Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Coastal saltmarshes as nature-based flood and erosion risk components

The Evidence Base

Image: Orplands, Essex. J Tempest

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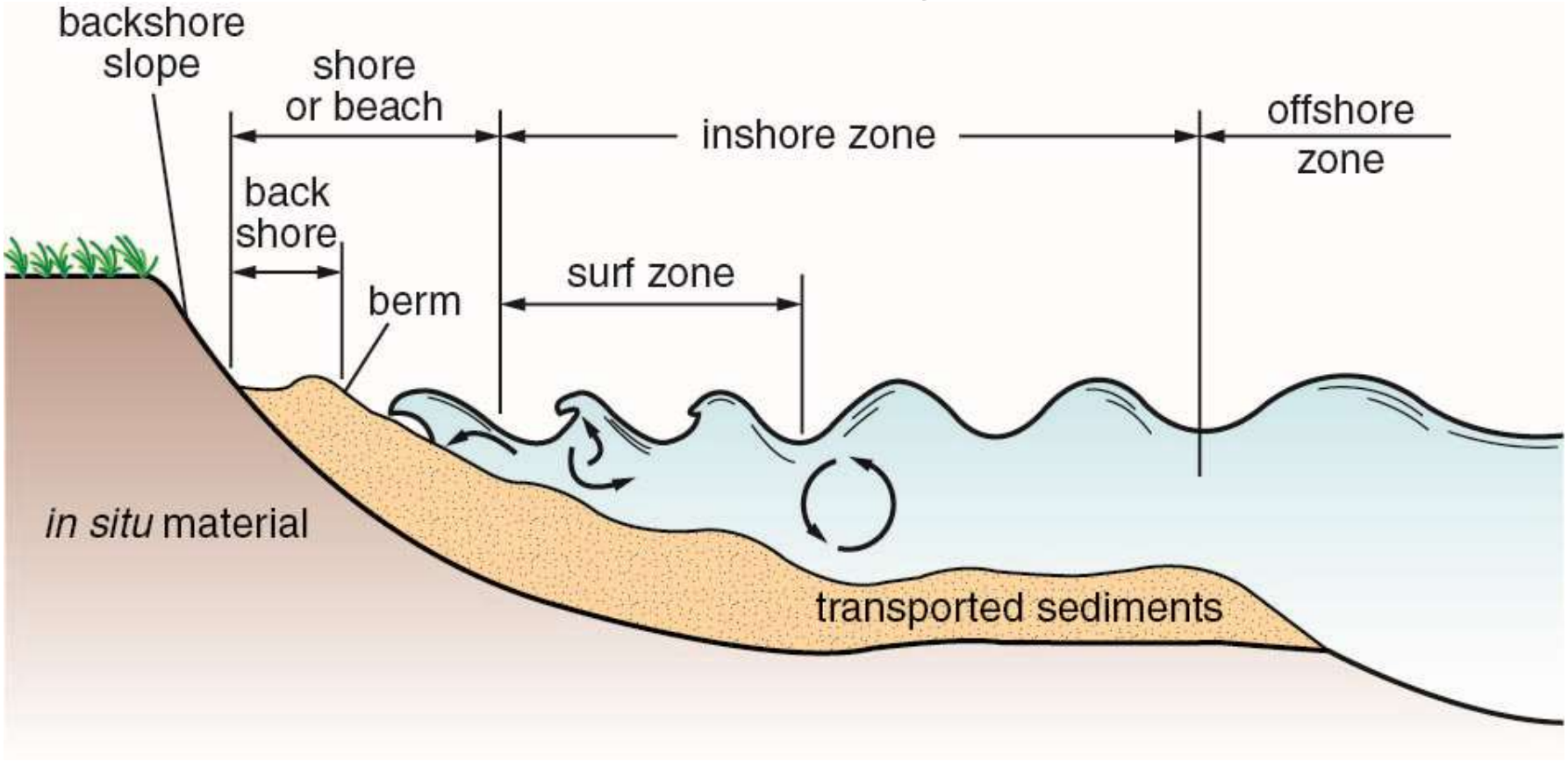
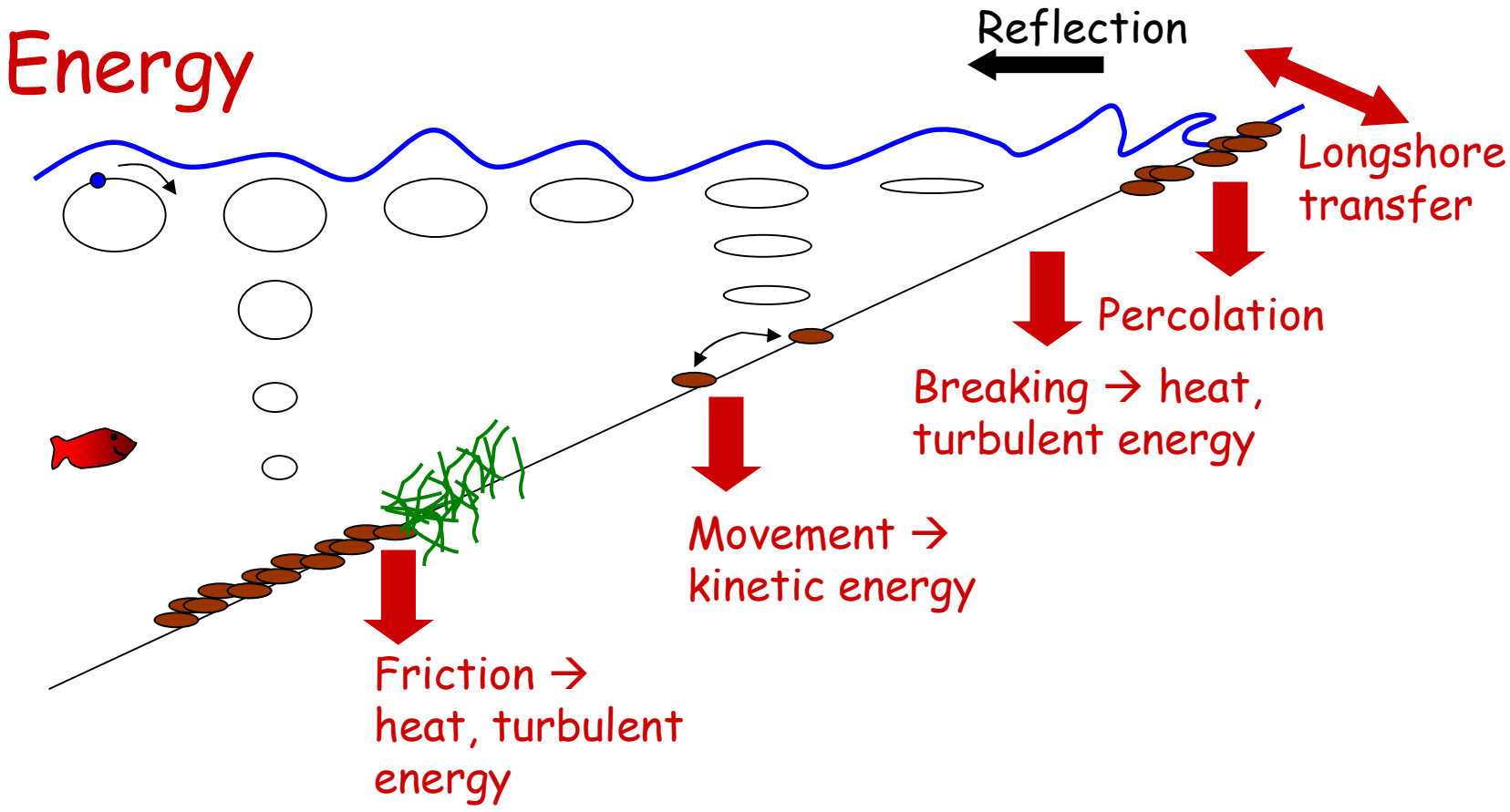
CIEEM Conference 2021 on Nature Based Solutions: Opportunities in a time of biodiversity crisis and climate emergency

