Building with Nature als kustbeschermingsstrategie

Tjeerd J. Bouma *et al.*

NIOZ is an institute of NWO

in cooperation with Utrecht University

tjeerd.bouma@nioz.nl

Hoog Water Besch

POV wadde

PROJECT
OVERSTIJGENDE
VERKENNING
HWBP

Onderzoeksplan 11 - procesinnovati	
Verantwoordelijk programmateamlid	Wette
Opsteller(s)	Arend Arjen
Versie	Defini
Datum	5 augustus 2015

105 km dijken voldoet niet
zou kunnen worden opgelost met voorlanden

Aanleiding en prioriteit

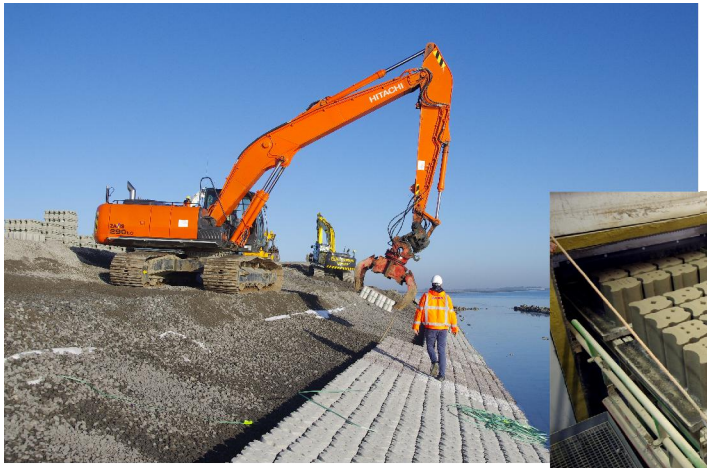
Aanleiding

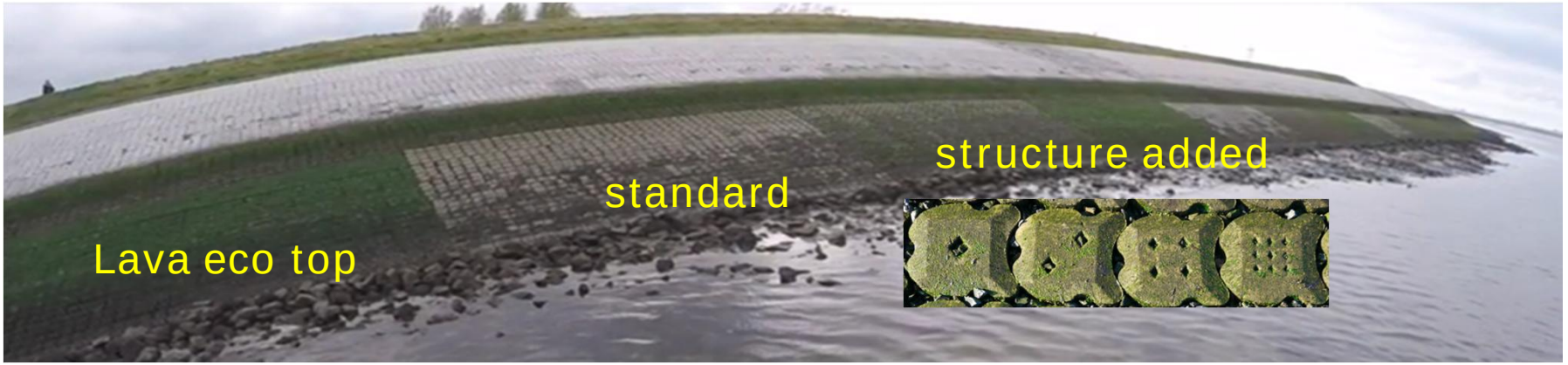
Ruim 105 km waterkering langs het IJsselmeer, de Waddenzee en de Dollard zijn afgekeurd. Uit onderzoek (de Groot, 2014) is gebleken dat indien overal voorland aanwezig zou zijn, het overgrote deel van de dijken ruimschoots aan de norm zou voldoen. Het voorland wordt momenteel beperkt meegenomen bij het ontwerp en toetsing van de dijk. Hiervoor zijn twee redenen. Ten eerste zijn de effecten van voorlanden nog niet in de praktijk gemeten. Ten tweede vallen grote delen van de voorland buiten het beheer van de waterschappen.

Rijke-dijk in practice

Sint-Annaland, t=5 months

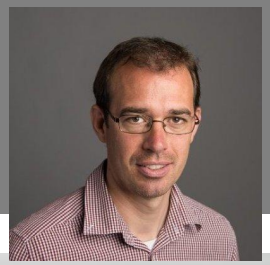
Tim van Oijen





NIOZ IMARES WAGENINGEN UR Deltares Enabling Delta Life HZ UNIVERSITY OF APPLIED SCIENCES

Oesterdam sand nourishment



Matthijs Boersema

- 350.000 m³ sand, Nov. 2013

Wave damping
For 25 year

Ecosystem preservation

NIOZ

IMARES WAGENINGEN UR

Deltares
Enabling Delta Life

UNIVERSITY OF APPLIED SCIENCES

Vegetation-Based Coastal Defense: opportunities & limitations

POV PROJECT OVERSTIJGENDE VERKENNING HWBP

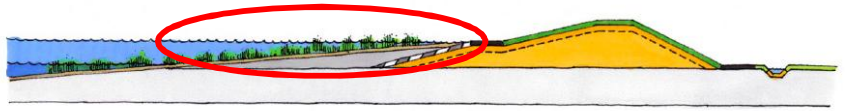
waddenzeedijken
lijk op de dijk

Onderzoeksplan 11 - procesinnovatie Dijk met voorland	
Verantwoordelijk programmateamlid	Wetterskip Fryslân, Jan Hateboer
Opsteller(s)	Arend van Woerden, Grontmij Arjen Luinenburg, Grontmij
Versie	Definitief
Datum	5 augustus 2015

Aanleiding en prioriteit

Aanleiding

Ruim 105 km waterkering langs het IJsselmeer, de Waddenzee en de Dollard zijn afgekeurd. Uit onderzoek (de Groot, 2014) is gebleken dat indien overal voorland aanwezig zou zijn, het overgrote deel van de dijken ruimschoots aan de norm zou voldoen. Het voorland wordt momenteel beperkt meegenomen bij het ontwerp en toetsing van de dijk. Hiervoor zijn twee redenen. Ten eerste zijn de effecten van voorlanden nog niet in de praktijk gemeten. Ten tweede vallen grote delen van de voorland buiten het beheer van de waterschappen.



NIOZ is an institute of NWO

in cooperation with Utrecht University

tjeerd.bouma@nioz.nl

Outline talk

RATIONALE

- Need for other coastal defense?

CURRENT KNOWLEGDE

- Which ecosystem to use?
- Effectiveness under extreme conditions?
- Effectiveness long-term?

FUTURE QUESTIONS

- Understanding long-term stability – SLR & GC?
- How to create *natural* salt marshes?
- Management for safety - winn-winn / trade off?
- Landscape-scale connectivity

Outline talk

RATIONALE

- Need for other coastal defense?

