Lugworms and Seagrasses shaping the morphology of a Wadden Sea tidal basin

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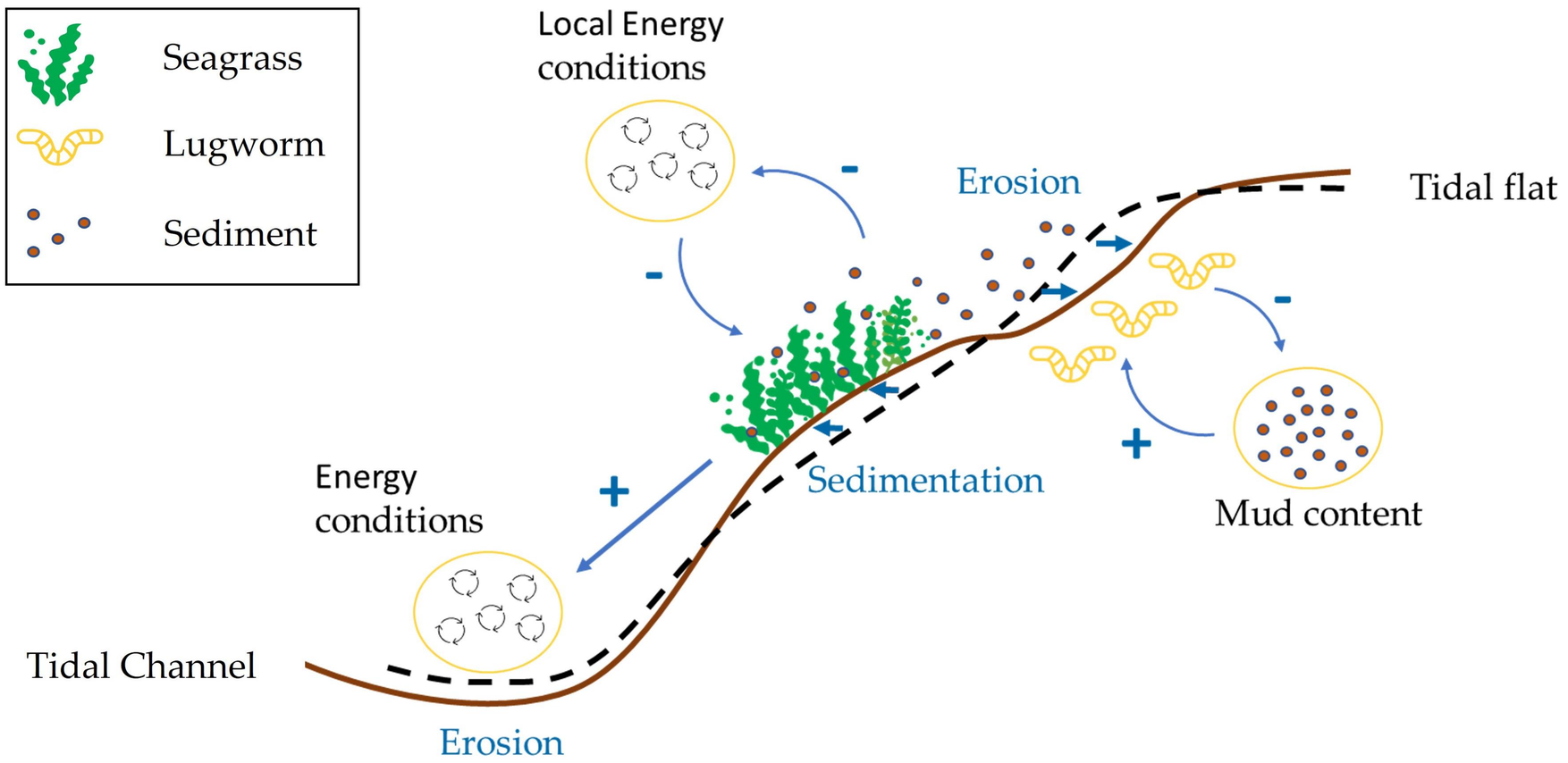

Abstract

- How do lugworms and seagrasses affect morphology on the scale of a tidal basin?
- Modelling study: coupling between Delft 3D FLOW and a MATLAB species model [1].
- Lugworms will erode the upper intertidal, seagrasses capture sediments in the lower intertidal. Erosion and incision of channels is enhanced by species presence.

Relevance of study

- Effects of one or more ecosystem engineers on large scale morphology are poorly understood [1].
- Ecosystem engineers are often studied individually.

What is the combined effect of a bioturbator and a biostabiliser on the morphology of a tidal basin?