Soft-sediment coasts dissipate energy naturally

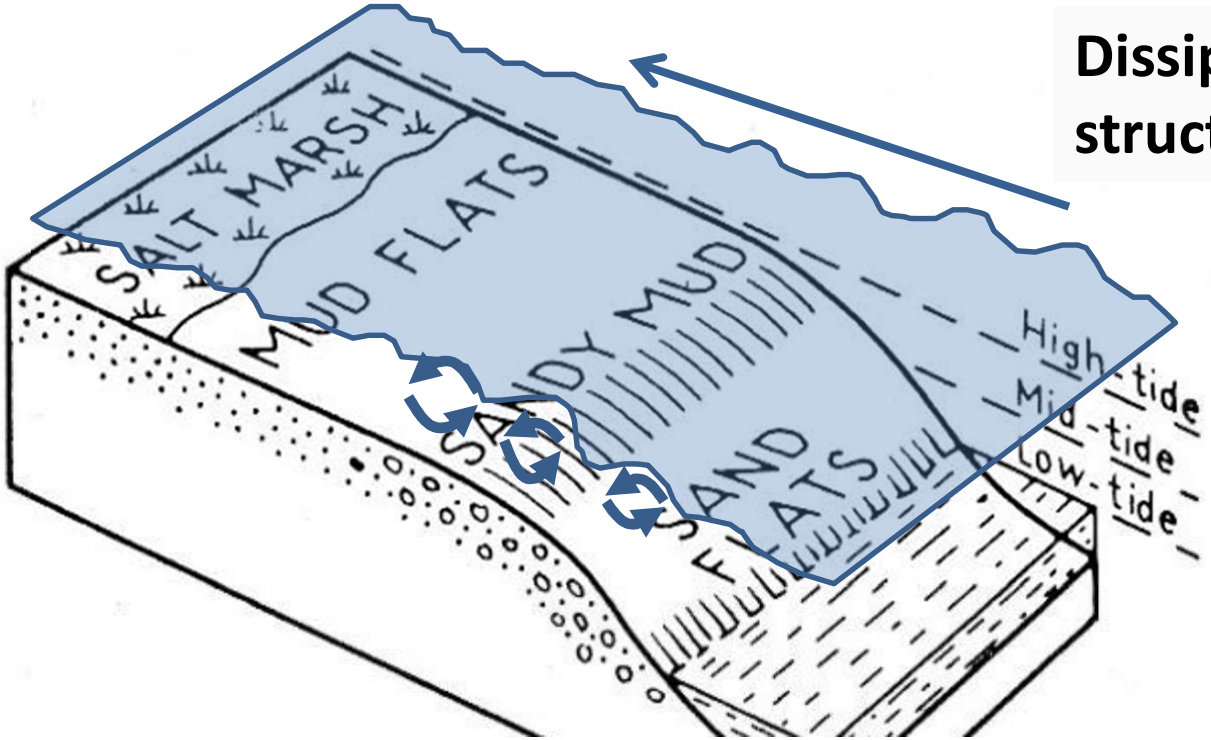


MARSH_Fig.22.18

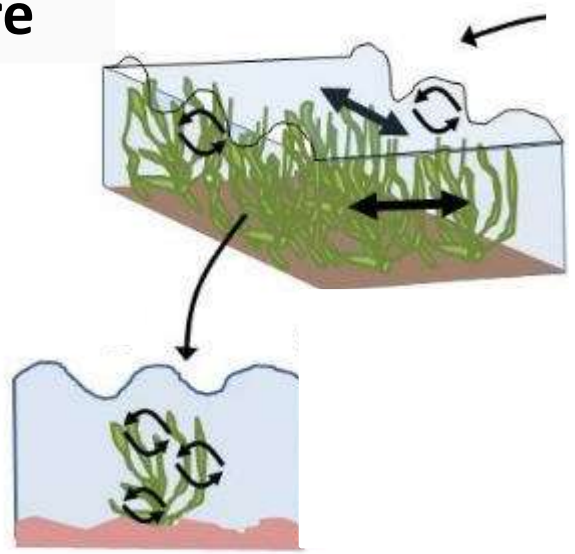
Energy dissipating processes



Saltmarshes …

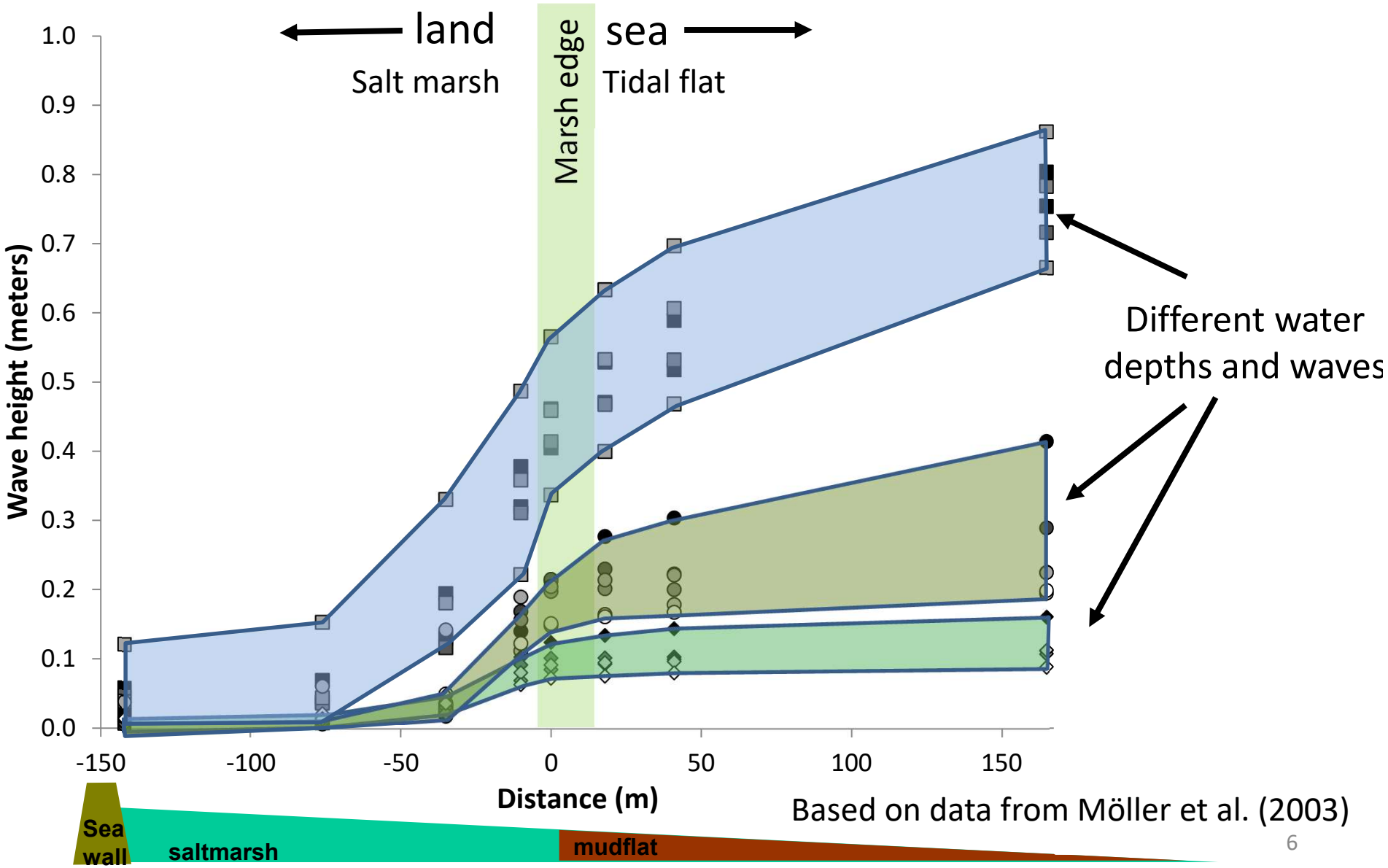


Dissipative structure



Field Evidence

Field wave reduction evidence



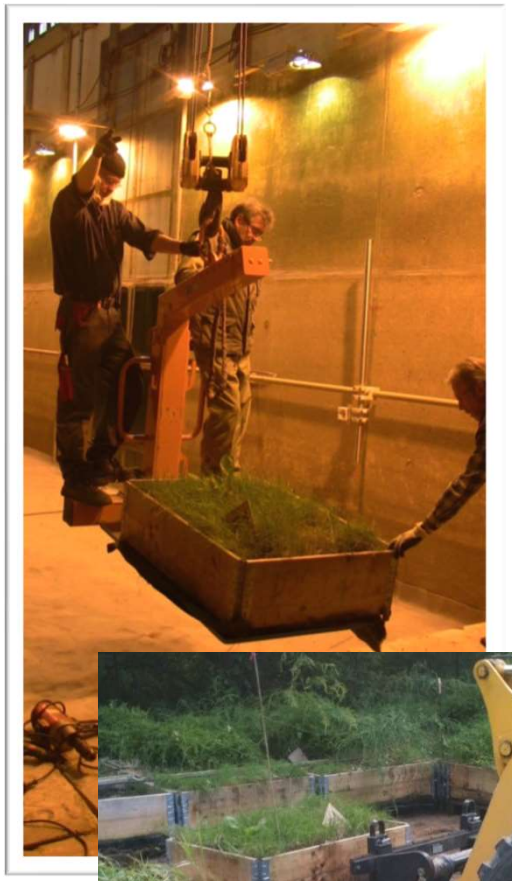
Based on data from Möller et al. (2003)

Laboratory evidence

Large Wave Flume (GWK) Hannover

www.thesaltmarshexperiment.org

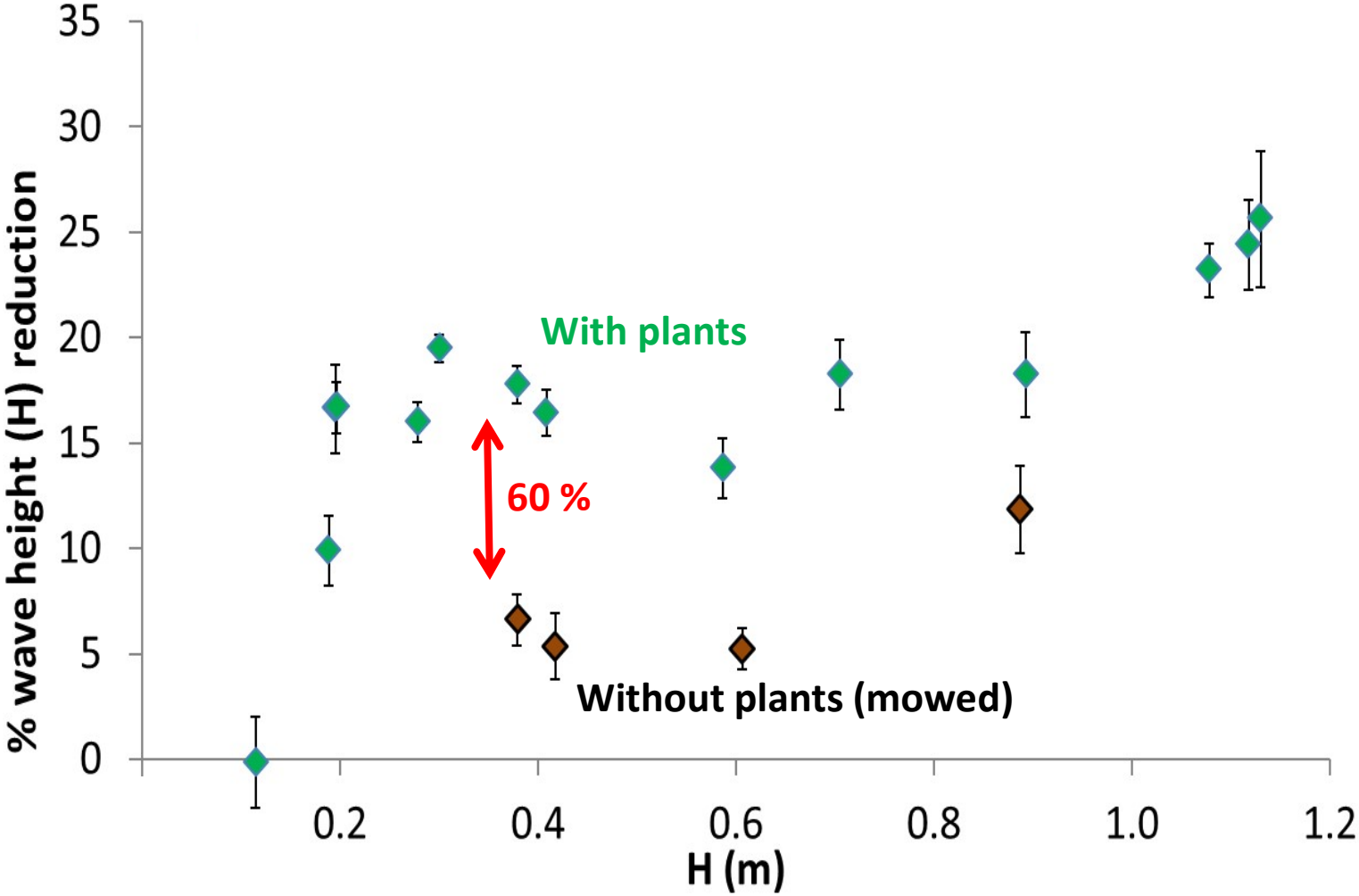
Video: James Tempest (CCRU)