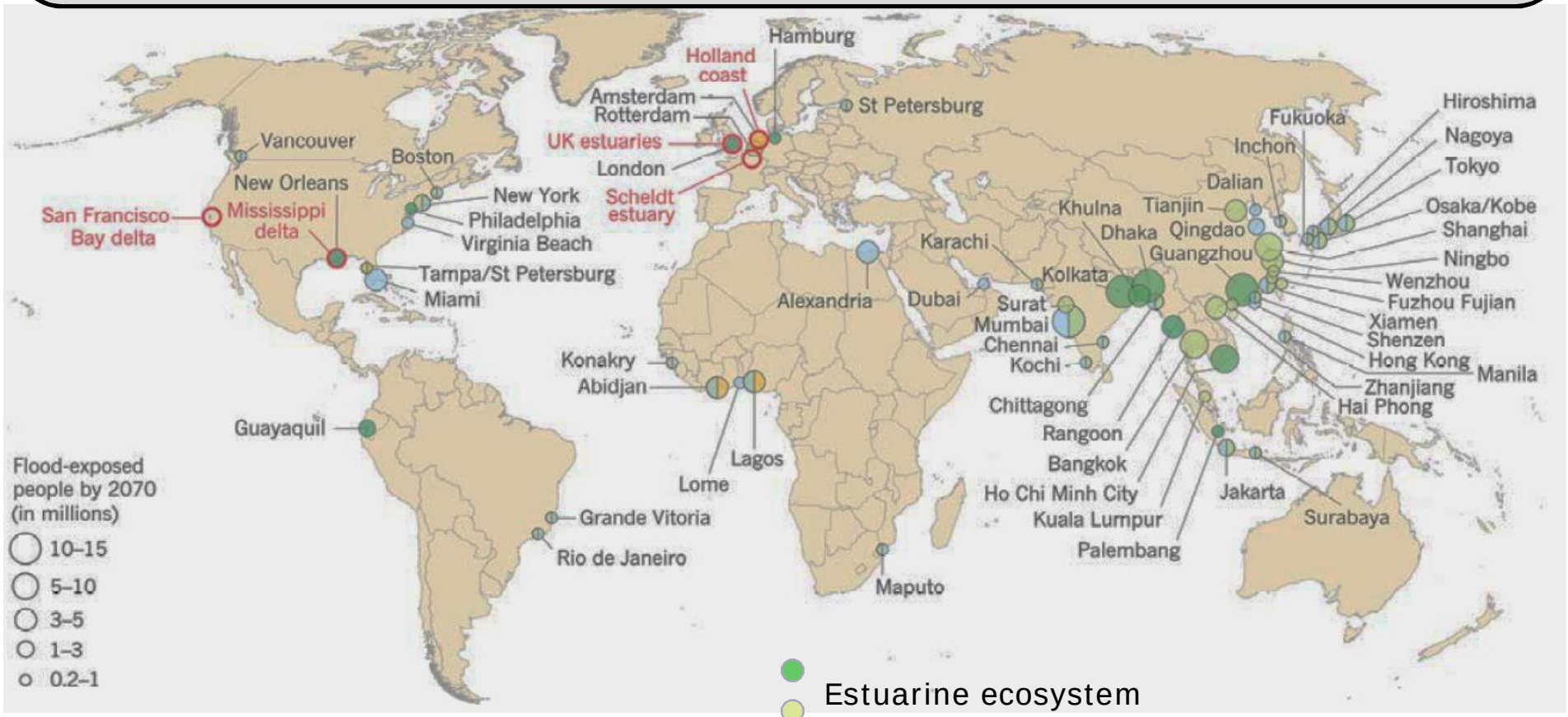
CURRENT KNOWLEGDE

- Which ecosystem to use?
- Effectiveness under extreme conditions?
- Effectiveness long-term?

FUTURE QUESTIONS

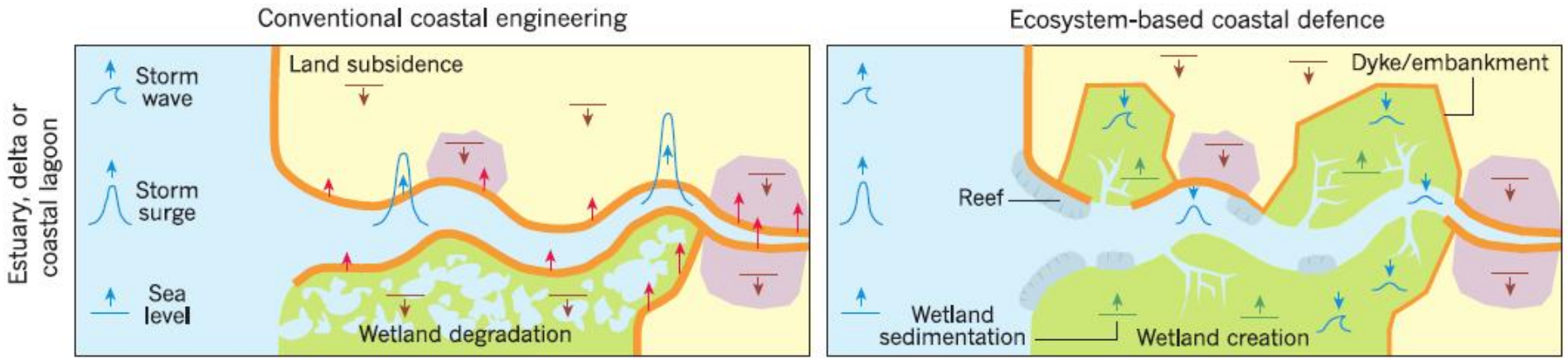
- Understanding long-term stability – SLR & GC?
- How to create *natural* salt marshes?
- Management for safety - winn-winn / trade off?
- Landscape-scale connectivity

Sea Level Rise & Climate Change & subsidence → Mega cities endangered by drowning in 2070 → need for new *cost effective* coastal defense



Temmerman et al. (2013) Nature

Towards a new coast ?



1) Which ecosystems to use?

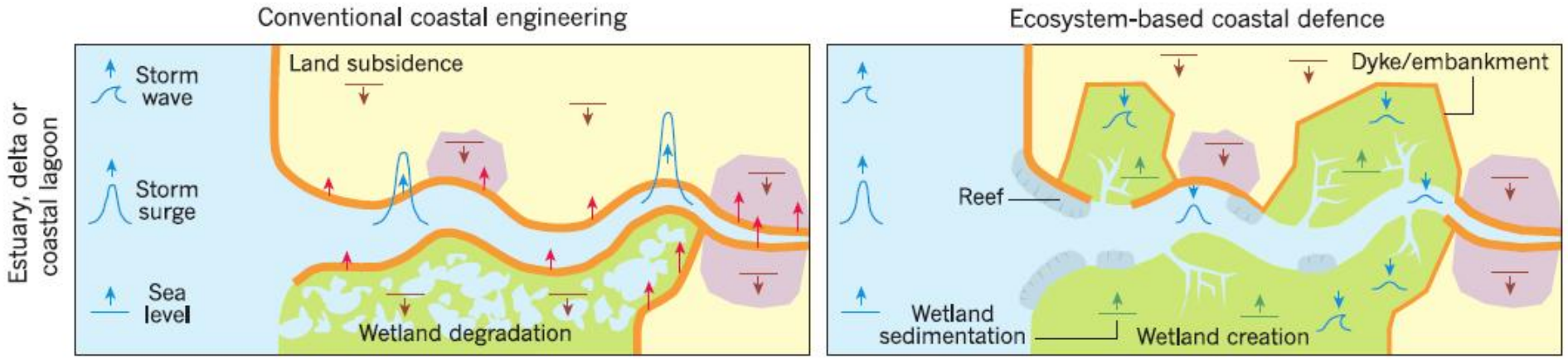
Temmerman et al. (2013) Nature

Ecosystems suitable for coastal defense:

Intertidal coastal vegetation ➔ most suitable !!!
high in intertidal ➔ stronger wave attenuation

Bouma et al. (2014) Coastal Engineering

Towards a new coast ?



1) Which ecosystems to use? → *intertidal veg.*
2) Effective under extreme conditions?

Temmerman et al. (2013) Nature

Wave attenuation by marshes:
➔ *also works under extreme conditions*

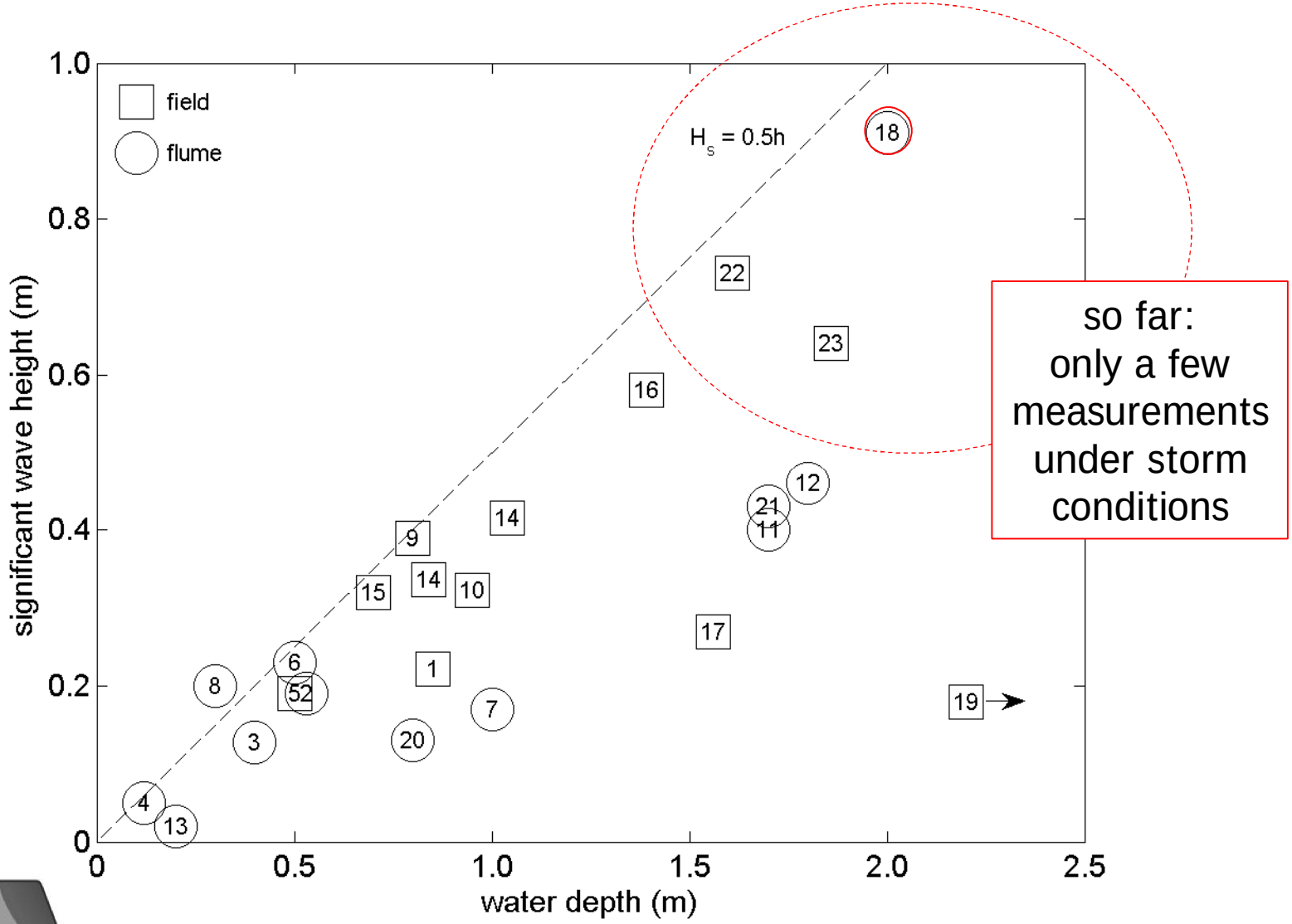
Möller I, Kudella M, Rupprecht F, Spencer T, Paul M, van Wesenbeeck BK, Wolters G, Jensen K, Bouma TJ, Miranda-Lange M, Schimmels S (2014) Wave attenuation over coastal salt marshes under storm surge conditions. Nature GeoScience 727-731

