Technische Universität Braunschweig

INSTITUT FÜR GEOÖKOLOGIE
Landschaftsökologie und Umweltsystemanalyse

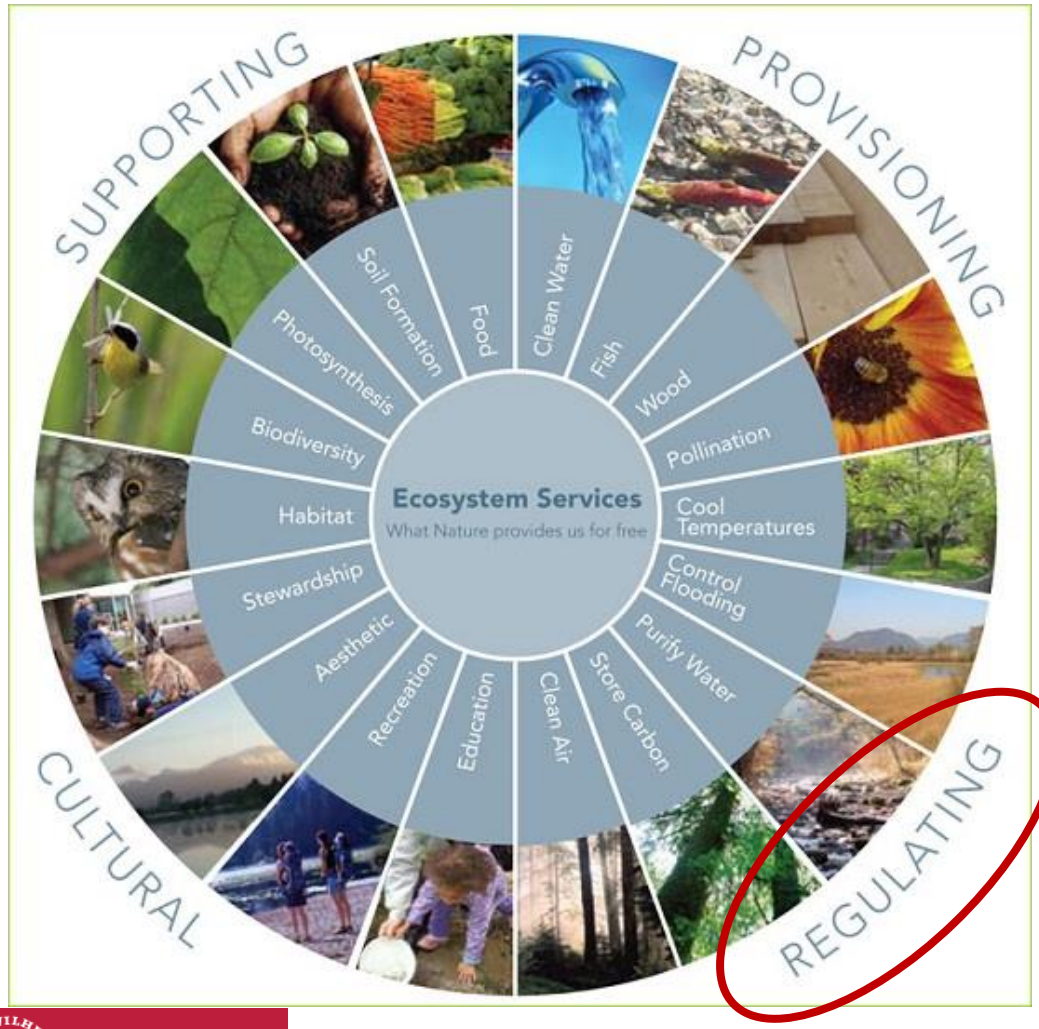
Coastal protection via vegetation

Maike Paul, Ph.D.

Coastal protection is more than storm flood protection

- Dimensioning of structures/measures in time and space
- Maintenance during lifetime
- Adaptation to future challenges

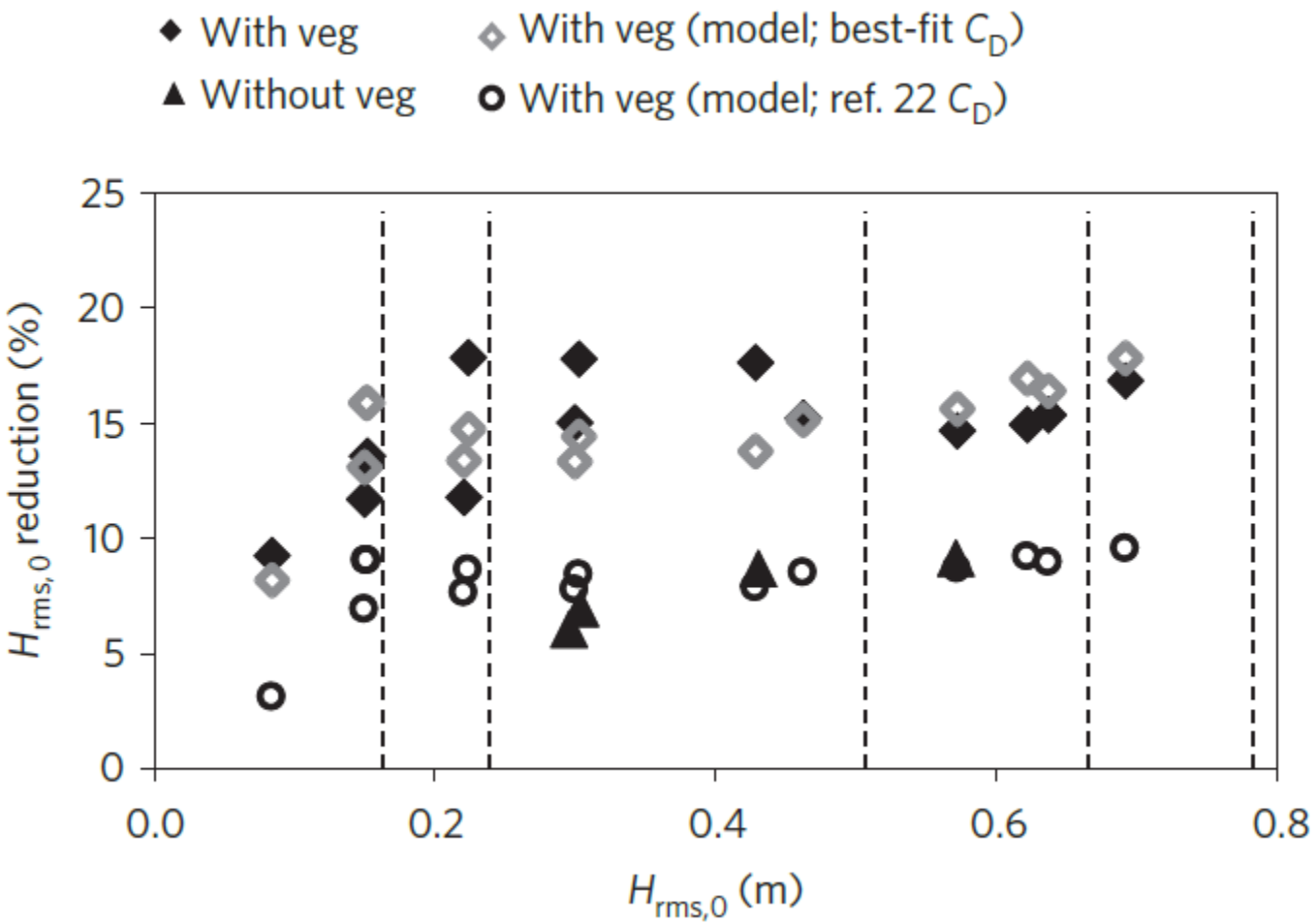
Ecosystem services in coastal protection