Möller, et al. 2014. *Nature Geoscience* 7, 727-731

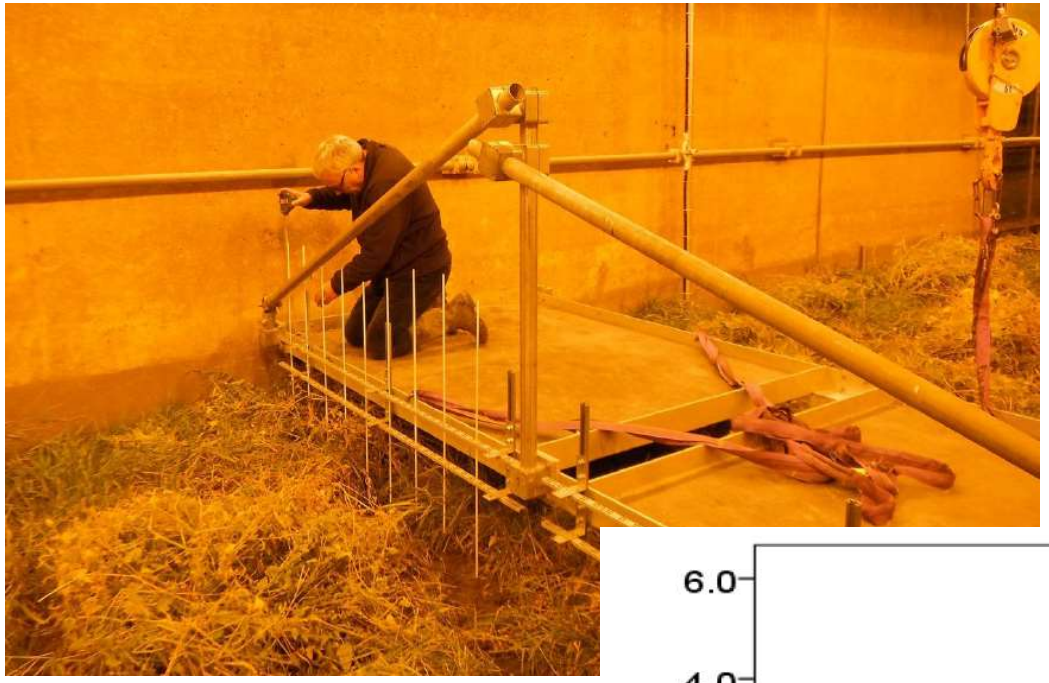
www.thesaltmarshexperiment.org

Under 2m water, 40 m distance → ~ 15 % wave height reduction

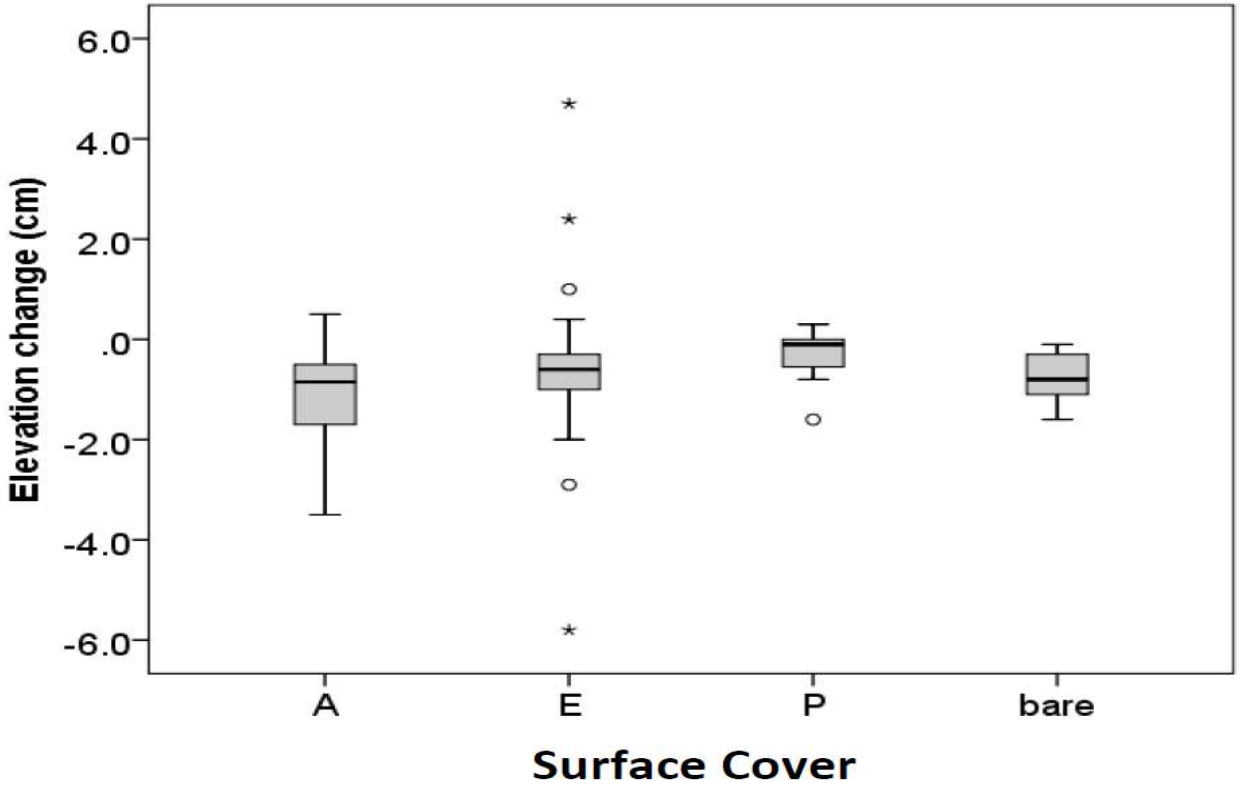


Möller et al. 2014. *Nature Geoscience* 7, 727-731

www.thesaltmarshexperiment.org



‘Storm’-induced erosion minimal and depends on plant species…



Spencer *et al*. (*2015*) ESP&L Special Issue

Resist UK

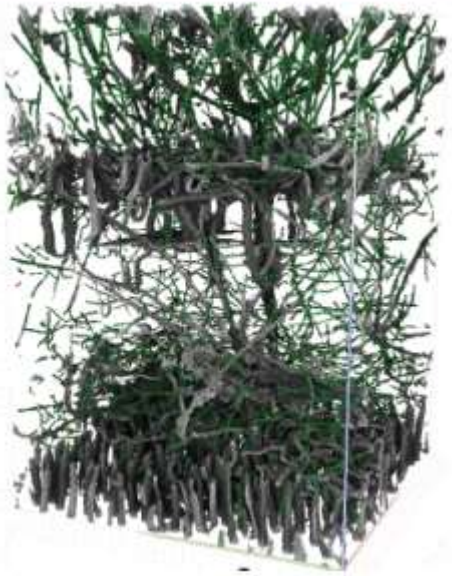
EARTH SURFACE PROCESSES AND LANDFORMS
Earth Surf. Process. Landforms , 0

Published online in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/esp.4912

State of Science

Resistance of salt marsh substrates to near-instantaneous hydrodynamic forcing

Helen Brooks,[1]* Iris Möller,[2] Simon Carr,[3] Clementine Chirol,[4] Elizabeth Christie,[1] Ben Evans,[1] Kate L. Spencer,[4] Tom Spencer[1] and Katherine Royse[5]



Salicornia roots (green) and porosity networks including bioturbation horizons (grey) as seen in X-Ray CT. Sample collected in Warton Sands, UK

Chirol *et al*., 2021
Geoderma 387

UNIVERSITY OF CAMBRIDGE · NERC · Queen Mary University of London · British Geological Survey · Technische Universität Braunschweig · NIOZ · hydralab+