330 m long, 7 m deep, 5 m wide

Wave attenuation by vegetation literature – few data on big storms

Vincent Vuik

TU Delft



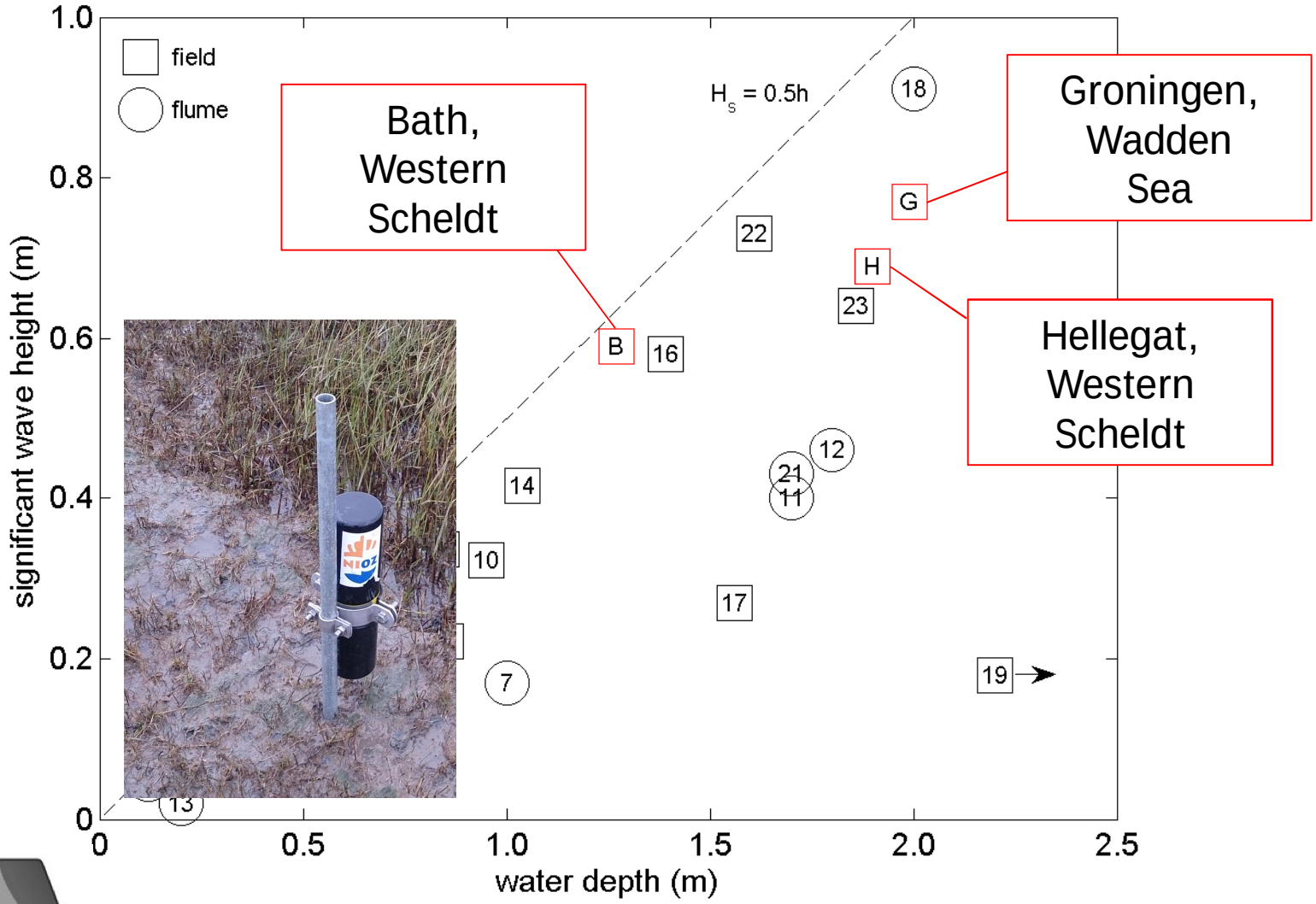
so far:
only a few measurements under storm conditions

Vuik et al. (2016) Coastal Engineering 116: 42–56

New measurements, focusing on storms

Vincent Vuik

TU Delft



Vuik et al. (2016) Coastal Engineering 116: 42–56

Upscaling using wave modelling

- Wave modelling (i.e. SWAN)
  - → up-scaling higher waves & larger depths
- New wave measurements → calibration $C_{d\text{-}veg}$
- *Conclusions modelling:*
  - Foreshores remain effective at high waters
  - Contribution of vegetation significant

BE SAFE

TU Delft

Vuik et al. (2016) Coastal Engineering 116: 42–56

Storm – 10 & 11 Jan. 2015, Wadden Sea

- WNW storm → 1.2 m tide + 2.0 m surge
- 8 wave gauges on salt marshes
- 30 km flotsam line measured

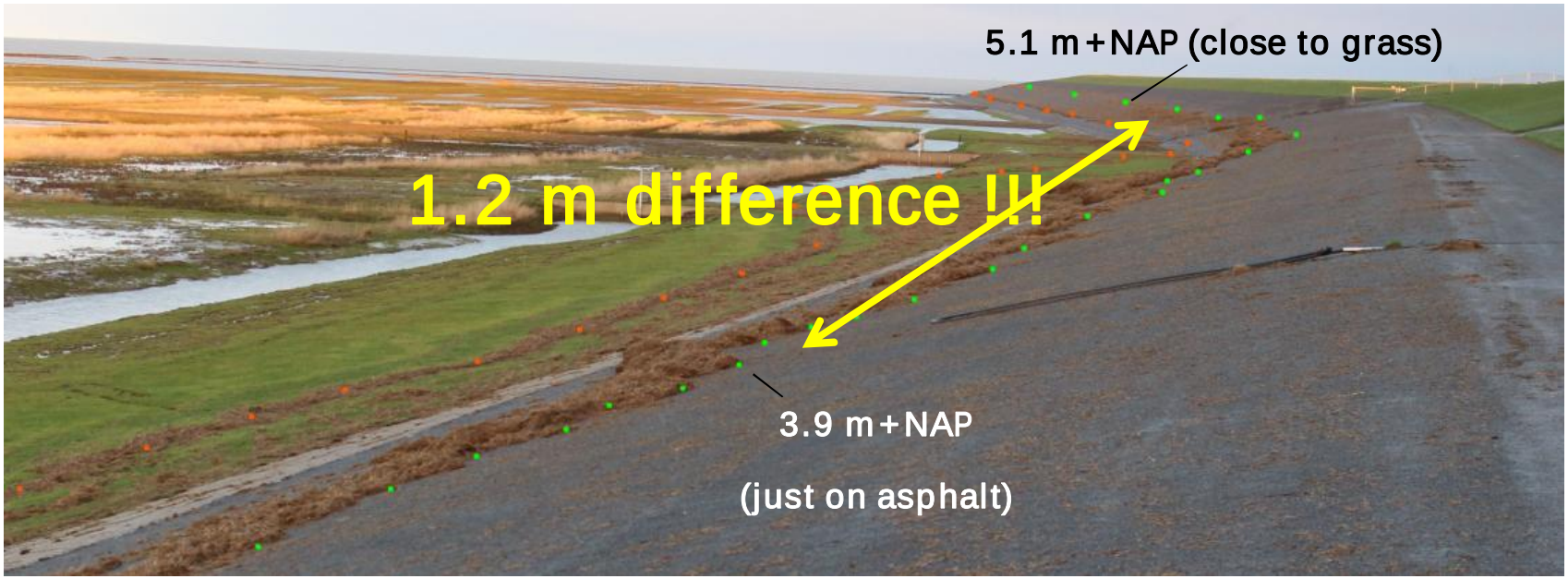
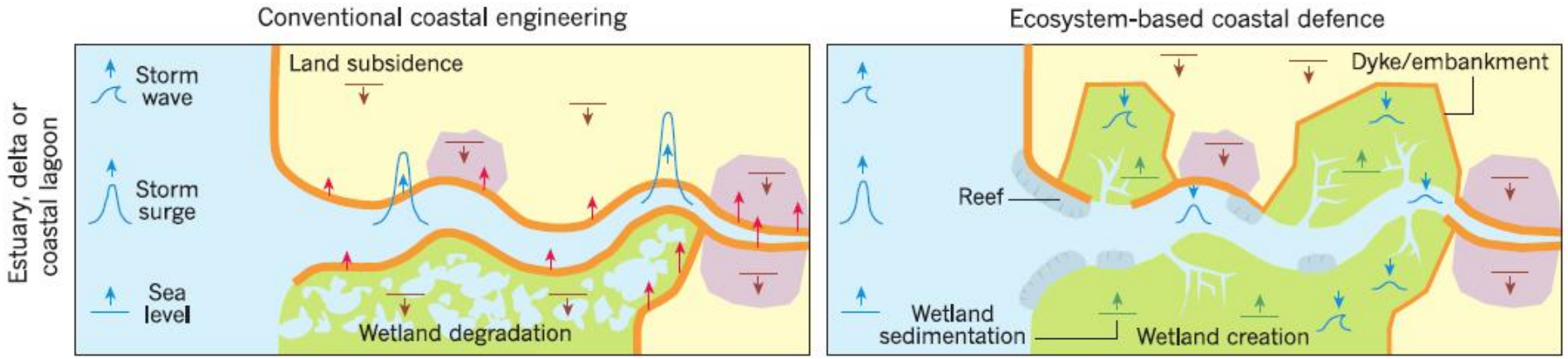