- Wave and flow reduction
- Shoreline stabilisation
- Adaptation to sea-level rise

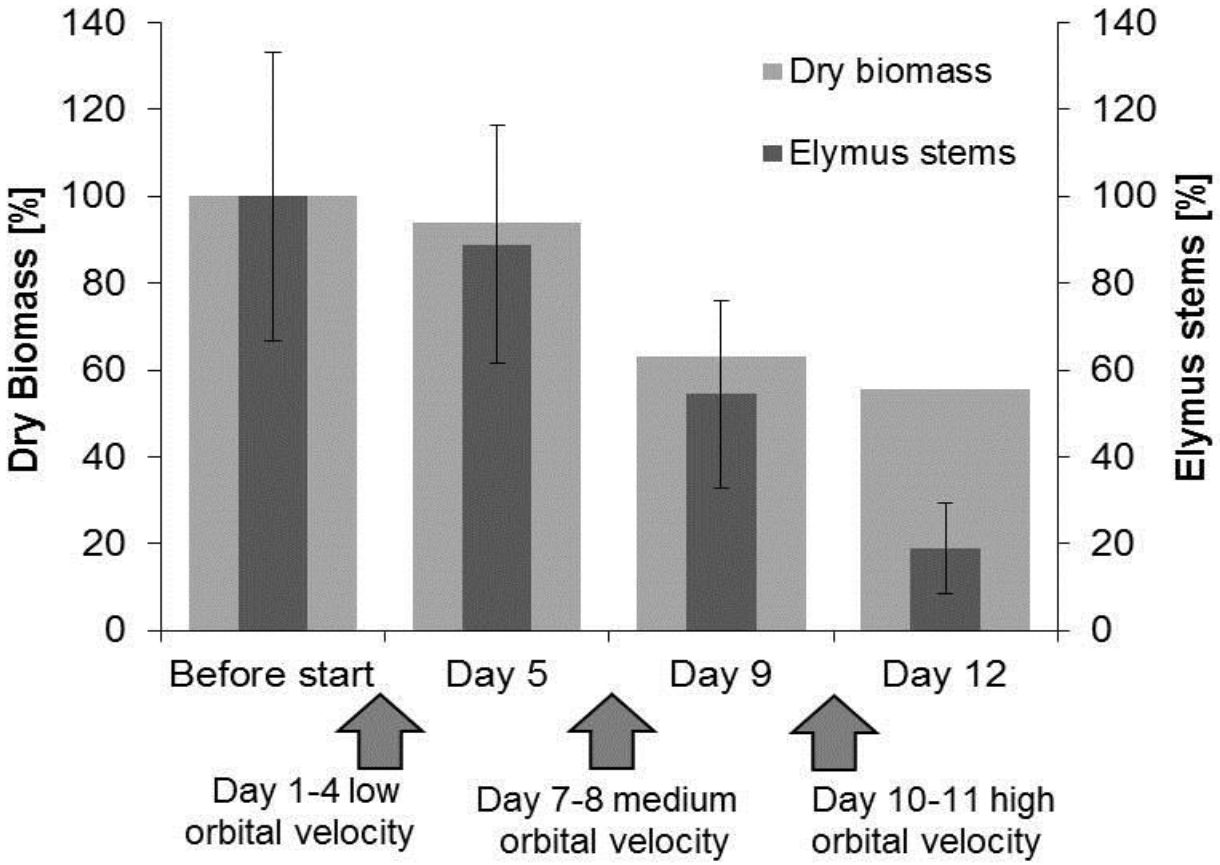
Thanks to James Tempest for the video

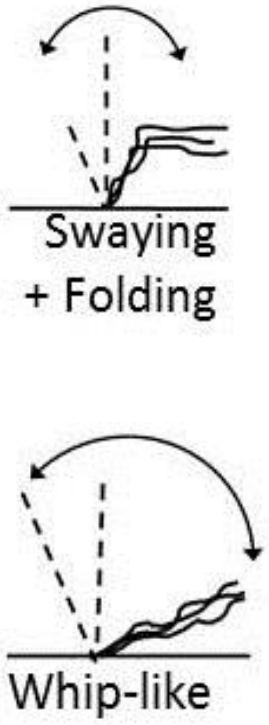
15-20% reduction over 40 m length



Möller et al., 2014, Nature Geoscience

Plants break under wave forcing





Rupprecht et al., 2017, Ecological Engineering

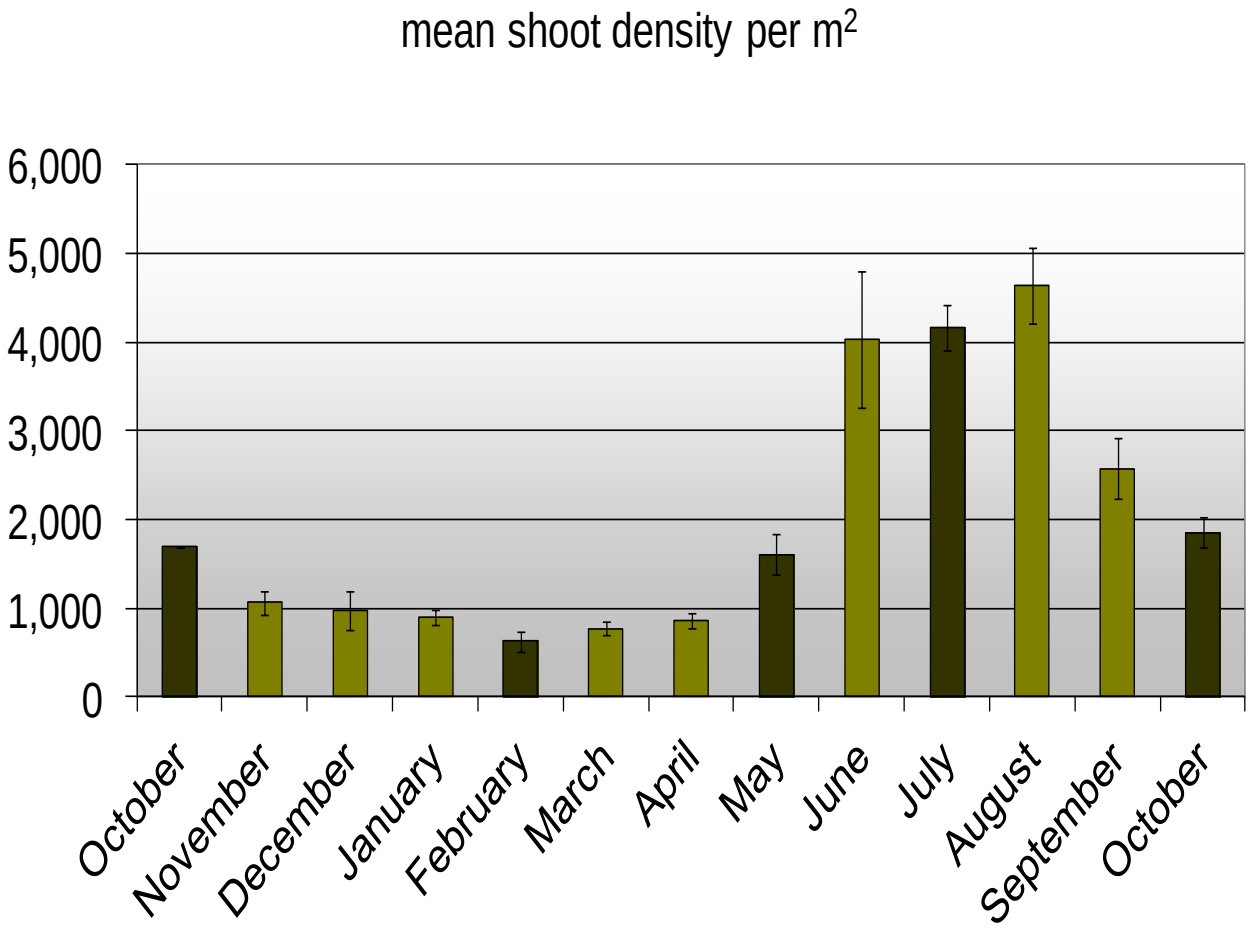
Same order of magnitude for attenuation by seagrass

* Field data
** averaged over a range of treatments

Species	shoot density m^{-2}	Submerg. ratio	wave height red. %	Length of meadow (m)	Source
Ruppia maritima	>1000	1:1	50	compared to unvegetated site	Newell and Koch, 2004*
Zostera noltii	4164	<7:1	20	95	Paul and Amos, 2011*
Thalassia testudinum	1100	Approx. 4:1	30	39	Bradley and Houser, 2009*
Halodule wrightii	1900-2870	<1:1	25.0	1	Fonseca and Cahalan, 1992**
Syringodium filiforme	230-1350	<1:1	26.5	1	Fonseca and Cahalan, 1992**
Thalassia testudinum	850-1500	<1:1	27.8	1	Fonseca and Cahalan, 1992**
Zostera marina	750-1000	<1:1	18.9	1	Fonseca and Cahalan, 1992**
Zostera noltii	13400	1.2:1	22.8	1	Bouma et al., 2005
artificial Z. noltii	500-4000	3:1	6.2-7.1	1	Paul et al., 2012
artificial Z. noltii	500-4000	2:1	6.2-7.7	1	Paul et al., 2012
artificial Z. noltii	500-2000	1:1	5.9-6.6	1	Paul et al., 2012
artificial Z. noltii	8000	3:1	8.5	1	Paul et al., 2012
artificial Z. noltii	8000	1:1	12.6	1	Paul et al., 2012