Hard structures …

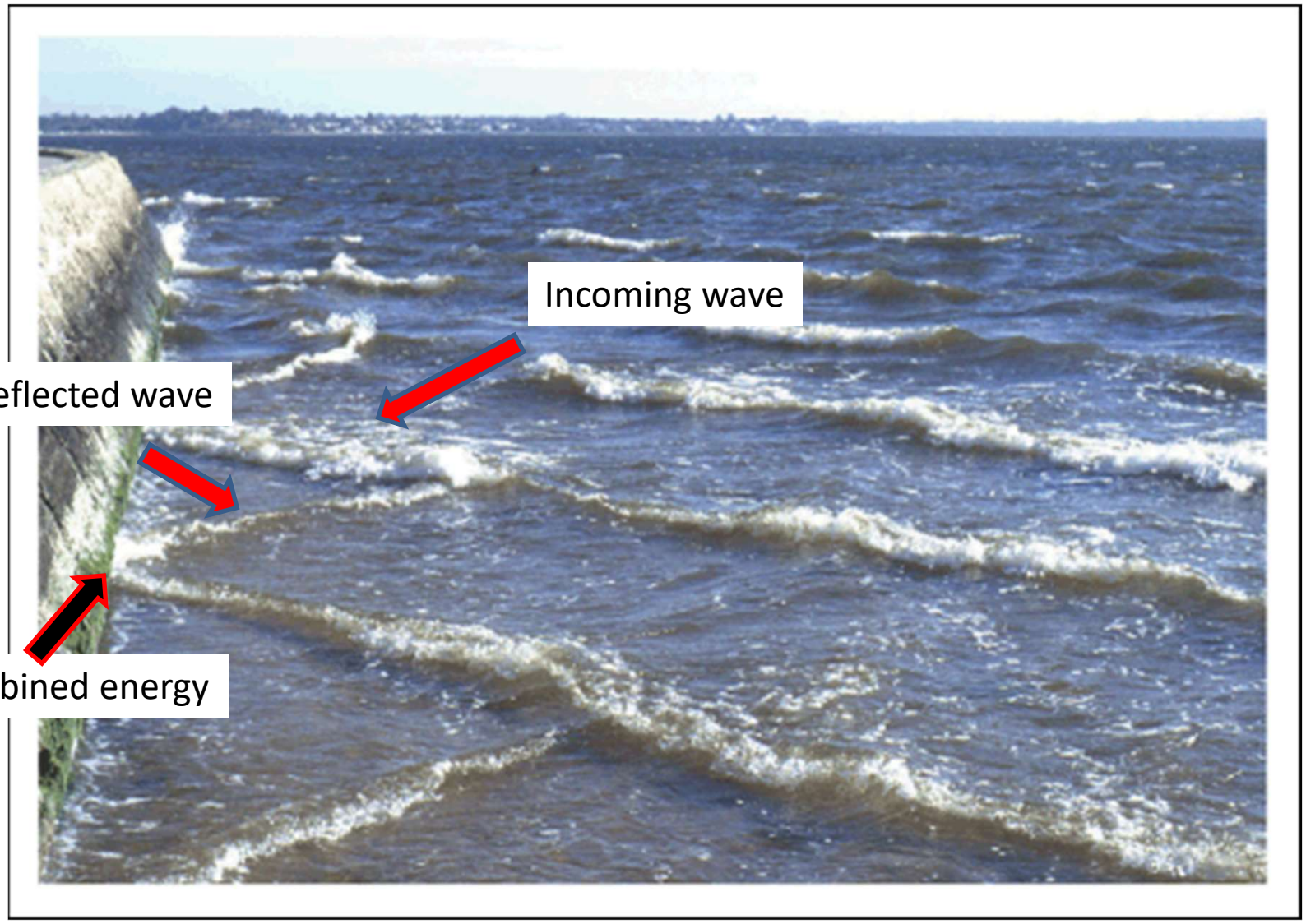
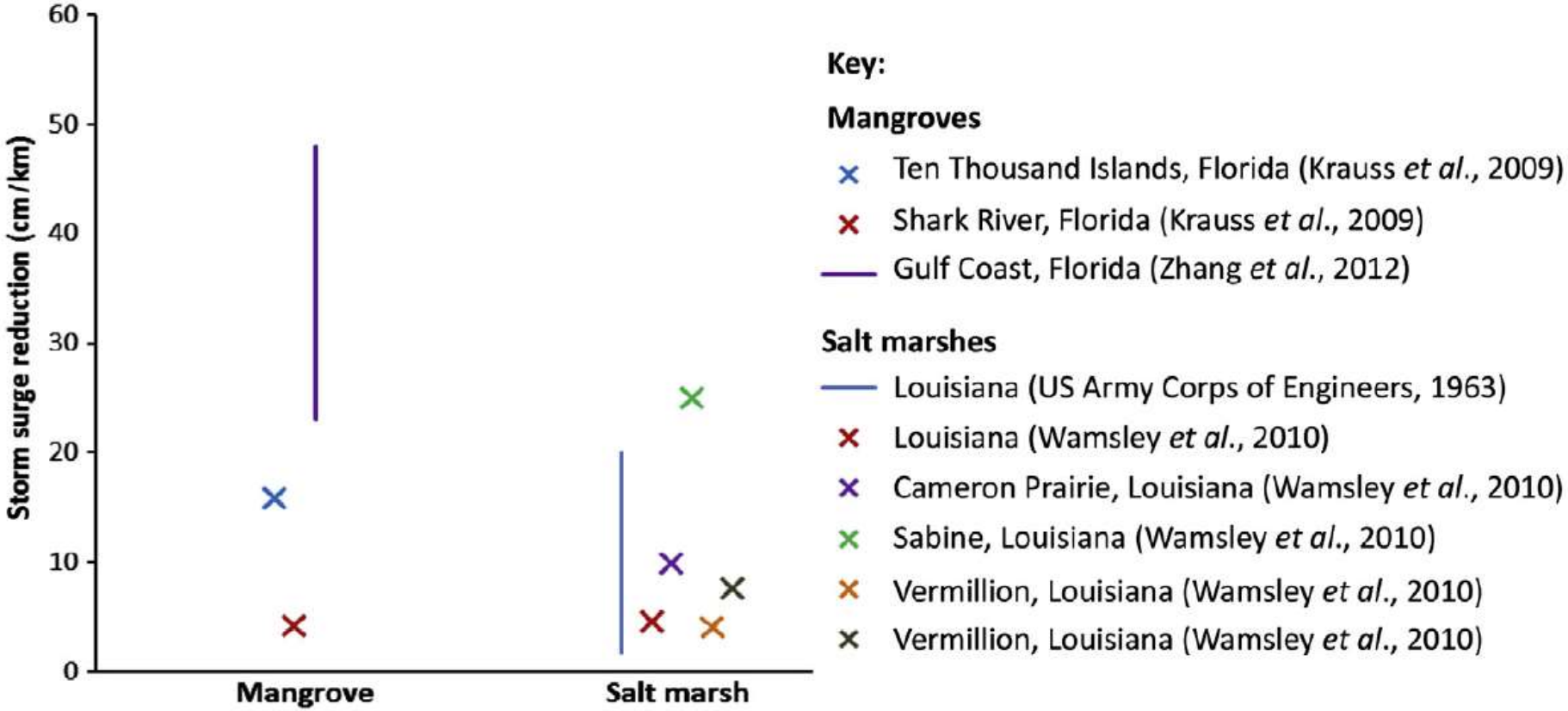


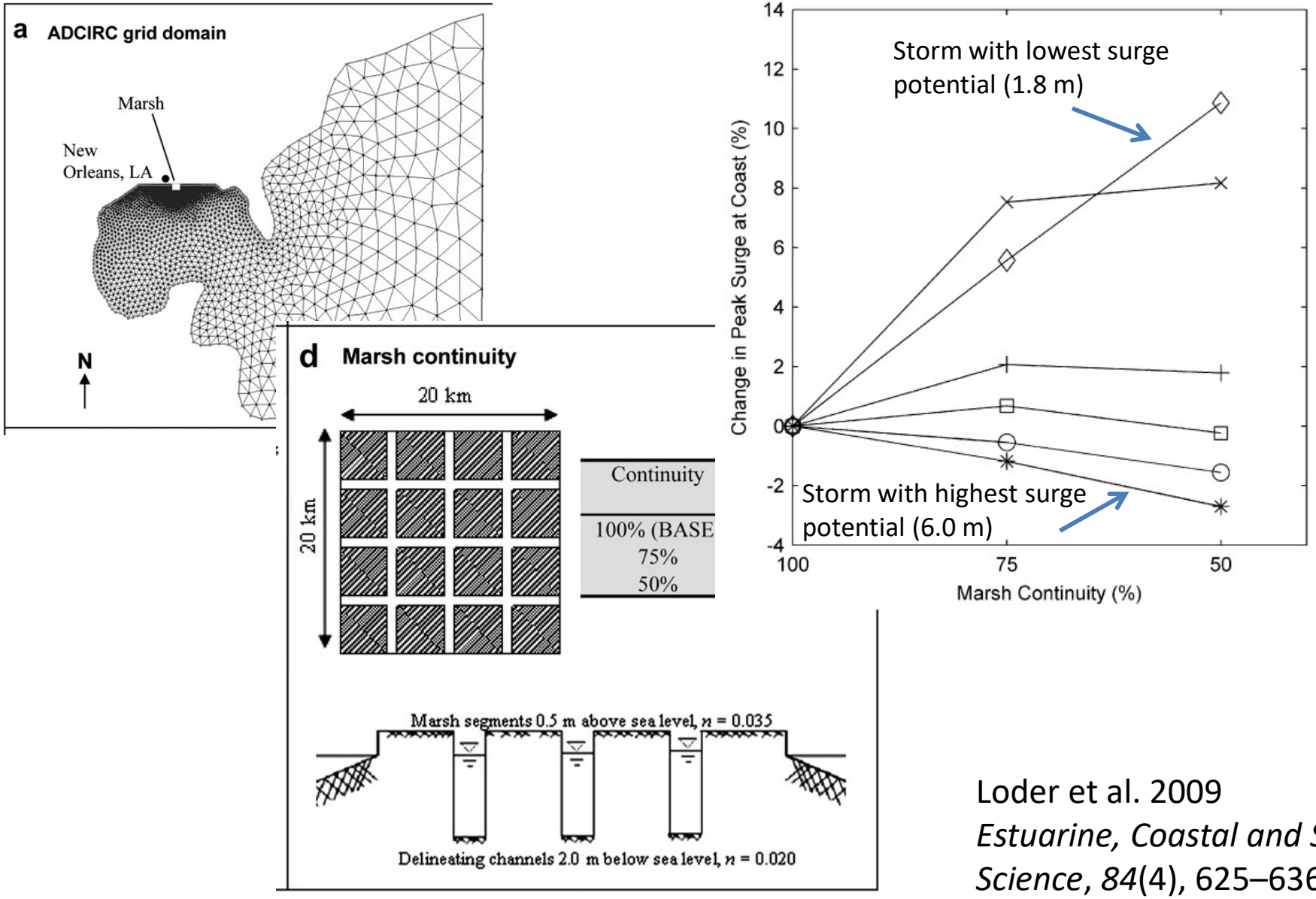
Figure 15.13 Reflection of breaking waves at the vertical face of a seawall giving rise to a criss-cross wave pattern.