Photo: Vincent Vuik (TU Delft / HKV)

BE SAFE

TU Delft

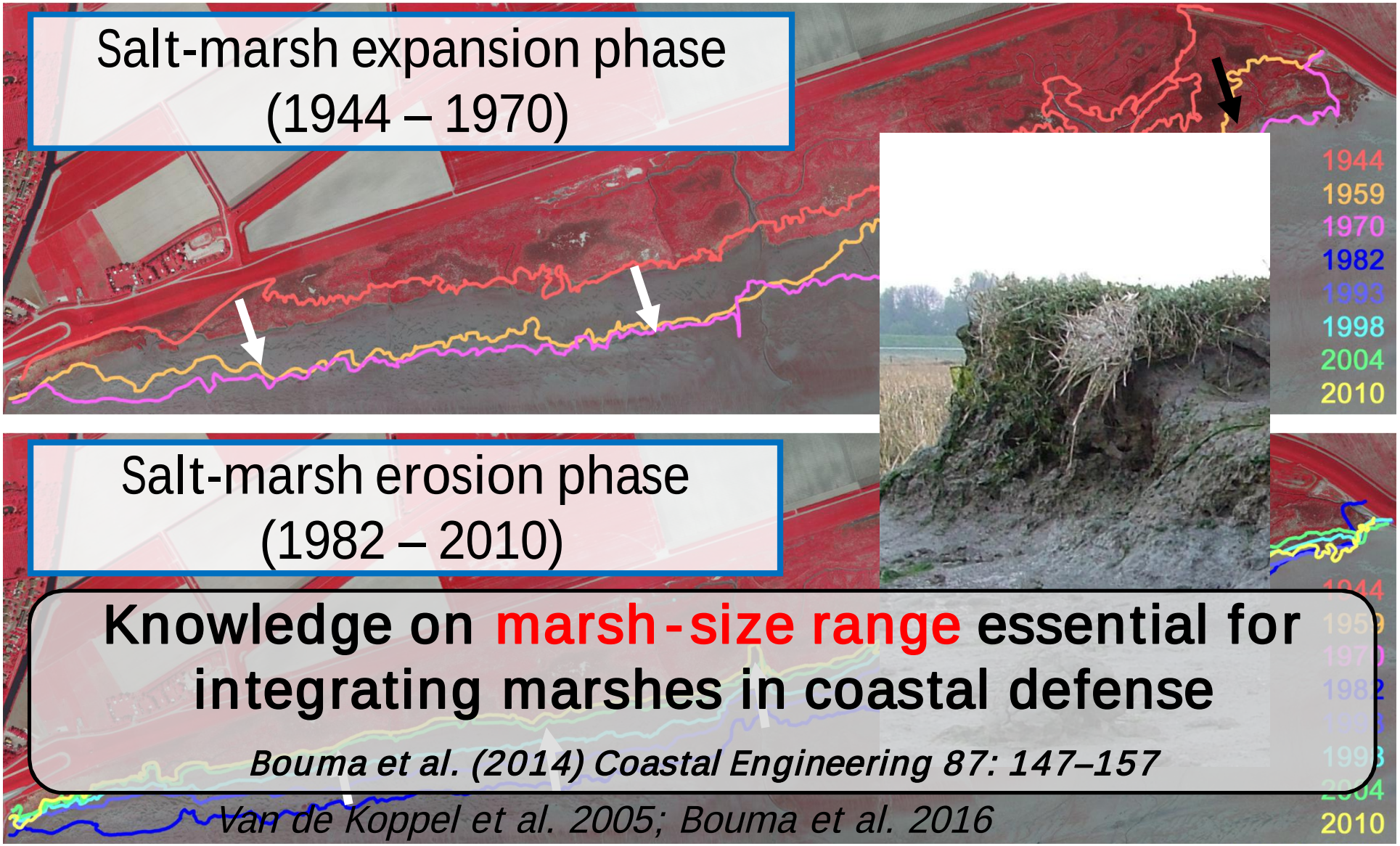
Towards a new coast ?



1) Which ecosystems to use? → *marshes & reefs*
2) Effective under extreme conditions? → *YES*
3) long-term coastal defense performance?

Temmerman et al. (2013) Nature

Problem application ➔ cyclic dynamics on decadal time-scale



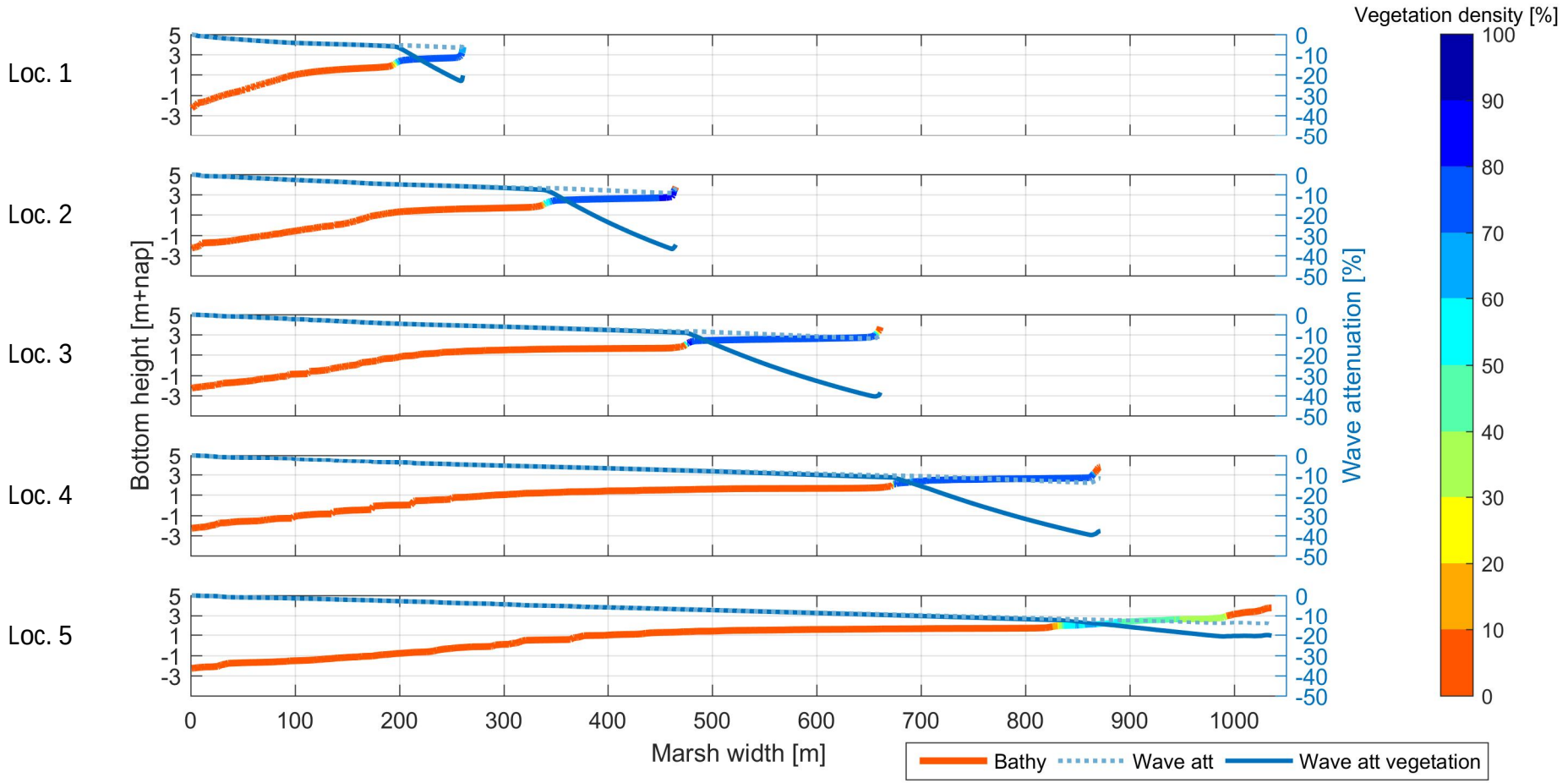
Using space for time: geometry & vegetation