Methods

- Research area inspired by a small tidal basin in the Eastern Wadden Sea (tidal signal (S2, M2, M4))
- Coupling between Delft 3D FLOW and a vegetation/benthos model (MATLAB).
- Total runtime of 50 morphological years.
- Grid cell size: 50x50 m

Results 1: Bioturbation by lugworms

- Erosion of the intertidal and a local decrease in mud fractions.
- Sediments end up near the inlet or in very deep or very shallow tidal channels where bed shear stresses are < 0.2N/m^2 (sedimentation of channels)
- Negative feedback between bioturbating activities and lugworm settlement

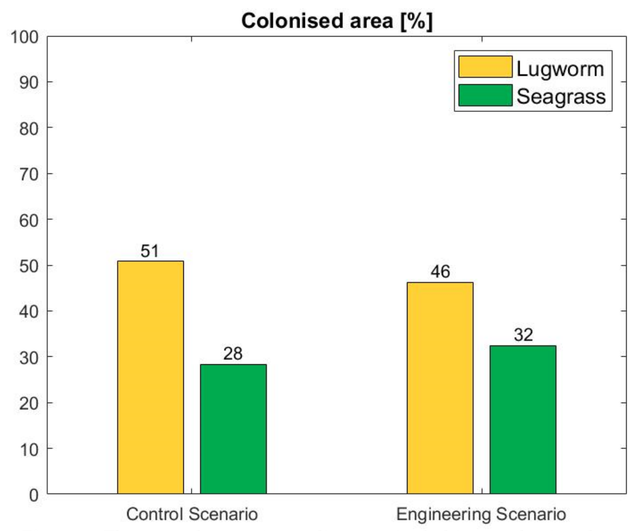

Figure 1: The control scenario predicts species habitat neglecting the effects of ecosystem engineering activities. The area colonised by lugworms in this scenario is larger than for the scenario with engineering activities (negative feedback of bioturbation on species habitat). For the seagrasses, this is the other way around.

Results 2: Biostabilisation by seagrasses

- Sedimentation in intertidal and increase of mud volume in the basin
- Scale-dependant feedback: local sedimentation, but erosion and fixation of the tidal channels
- Positive feedback between stabilising activities and seagrass settlement

Results 3: Competing ecosystem engineers

- Lugworms colonise upper intertidal, seagrasses are restricted to the lower intertidal
- Erosion of the higher intertidal and sedimentation in the lower intertidal
- Incision of the tidal channels

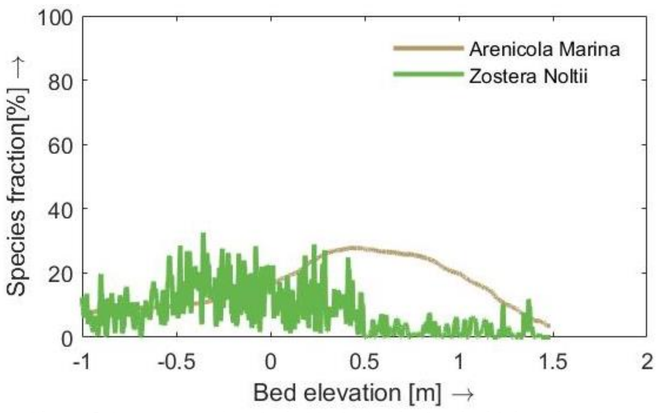

Figure 2: Lugworms (Arenicola Marina) colonise the higher elevations of the intertidal area. Seagrasses (Zostera Noltii) are restricted to the lower areas.

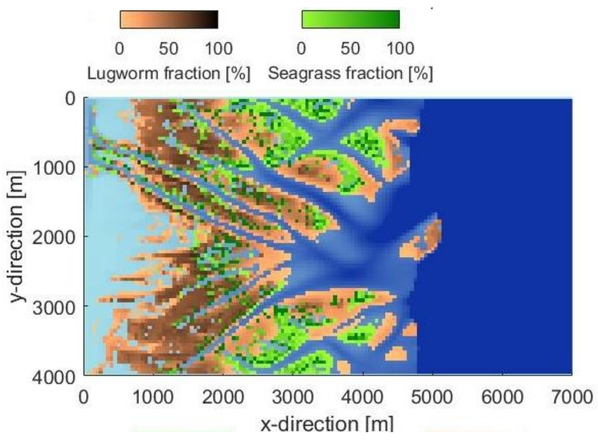

Figure 3: Distribution of lugworms and seagrasses over the modelled tidal basin. The blue colours indicate the water depth (ocean basin on the right side).

Conclusions and Questions

- Biostabilising seagrasses and bioturbating lugworms affect the morphology on the scale of a Wadden Sea tidal basin
- Lugworms erode the upper tidal flats
- Seagrasses capture the eroded sediments in the lower intertidal
- Fixation and erosion of tidal channels is promoted by the ecosystem engineers
- What are the detailed mechanisms behind the negative feedback of lugworm habitat suitability?
- How are vegetation patterns determining sedimentation dynamics on the scale of a tidal basin?

References

[1] Brückner, M. Z., Schwarz, C., Coco, G., Baar, A., Boechat Albernaz, M., & Kleinhans, M. G. (2021). Benthic species as mud patrol - modelled effects of bio-turbators and biofilms on large-scale estuarine mud and morphology. *Earth Surface Processes and Landforms*, 46 (6), 1128–1144.

Ideas? Data?
Please contact Sanne Vaassen!

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