Surge water level reduction evidence

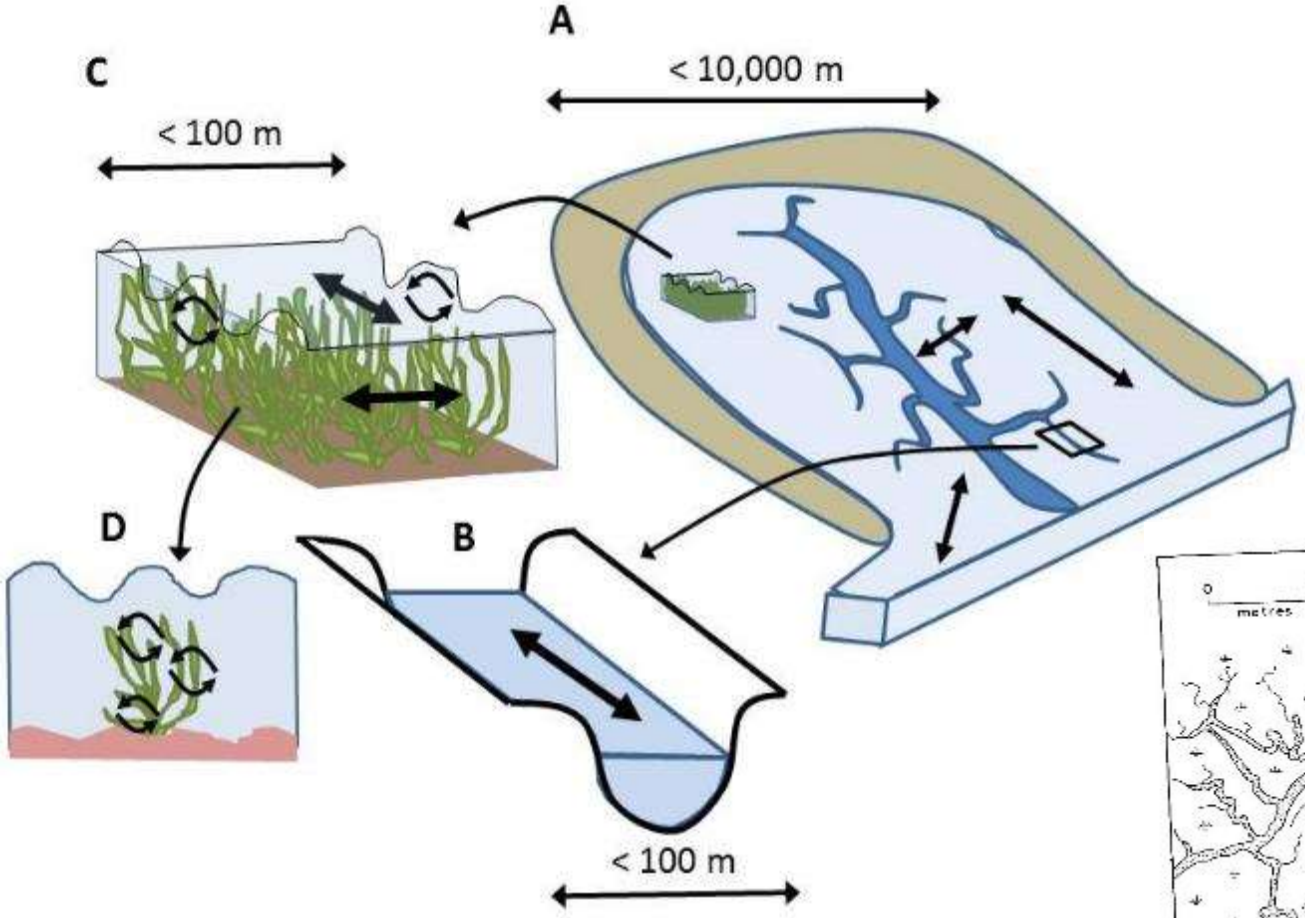


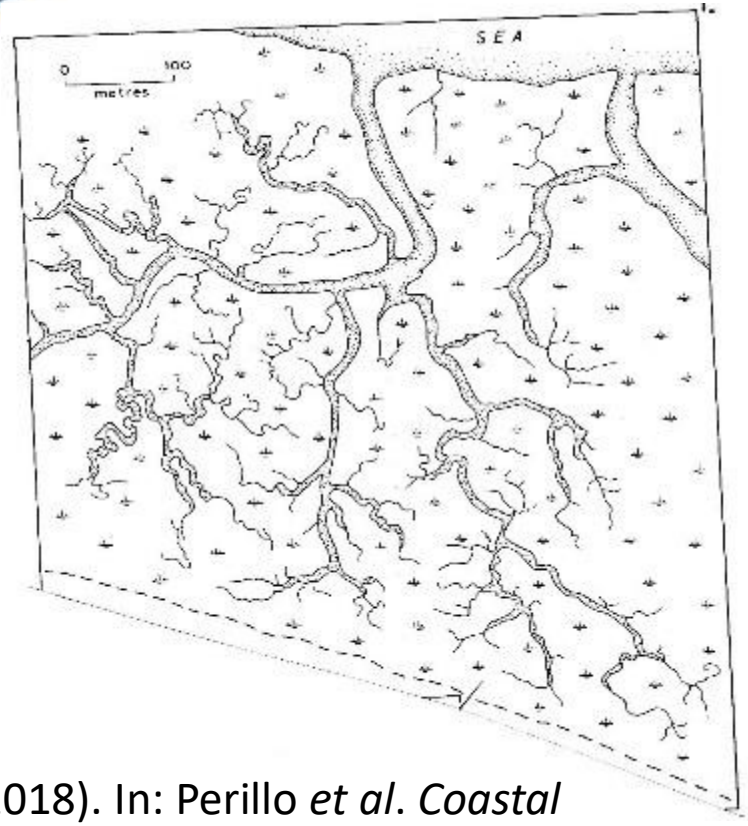
McIvor et al. 2015. Mangroves, Tropical Cyclones, and Coastal Hazard Risk Reduction. Chapter 14 in: Shroder et al., (eds) '**Coastal and Marine Hazards, Risks, and Disasters**'. Elsevier

New Orleans: storm surge attenuation



Loder et al. 2009
Estuarine, Coastal and Shelf Science, *84*(4), 625–636.