Hypsometric curves

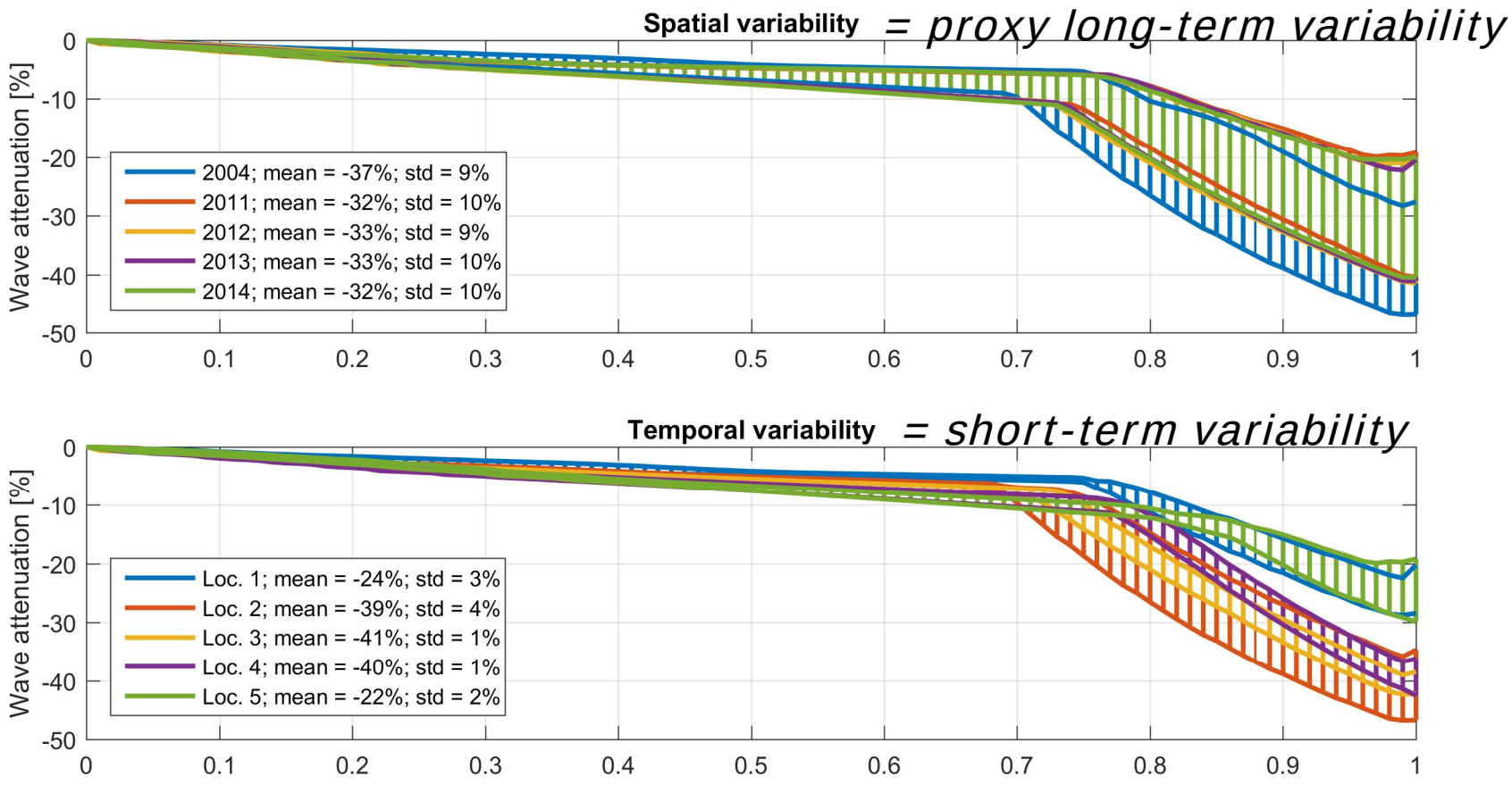
Pim Willemsen

University of Twente
The Netherlands

Wave attenuation per curve (2014)



Results (2004-2014)



Conclusions

- Wave attenuation @ dike
  - → mostly determined by veg. width

- Spatial variability > (short) temporal variability
  - *But → space = proxy for long-term variability*

- ONGOING RESEARCH

Pim Willemsen

University of Twente
The Netherlands

Outline talk

RATIONALE

- Need for other coastal defense?

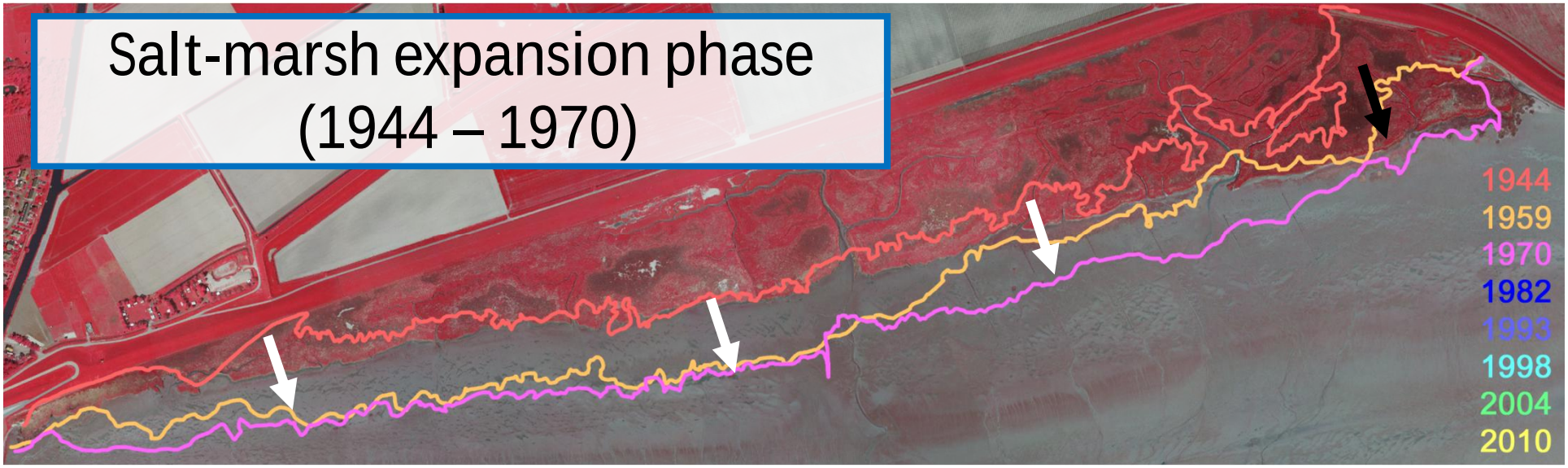
CURRENT KNOWLEGDE

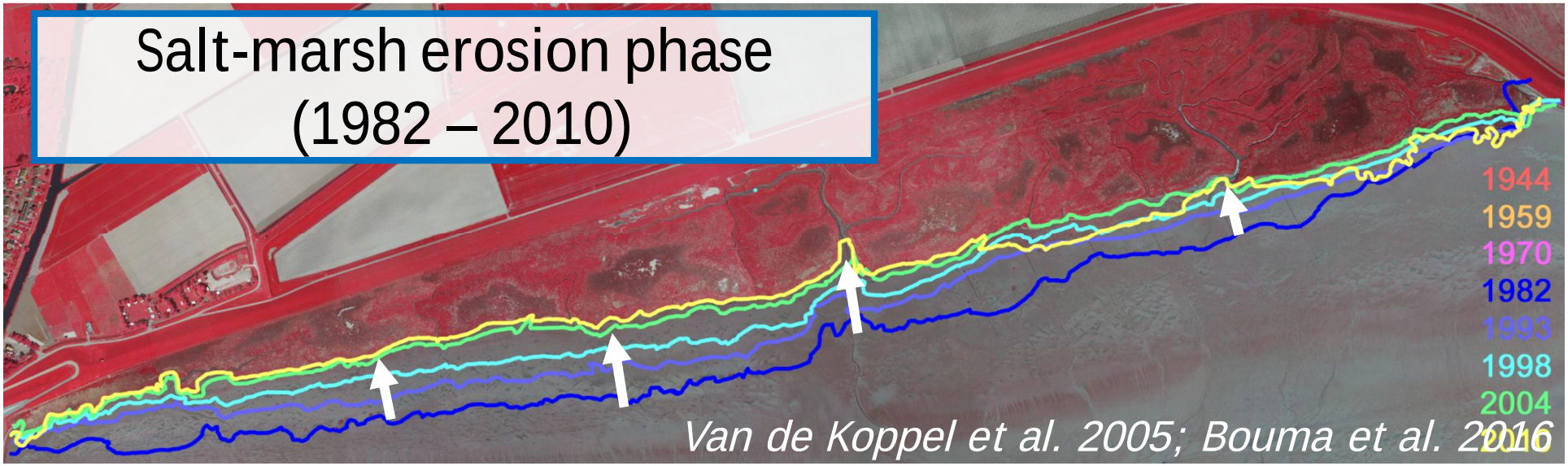
- Which ecosystem to use?
- Effectiveness under extreme conditions?
- Effectiveness long-term?