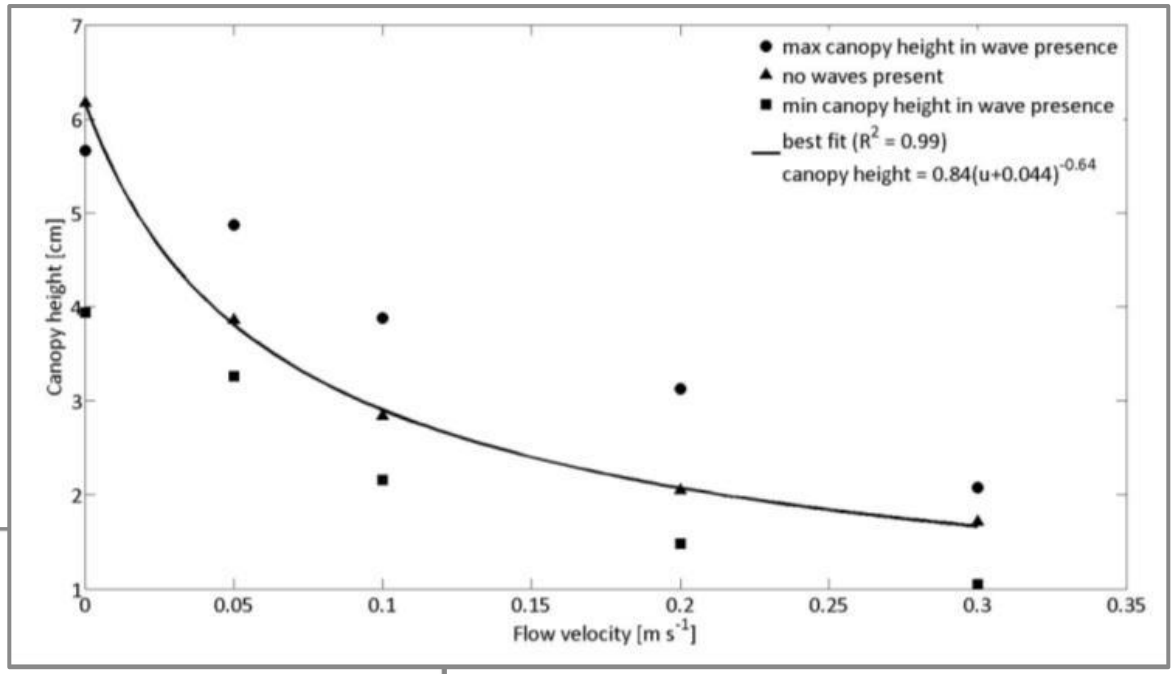
Paul, 2017
Marine Pollution Bulletin

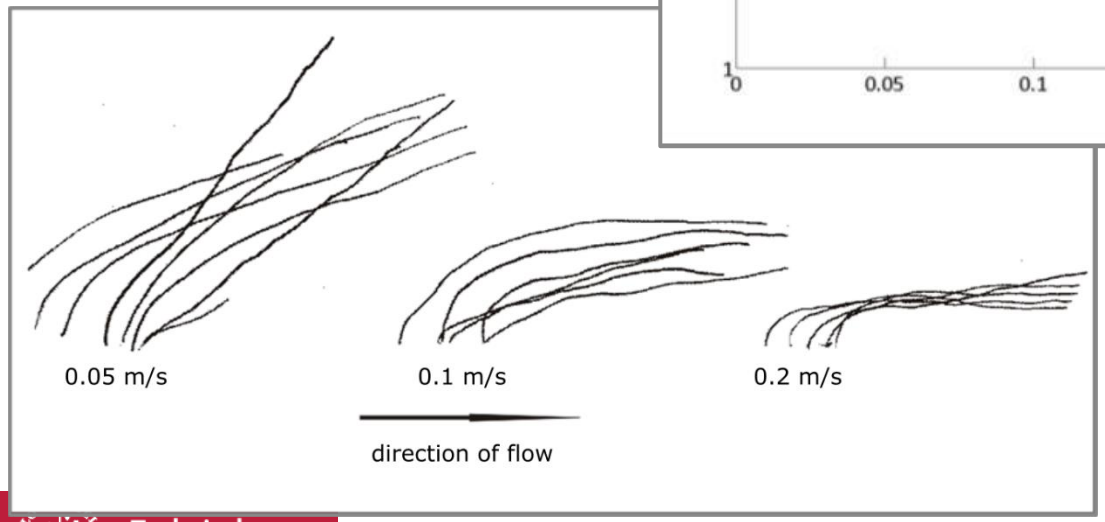
Natural dynamic of plant paramters



Paul & Amos, 2011, JRG- Oceans

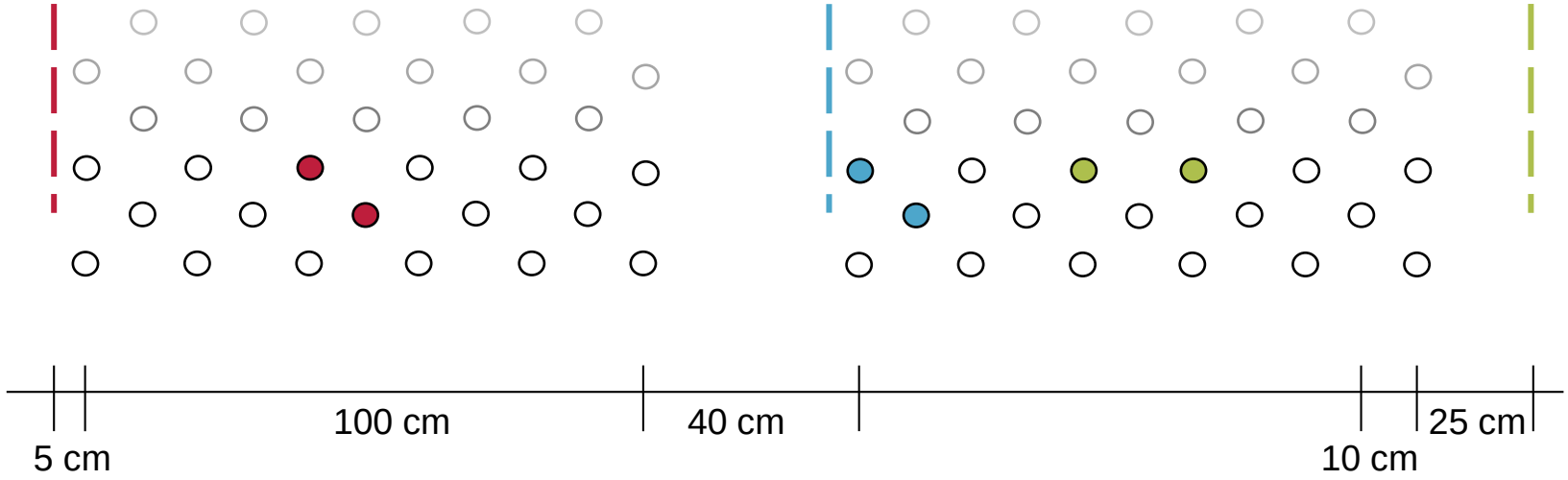
Canopy height changes with flow velocity