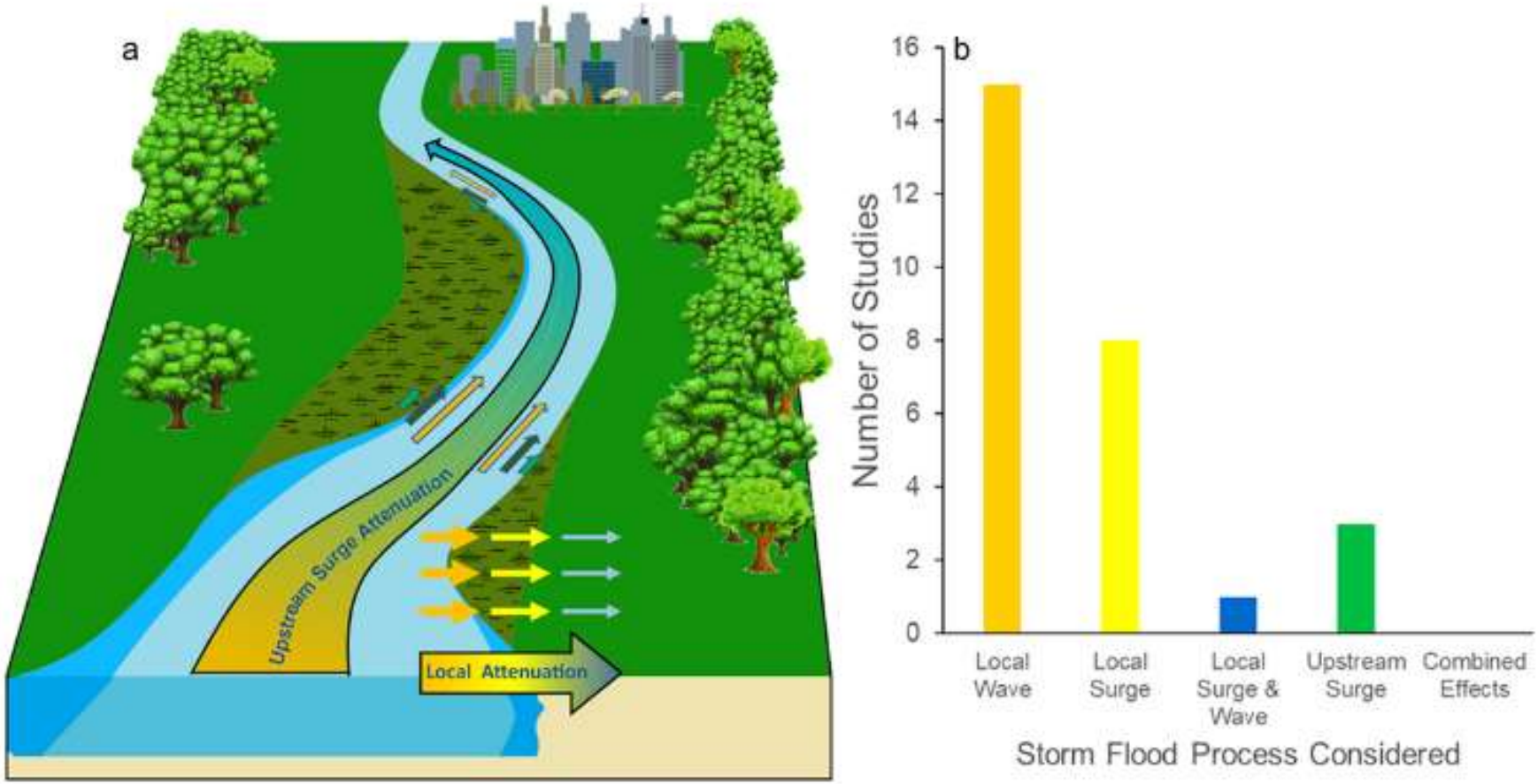




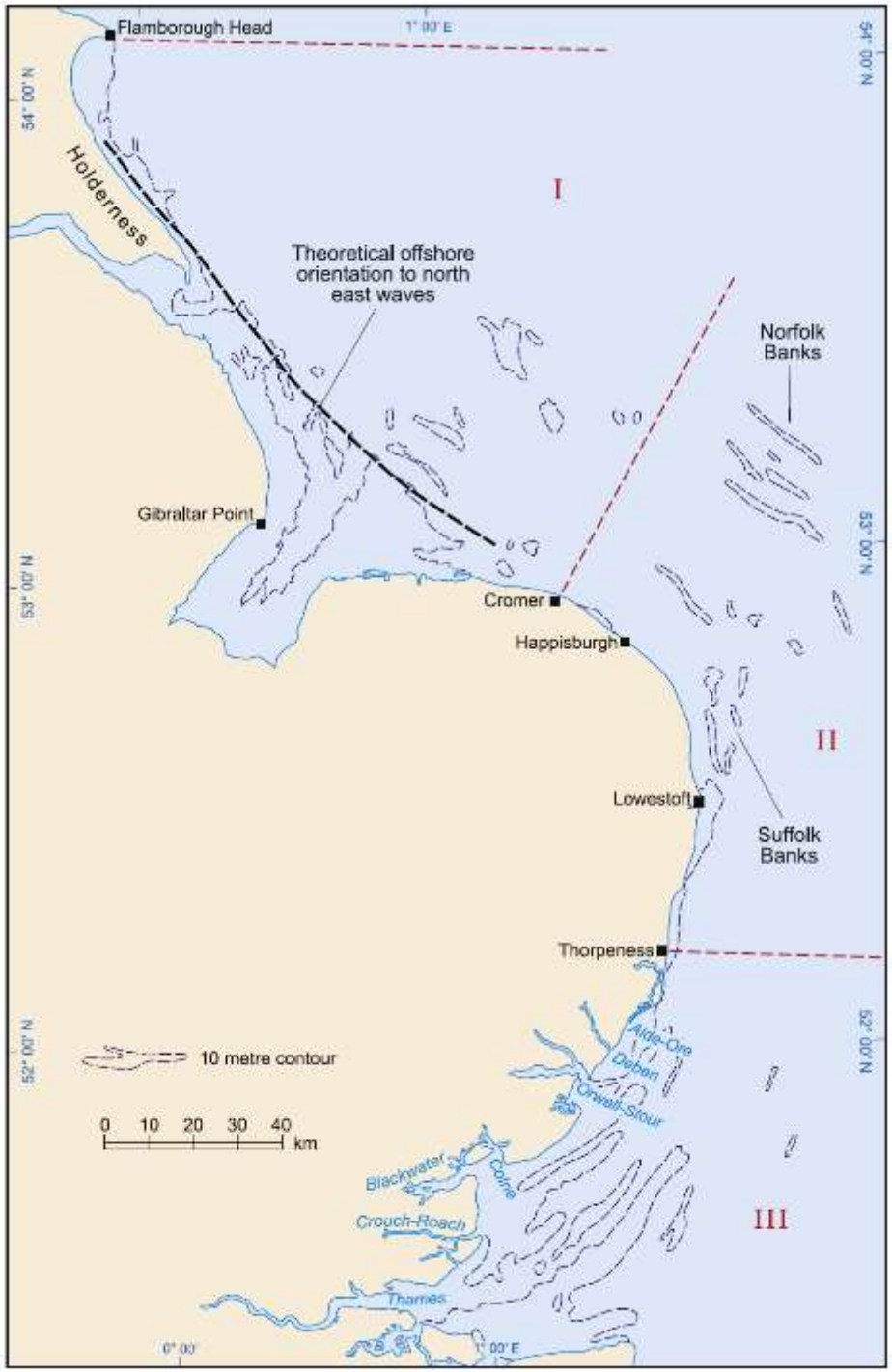
Scales of roughness in coastal wetlands

Möller, I., & Christie, E. (2018). In: Perillo *et al*. *Coastal Wetlands. An integrated ecosystem approach.*

Combined surge/wave attenuation



Fairchild et al. (in review) – preview: https://www.researchsquare.com/article/rs-244327/v1



Storm surges

- Complex seabed topography
- Complex surge dynamics
- Complex nearshore bathymetry

→ Wave and surge water level dissipation

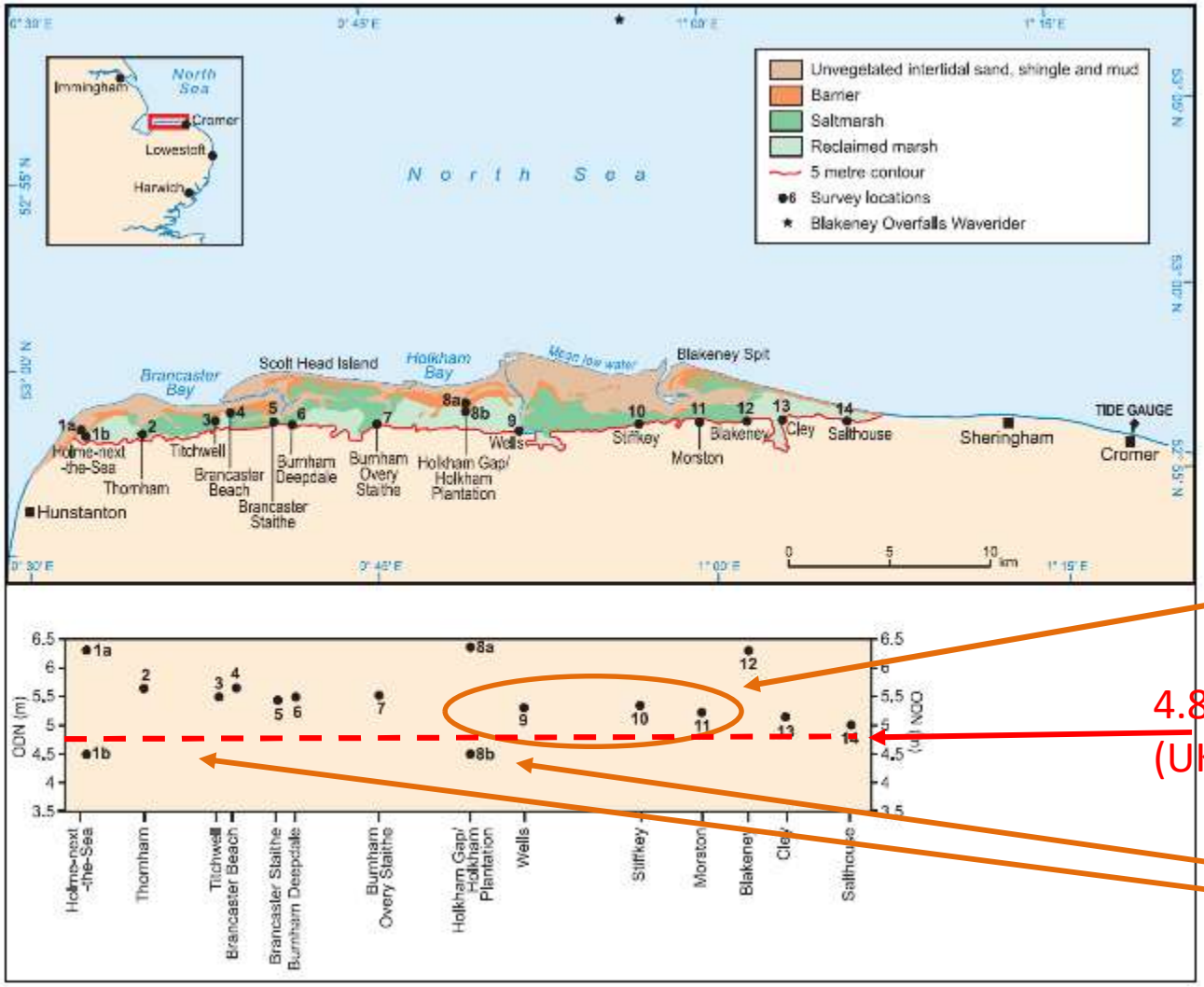
Spencer et al. 2015 Earth-Science Reviews 146, 120-145

2013 Surge Impacts

- Complex seabed topography
- Complex surge dynamics
- Complex nearshore bathymetry

Earth-Science Reviews 146, 120-145

Local effects on max water levels



Widest foreshores

4.86 m Predicted water level
(UK Env Agency flood warning)

Dune sheltered

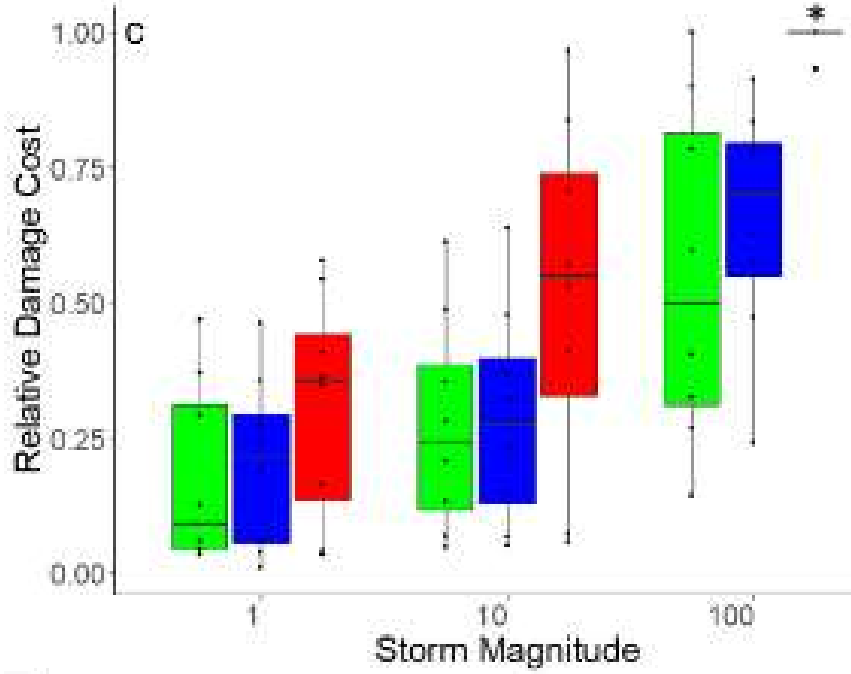
Fig. 1. Alongshore variation in maximum water levels reached during the storm surge of 5 December 2013 on the barrier coastline of North Norfolk, eastern England (ODN = Ordnance Datum Newlyn, where 0.0 ODN approximates to mean sea level).