FUTURE QUESTIONS

- Understanding long-term stability – SLR & GC?
- How to create *natural* salt marshes?
- Management for safety - winn-winn / trade off?
- Landscape-scale connectivity

Mechanisms explaining marsh dynamics





Van de Koppel et al. 2005; Bouma et al. 2016

Mechanisms explaining marsh dynamics

Based on experimental studies:

Sh

implications for:

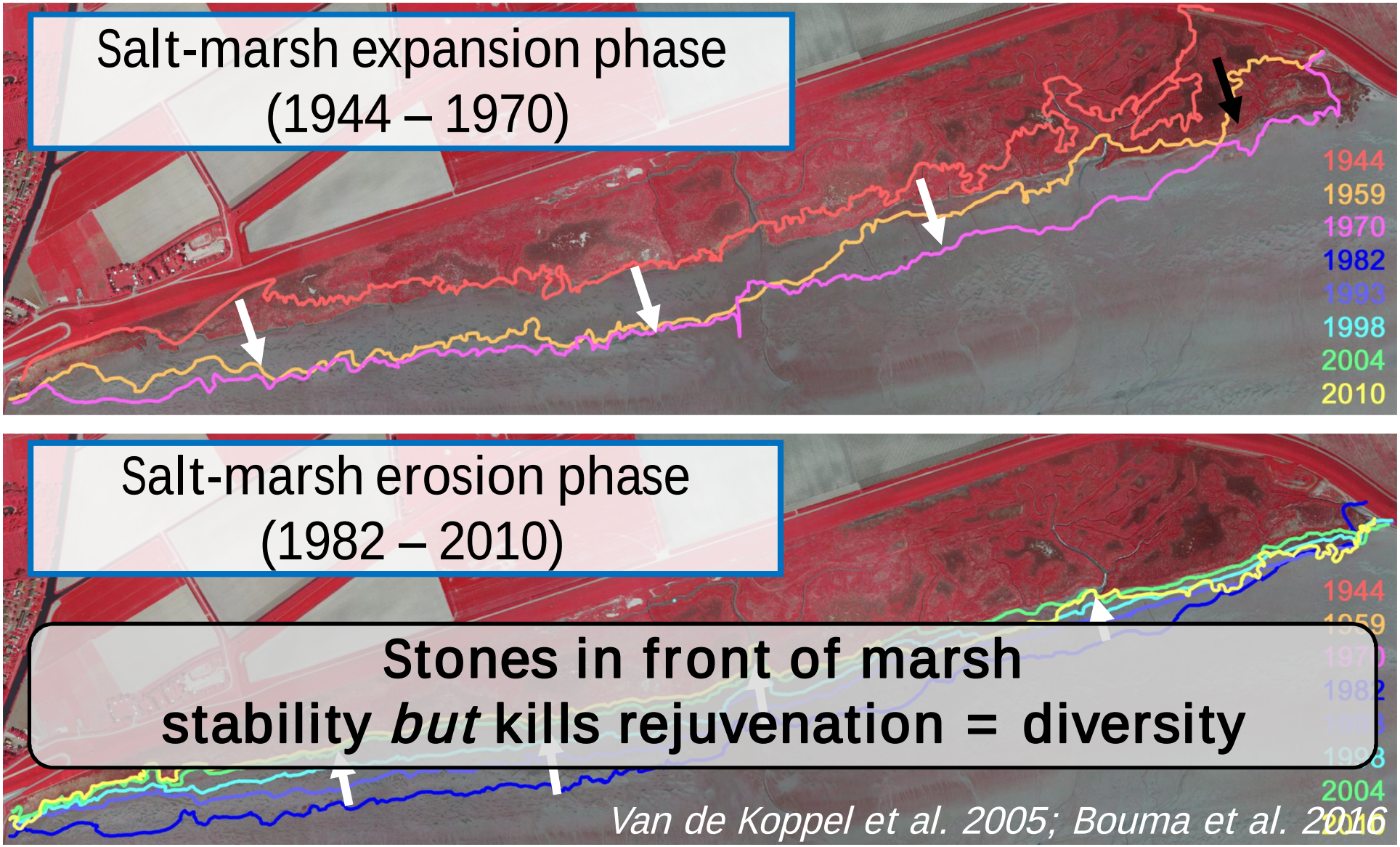
- Monitor daily sediment dynamics
  - Possible *(Hu et al. 2015a)*, but too few data
- dependence marsh restoration on:
  - foreshore shape *(Hu et al. 2015b)*
  - minimum length WoO establishment *(ongoing)*
  - use of dredging material *(ongoing)*
  - climate change → *SLR & storminess*

Bouma et al. L&O 2016

Optimizing marsh management ?

Optimizing marsh management ?

cyclic dynamics = burden & treasure



Outline talk

RATIONALE

- Need for other coastal defense?

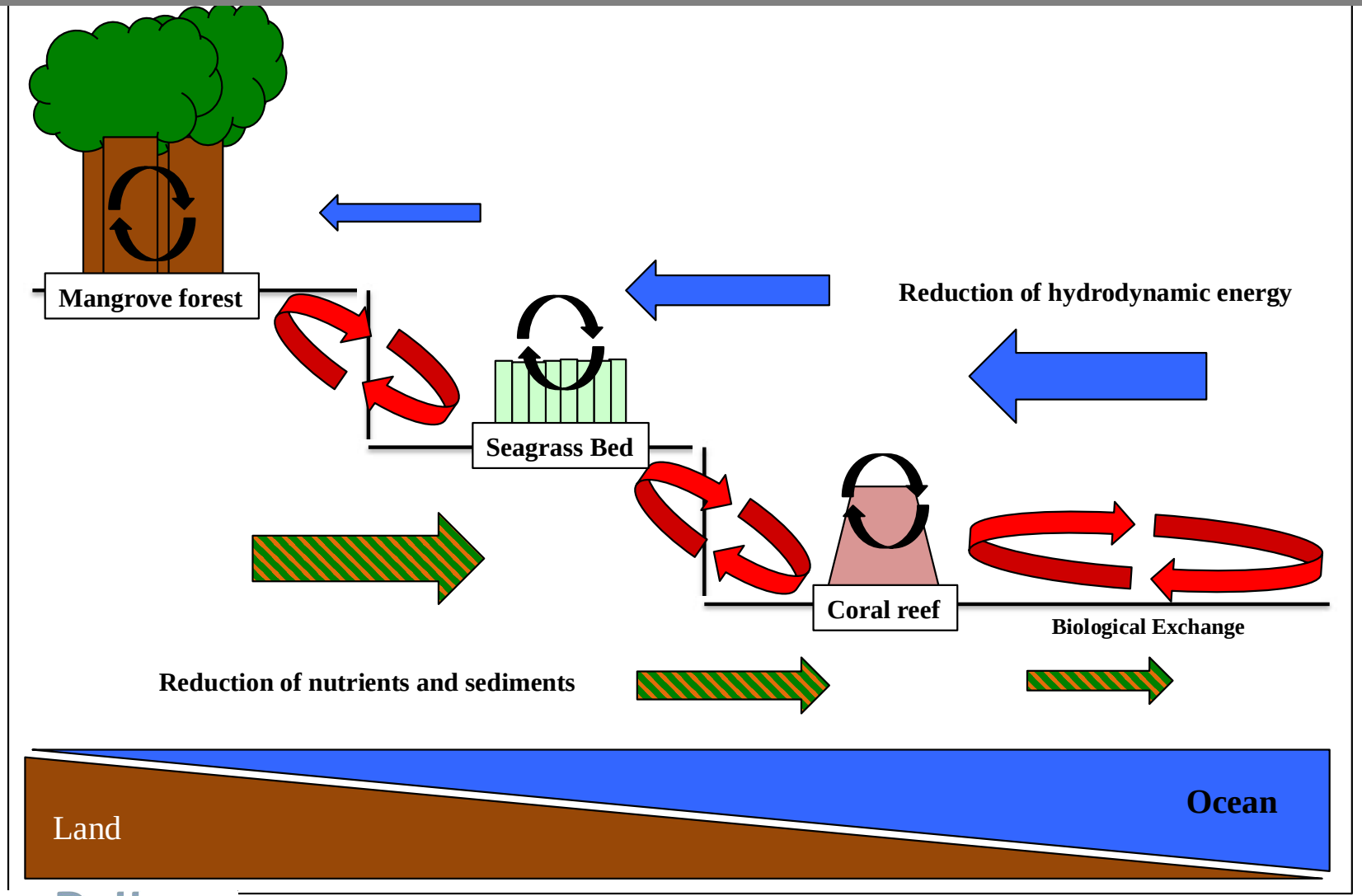
CURRENT KNOWLEGDE

- Which ecosystem to use?
- Effectiveness under extreme conditions?
- Effectiveness long-term?