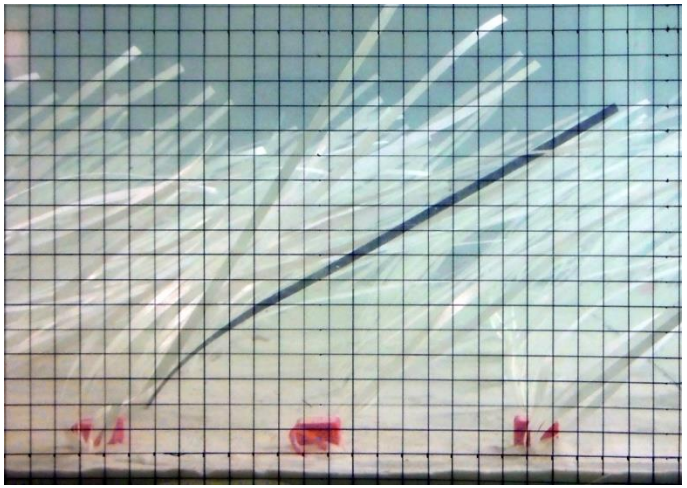




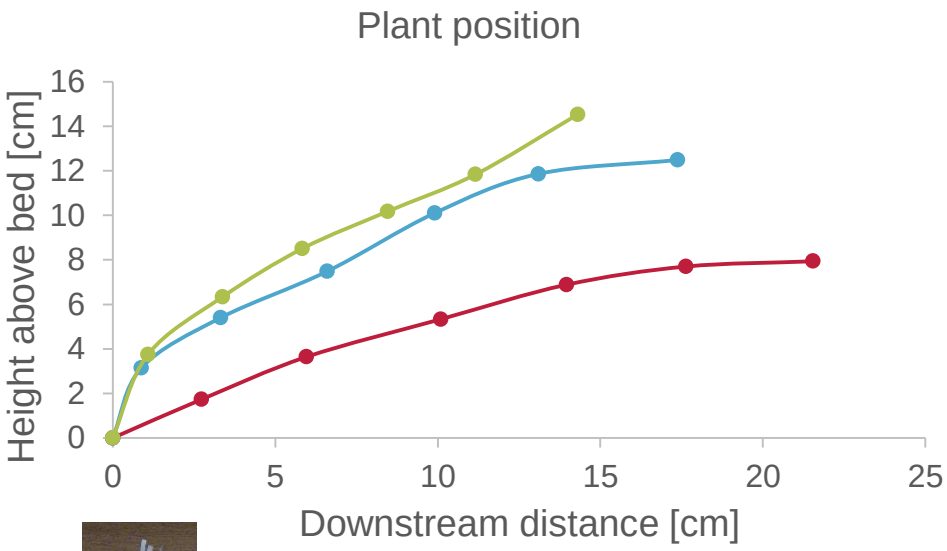
Paul & Gillis, 2015
Marine Ecology Progress Series