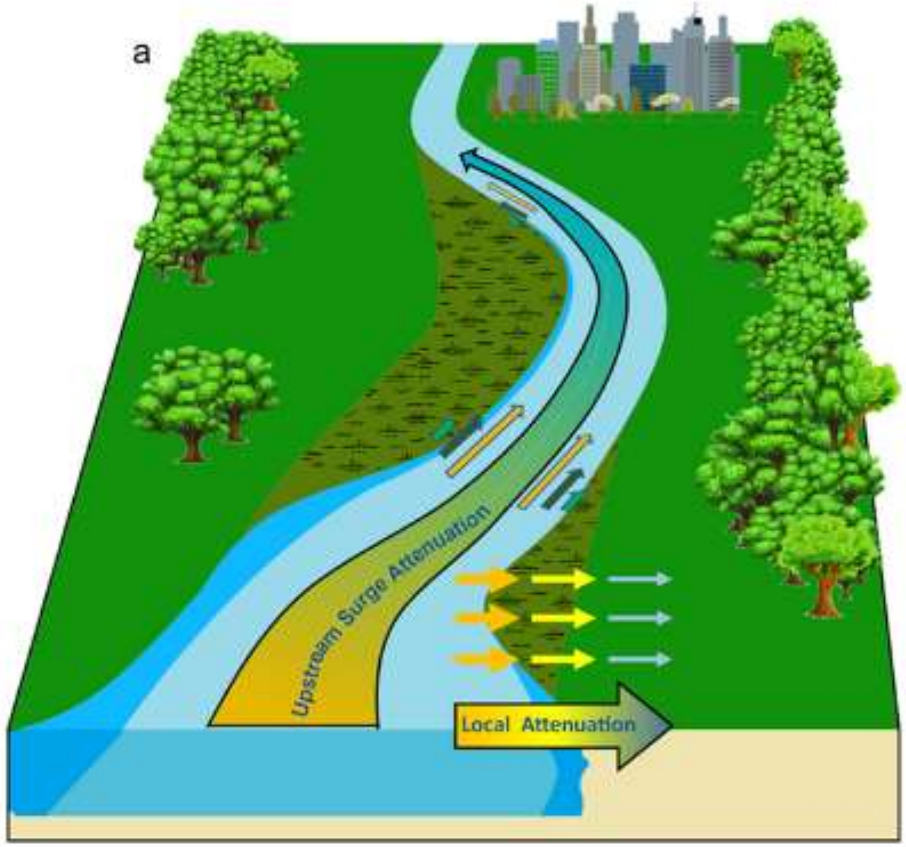
ARTICLE

Coastal wetlands mitigate storm flooding and associated costs in estuaries

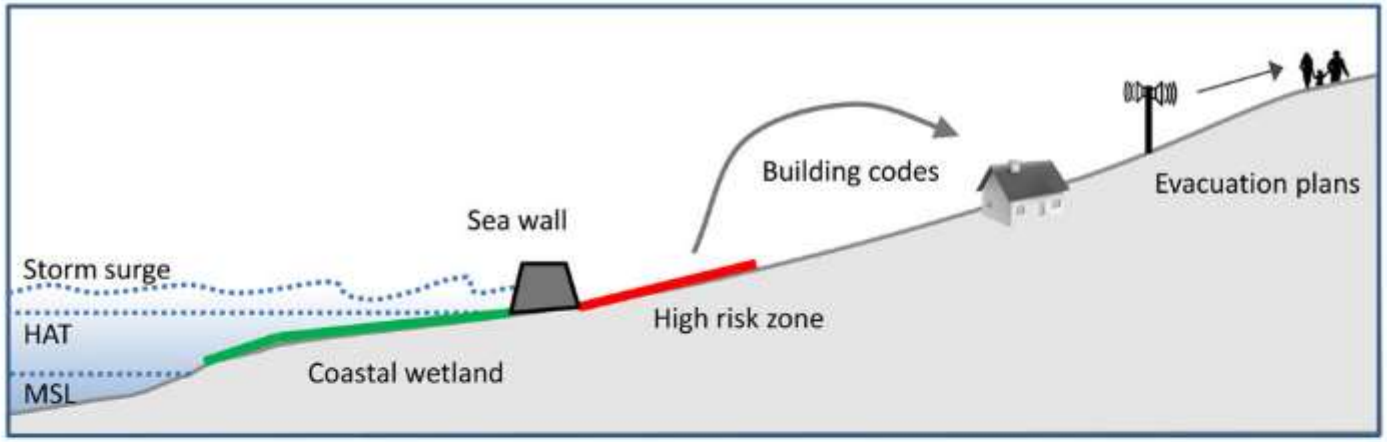
Tom Fairchild, William Bennett, Greg Smith, Brett Day, Martin Skov, Iris Möller, Nicola Beaumont, Harshinie Karunarathna, John Griffin

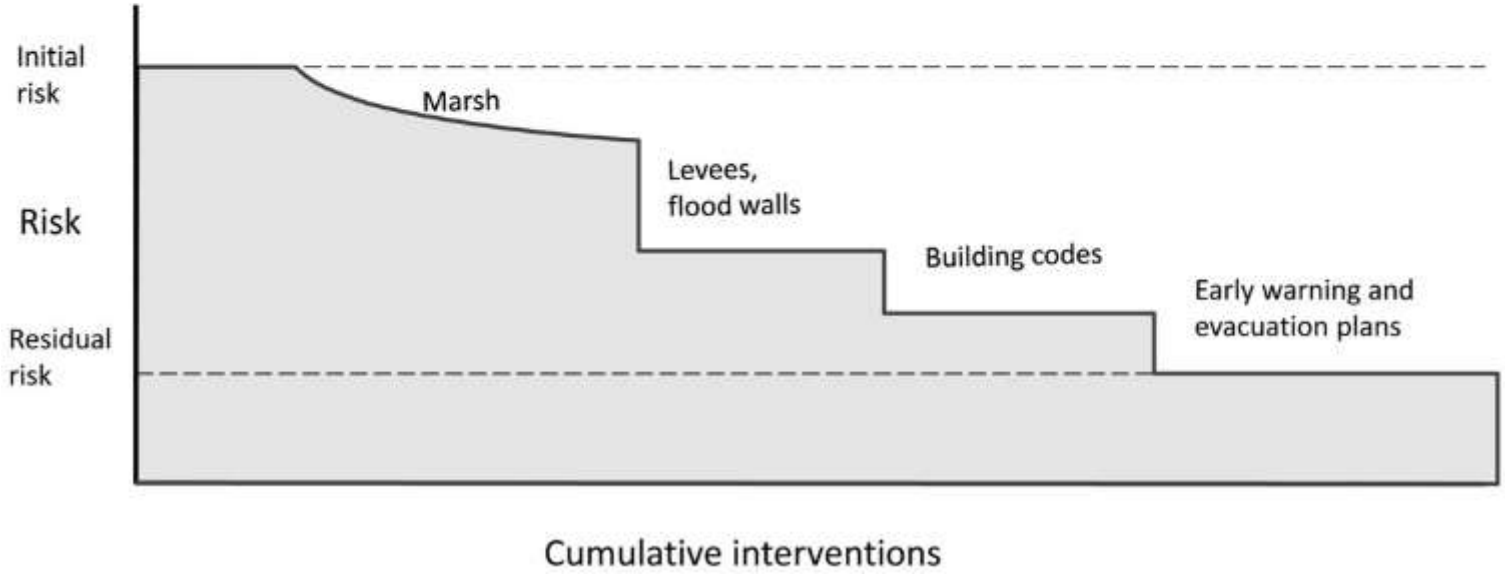
DOI: 10.21203/rs.3.rs-244327/v1 Download PDF