FUTURE QUESTIONS

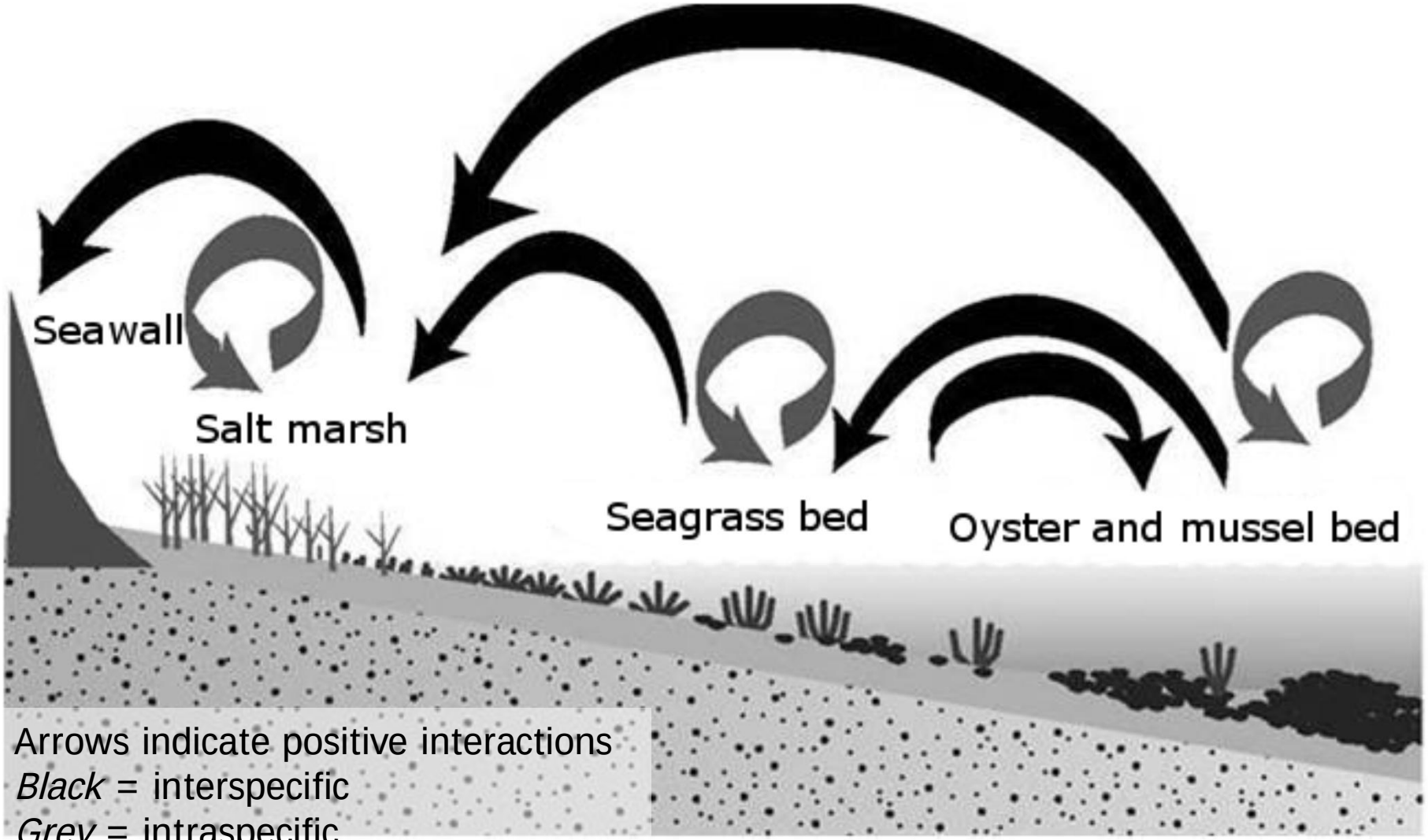
- Understanding long-term stability – SLR & GC?
- How to create *natural* salt marshes?
  - Winn-winn / trade offs
- Landscape-scale connectivity

Reciprocal facilitation between connected ecosystems



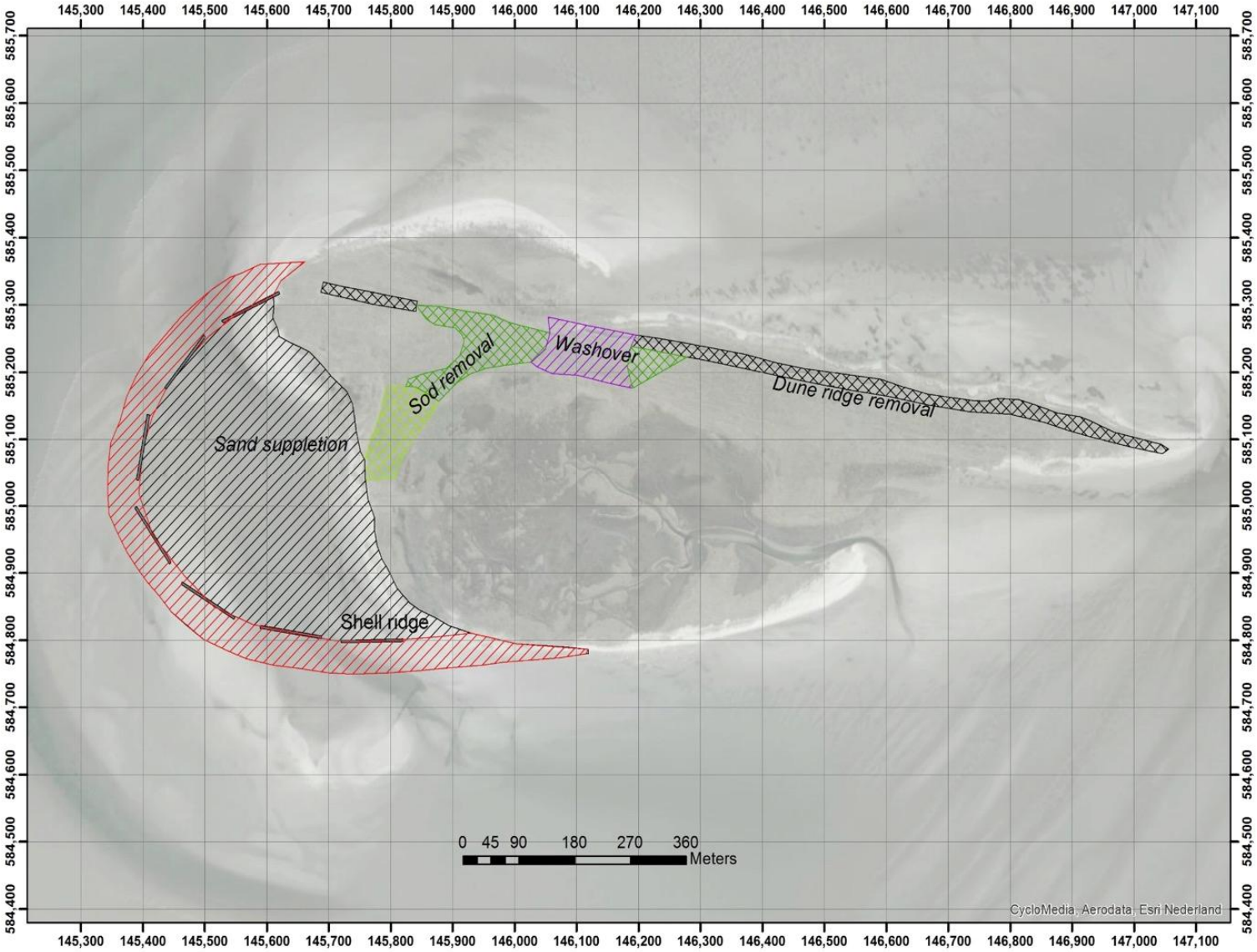
Gillis et al. MEPS 2014

Dutch equivalent?