Flow velocity changes with canopy height





Flow velocity changes with canopy height

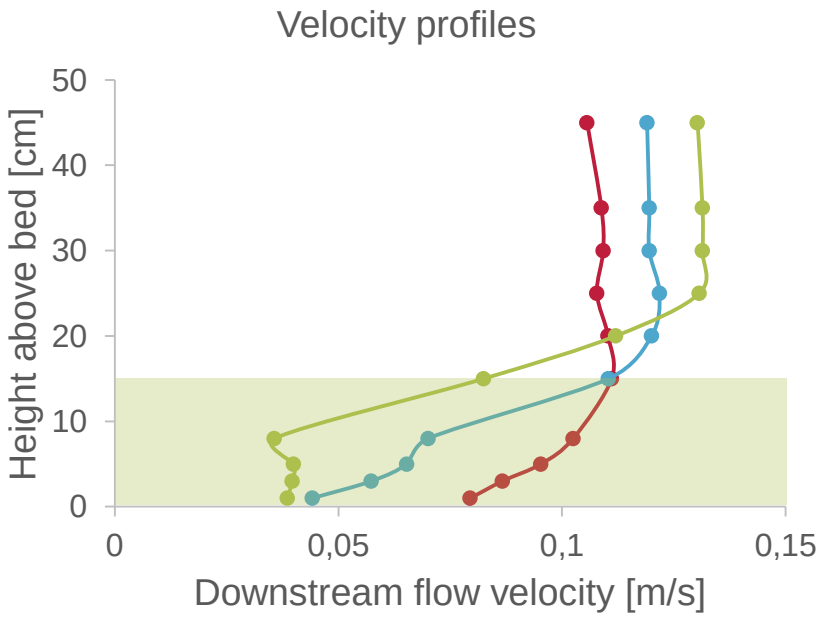


Front

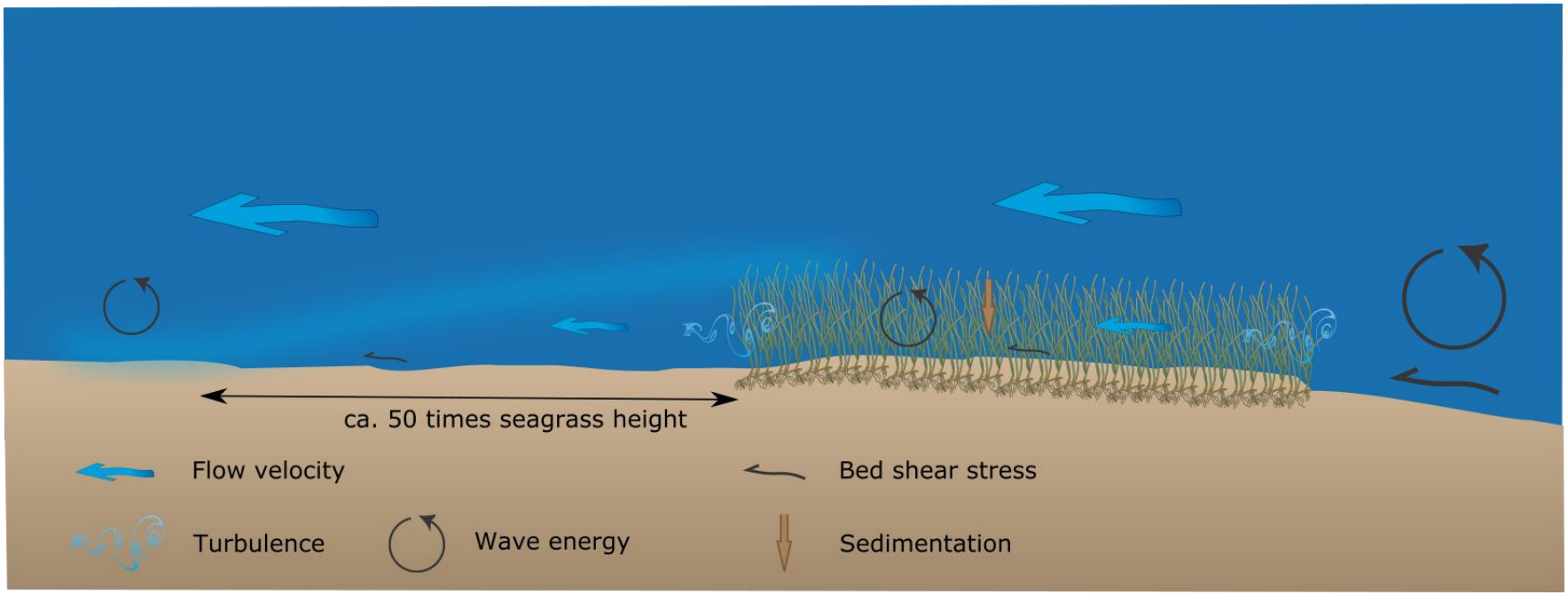
Centre

Back

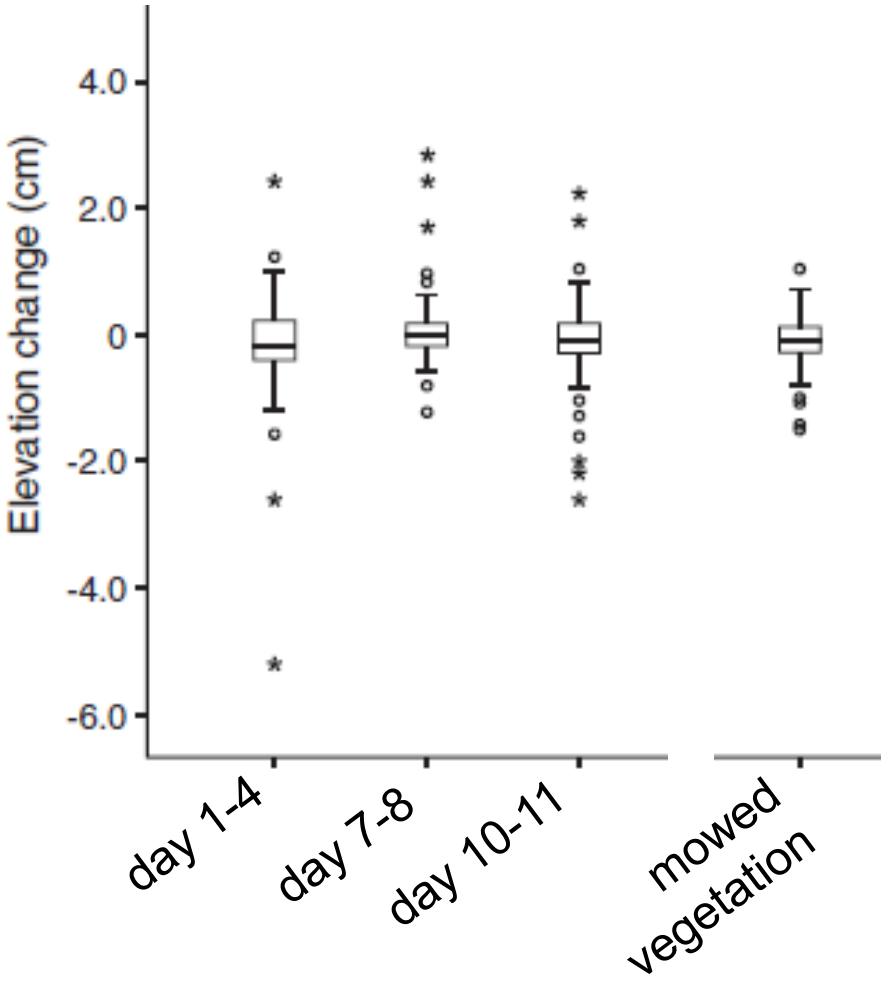
Mean of all profiles: 0.10 m/s



