  - Wave run-up
  - Failure probability of the dike system
  - Dominating uncertainties

Reduction of significant wave height on veg. foreshore







Implementation and governance

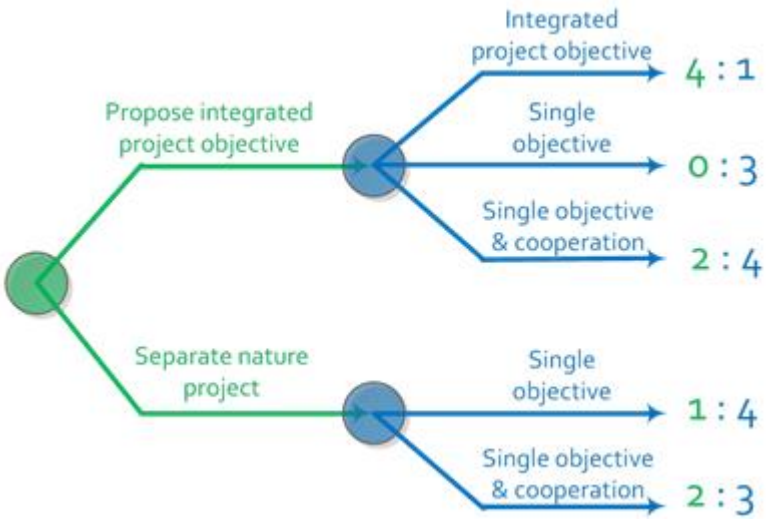
Focus on actor-interactions needed to enable implementation:

- Find ‘typical’ BwN interactions
- Indicate chances for cooperation
- Use of game theory
- Develop a decision-support tool

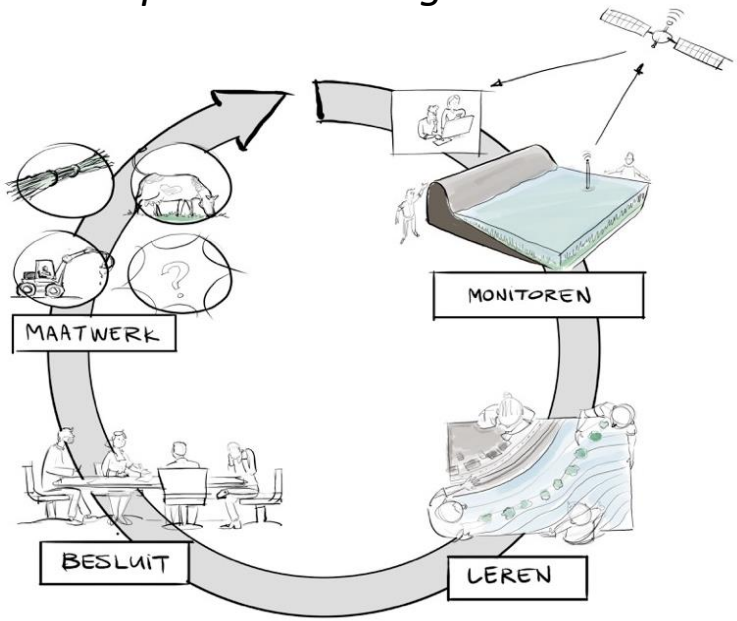
Flood defense actor

Nature actor

Game tree, NBFD case study



Adaptive co-management



Closure

- Promising alternative as part of dike reinforcements
- Veg. foreshores → significant wave run-up reduction
- Several uncertainties
- BE SAFE: Understanding of morphological, hydraulic and ecological functioning and actor interactions
- Outlook:
  - Implementation case
  - International exchange
    (e.g. Louisiana, NJ)