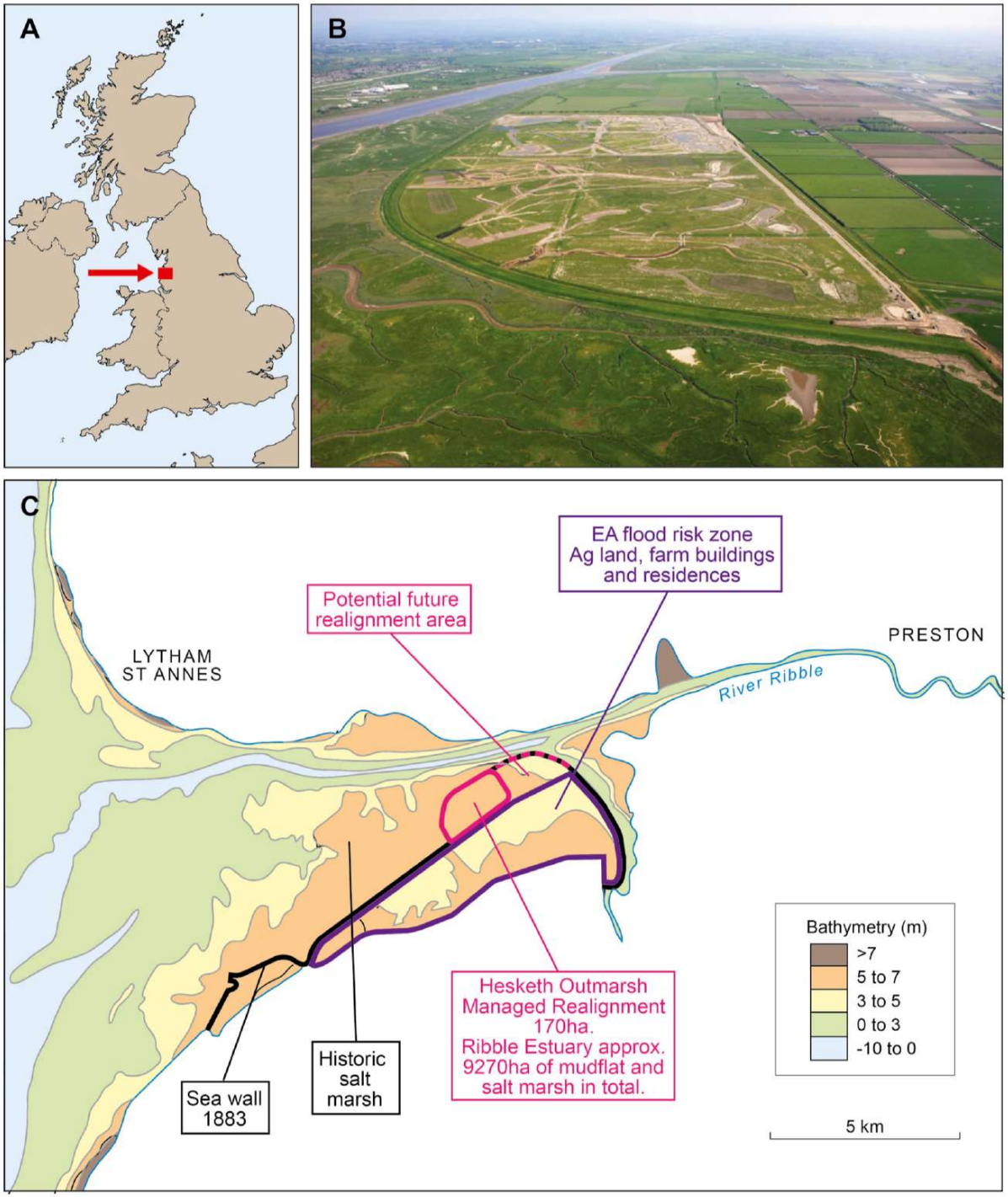


Coastal landforms & ecosystems as critical elements of our solutions





Spalding et al. 2013 *Cons. Letters*, 1-9



Hesketh Outmarsh
West
Managed
Realignment
UK

180 ha

2008/2009: x 4
breaches in outer
seawall

New seawall +
saltmarsh protect
1260 ha farmland
74 residential
properties
100 farm buildings

Implementation challenges

- Requires space we don't have…
- Nature = inherently variable
- No perceived fixed future
- Context dependency
- No specified 'design life'
- No 'easy' costing model
- No 'project end' date…

The 'sand motor', The Netherlands

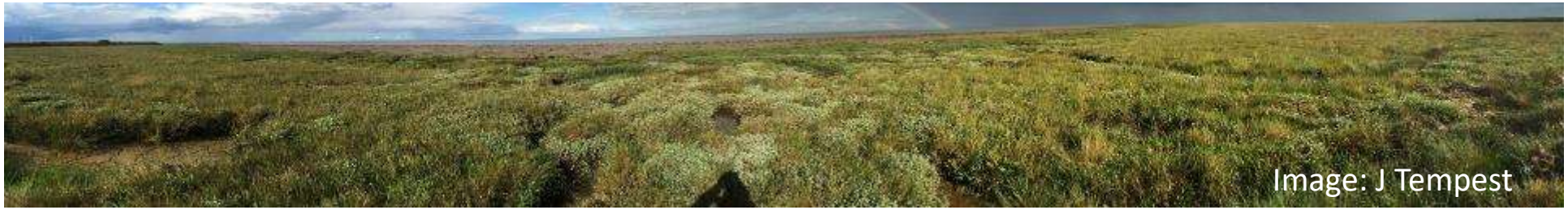
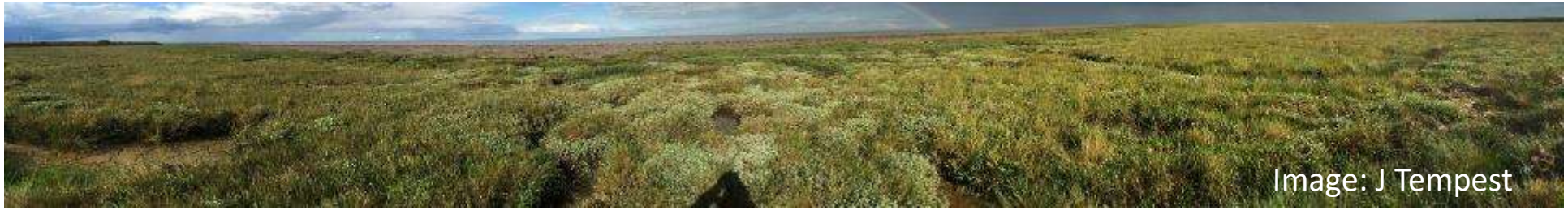
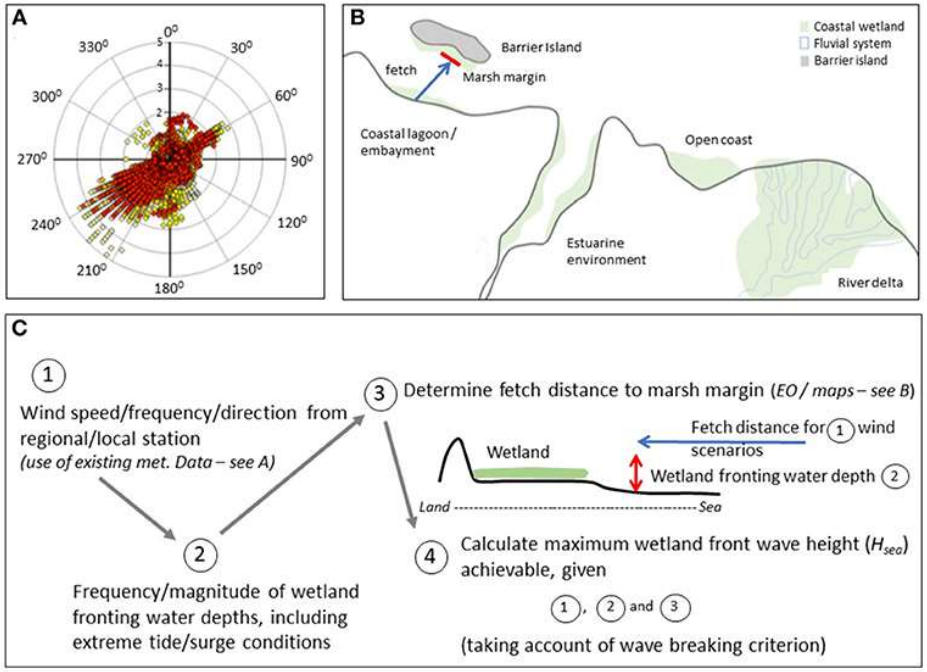


Image: J Tempest

Advantages & Opportunities

- Self-adjusting dynamic system
- Building respect for nature
- Empowering communities / individuals
- Building knowledge / scientific understanding





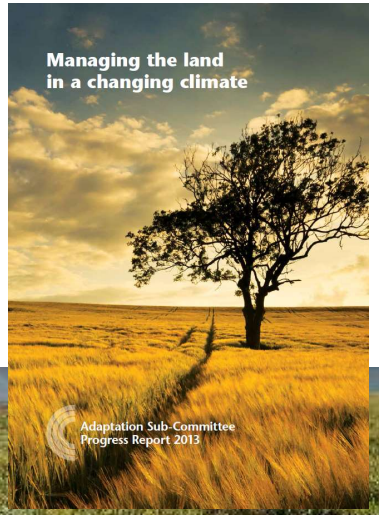
* Using Möller et al. (2014), it can be assumed with certainty (95% probability of assuming correctly) that the marsh will reduce wave heights by ***at least*** 15 % for as long as it retains > 40 m width.

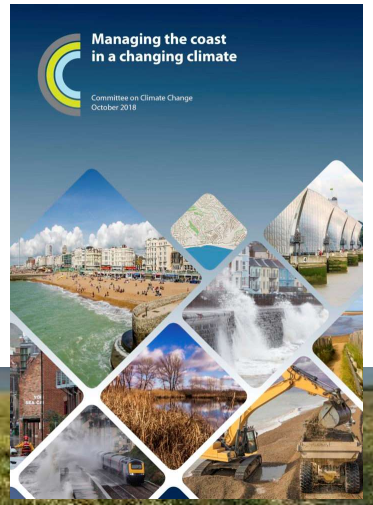
Möller 2019, *Front. Environ. Sci*. 24 April 2019

TESSA – Toolkit for Ecosystem Service Site-based Assessment

Advantages & Opportunities

- Self-adjusting dynamic system
- Building respect for nature
- Empowering communities / individuals
- Building knowledge / scientific understanding
- Lower cost in the long run
- Realisation of multiple benefits



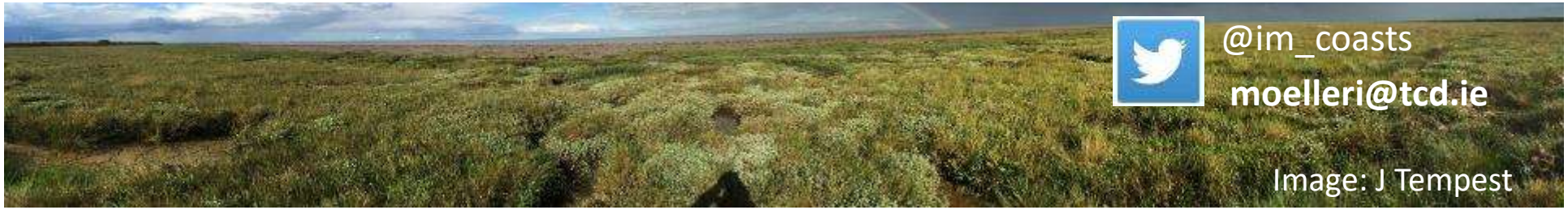


https://www.theccc.org.uk/publication

Image: J Tempest

Conclusions: Saltmarshes as NBS

- We have the evidence base for both all of erosion resistance, water level and wave reduction ***and more!***
- Implementation has to be context specific
- Implementation challenges our traditional planning models & expectations
- Long-term benefits are clear and evidenced
- Clear policies now need to follow…



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Thank you!

https://www.pml.ac.uk/CoastWeb/Home

Illustrations by @tonixllobet

CoastWEB