Flow reduction leads to sedimentation

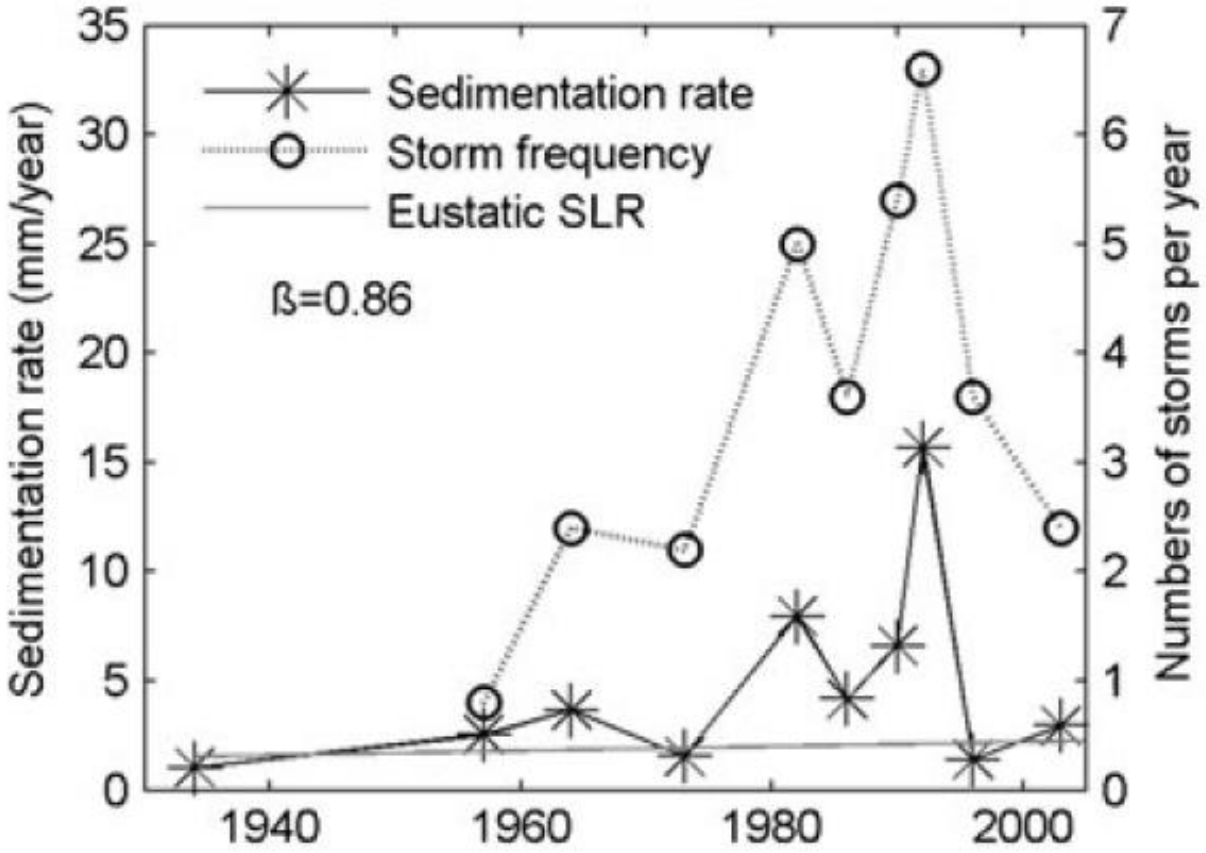


Soil stability independent of aboveground biomass



Spencer et al., 2015
Earth Surface Processes and Landforms

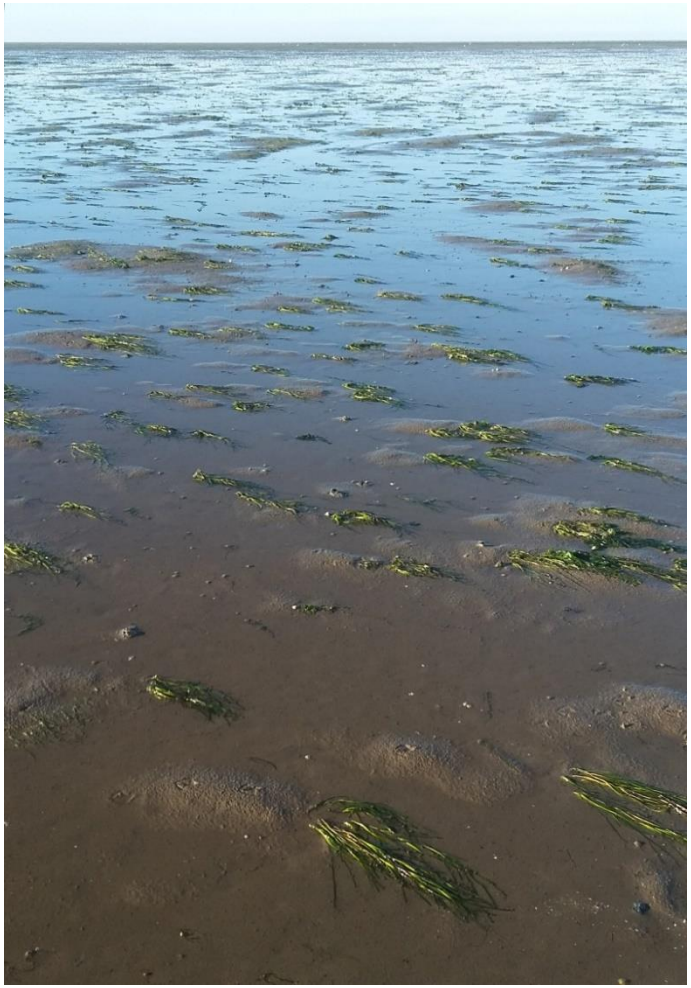
Storms contribute to salt marsh accretion