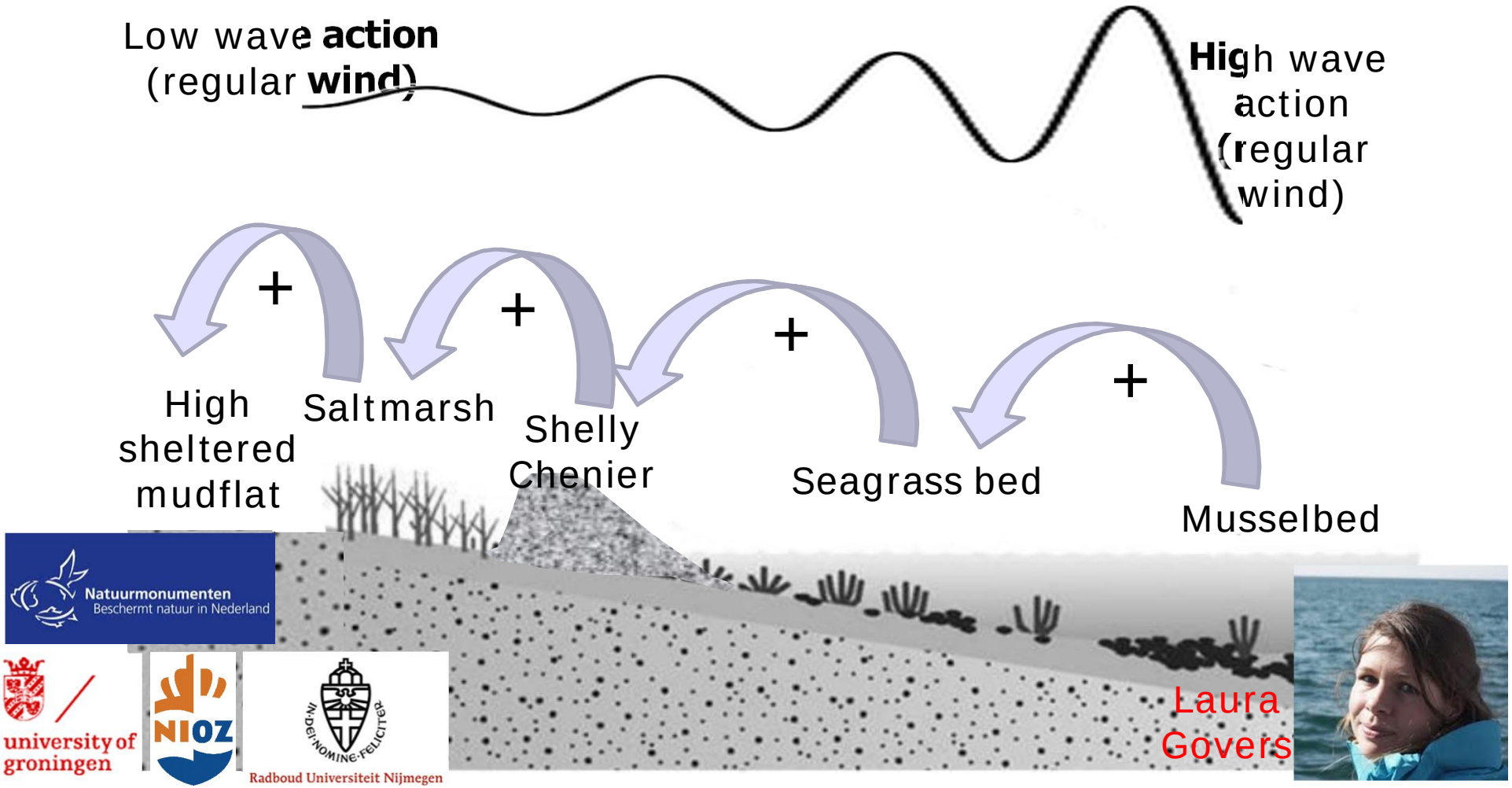


Arrows indicate positive interactions
Black = interspecific
Grey = intraspecific
(Van Katwijk e.a. 2007)

Griend: restoring natural dynamics ...



by restoring long-distance interactions



Sequential facilitation of different communities

Many vacancies @ NIOZ (YE & TX)

working at nioz – Our jobs

https www.workingatnioz.com/our-jobs/

SciNow MarSciToday NIOZ intranet Google Scholar Google Spatial Ecology at NIOZ Spatial Ecol...y | Facebook NIOZ Web mail NS.nl Buienradar.nl WindGURU nu.nl autoweek.nl

Job Opportunities – NIOZ working at nioz – Our jobs

Junior Scientist (tenure track) or Senior Scientist in Deep Sea Benthic Biogeochemistry >

23 September 2016
Junior Scientist (tenure track) or Senior Scientist in Marine Chemical Oceanography >

23 September 2016
Junior Scientist (tenure track) or Senior Scientist in Observational Physical Oceanography (b) >

23 September 2016
Junior Scientist (tenure track) or Senior Scientist in Observational Physical Oceanography (a) >

20 September 2016
PhD "The environmental controls of life cycles of seaweeds and seagrasses" >

20 September 2016
PhD "Modelling biogenic reefs as hotspots of production and biodiversity" >

20 September 2016
PhD "Field flumes studies of Global Change effects on estuarine ecosystems" >

20 September 2016
Scientist (or tenure track) in Experimental Ecology >

18 August 2016
Postdoc "Evolution and genetics of synthetic pathways of microbial lipid biomarkers" >

18 August 2016
2 PhD's "Evolution and genetics of synthetic pathways of microbial lipid biomarkers" >

16 August 2016
Senior (or tenure track) position in Marine Isotope Ecology and Microbiology >

8 August 2016
"Microbial Ecologist / Microbiologist (tenure track) for a research programme within the Soehngen Institute of Anaerobic Microbiology (SIAM)" >

3 August 2016
Senior (or tenure track) position in Marine Optics & Remote Sensing >

12 July 2016
Three Women In Science Excel (WISE) tenure tracks at NWO's research institutes >

5 July 2016
NL | Senior Communications Officer (fulltime) >

5 July 2016
2 Senior (or tenure track) Marine Phytoplankton Microbiologists >

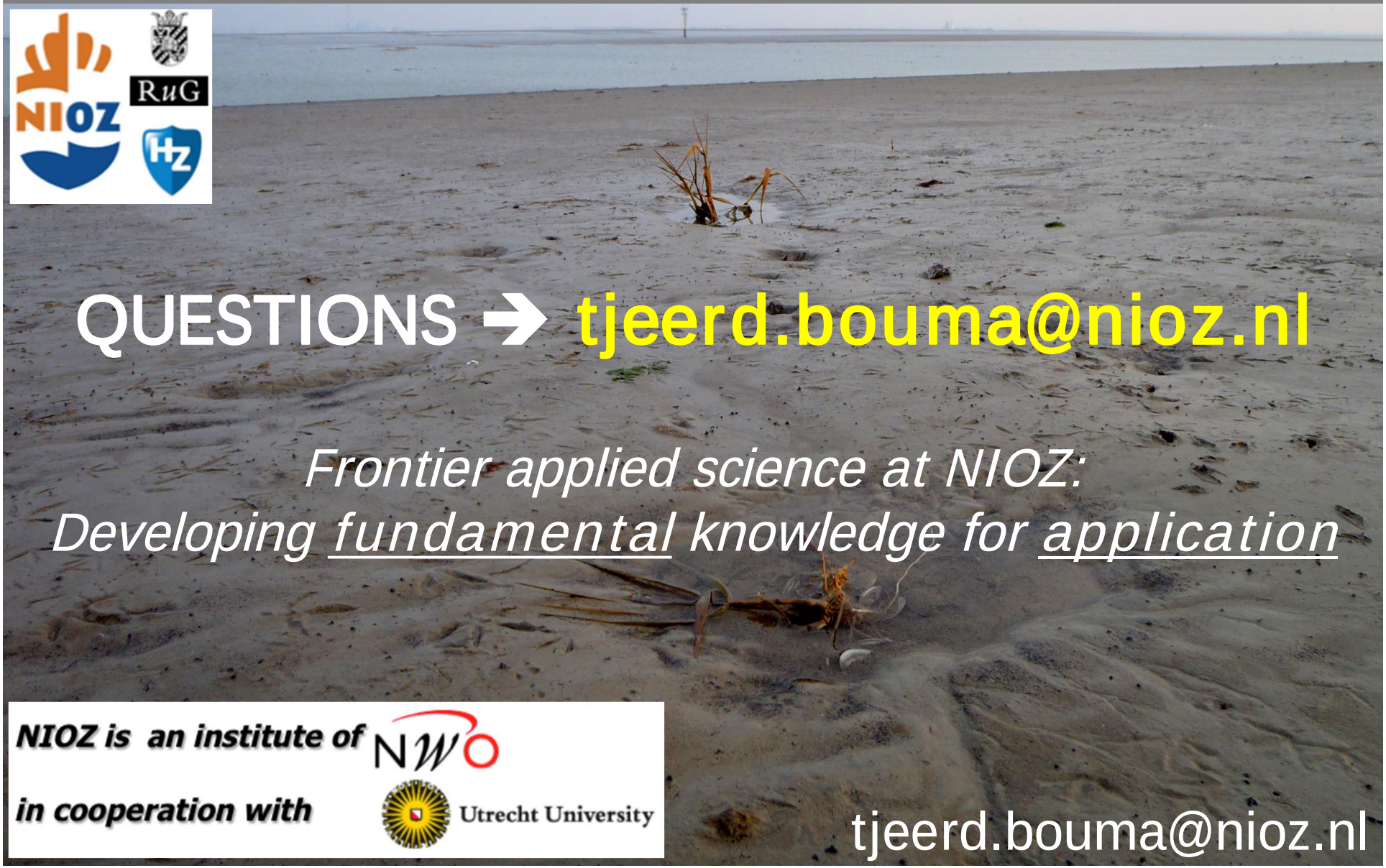
SOCIAL

SEE WHO YOU KNOW ALREADY?
WE LIKE TO LINK WITH YOU >

BEHIND THE SCENES
MARINE ORGANIC BIOGEOCHEMISTRY IS SOCIAL >

NIOZ

Thank you for your attention ☺



QUESTIONS ➔ tjeerd.bouma@nioz.nl

Frontier applied science at NIOZ:
Developing fundamental knowledge for application

NIOZ is an institute of NWO

in cooperation with Utrecht University

tjeerd.bouma@nioz.nl