Schürch et al., 2012
Estuaries and Coasts

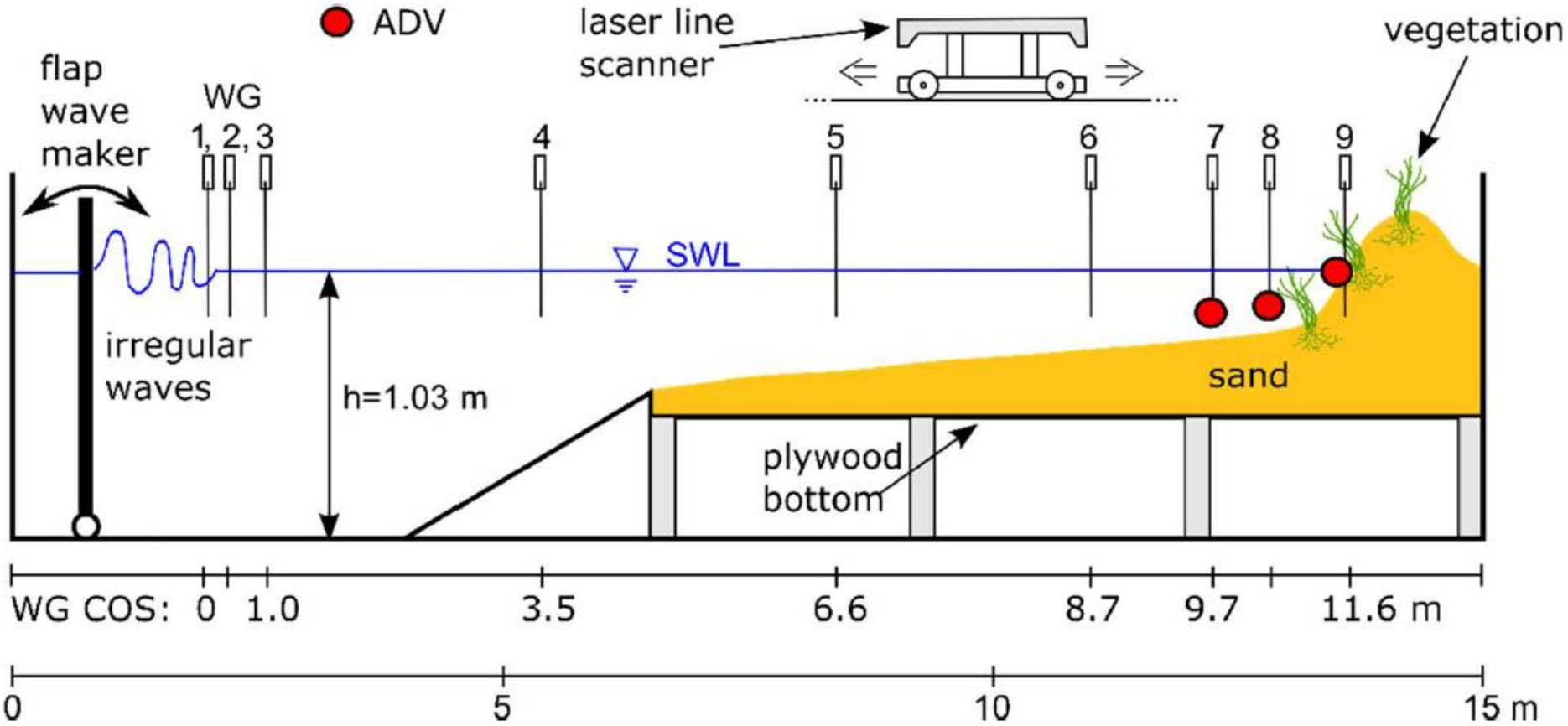
Processes apply to all sediment types

Pellworm, Germany
muddy



Isle of Wight, UK
sandy

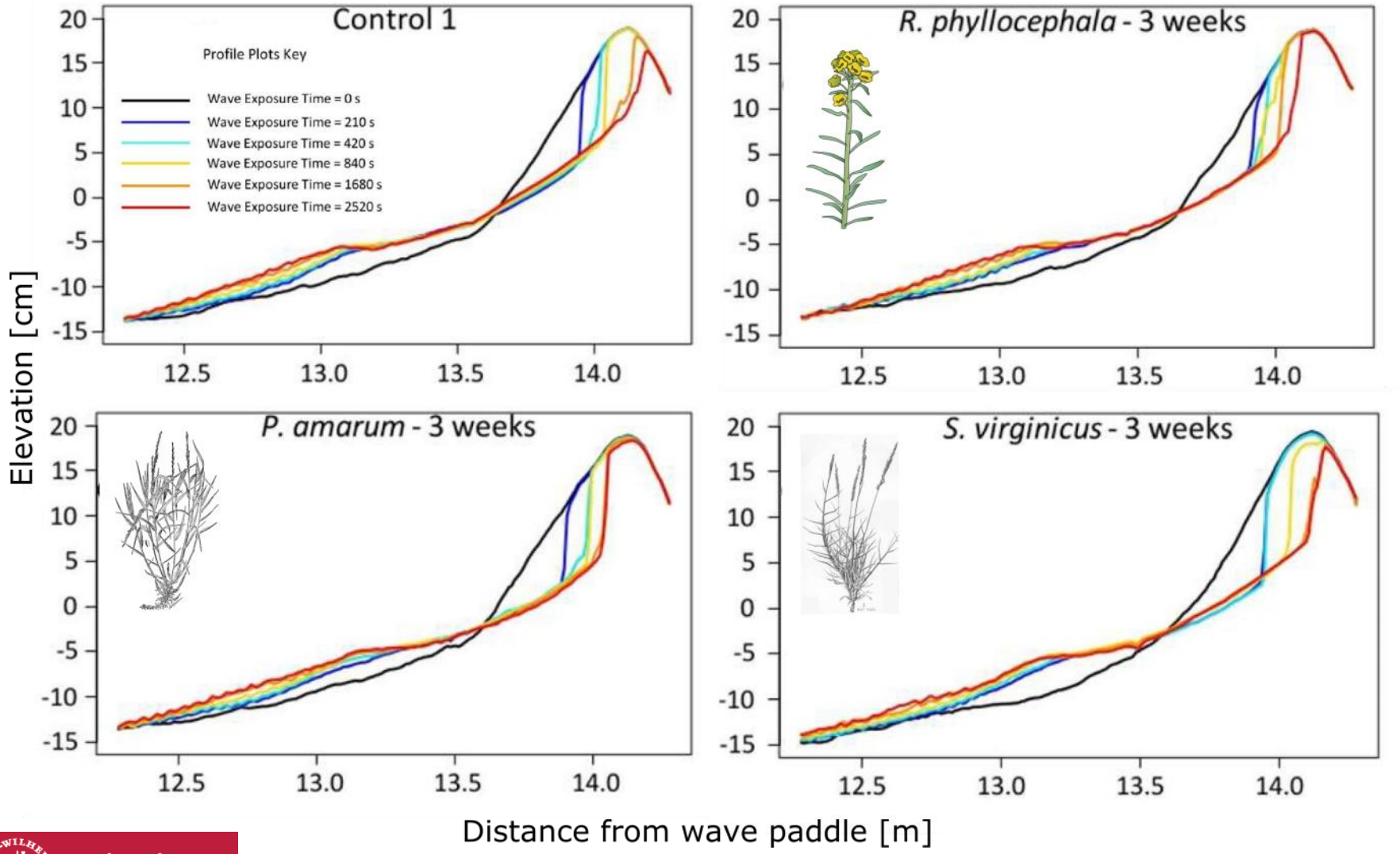
Dunes as extremely sandy locations



Figlus et al., 2017

Coastal Dynamics

Soil erosion is even reduced by young plants



adapted from
Figlus et al., 2017
Coastal Dynamics

Vegetation‘s role in coastal protection



	Seagrass	Salt marsh	Dune vegetation
Wave attenuation	up to 20% per 95 m (low energy)[1]	~80% per 160 m (low energy)[2] up to 20% per 40 m (high energy)[3]	unknown
Bed stabilisation	Yes	Yes[4]	Yes[5]
Adaptation to sea-level rise	Yes	19–22 mm/yr[6]	unknown

[1]Paul & Amos, 2011, JGR – Oceans; [2]Möller & Spencer, 2002, J. Coast. Res.; [3]Möller et al., 2014, Nat. Geo.; [4]Spencer et al., 2015, ESPL; [5]Figlus et al., 2017, Coastal Dynamics; [6]Schürch et al., 2013, JGR - Earth Surf.

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Landschaftsökologie und Umweltsystemanalyse

Thank you for your attention

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Bundesministerium für Bildung und Forschung

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Initial Phase

Sea Art

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DFG

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