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TIDE OF CHANGE: HYDRODYNAMIC RESPONSES TO SEA LEVEL RISE IN INTERTIDAL ENVIRONMENTS.

CASE STUDY OF THE SYLT-RØMØ BIGHT, THE WADDEN SEA

Overview

The Sylt-Rømø Bight is a semi-enclosed, tidally energetic basin in the Wadden Sea (SE North Sea). As sea level rise (SLR) accelerates, complex non-linear feedback between the rising water levels, geomorphology and tidal dynamics poses a threat to the functioning of coastal ecosystems and the provision of ecosystem services.
This study analyzes changes in areas of intertidal zones, max and mean transport velocities, and tidal asymmetry between ebb and flood phases in response to SLR.

** tidal asymmetry plays a significant role in creating residual sediment transport and associated large-scale morphological evolution in tidal environments.*

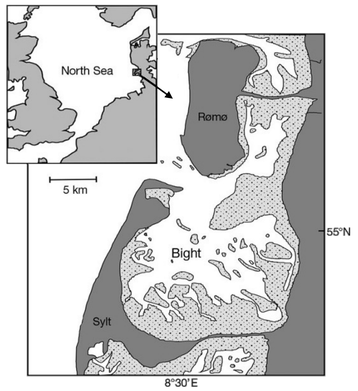

Fig 1: Location and map of the Sylt-Rømø Bight ecosystem. The intertidal area is indicated in stippled grey. ***Baird D, Asmus H, Asmus R (2012)***

Fig 2: Satellite images of low tide (left panel) and high tide (right panel).
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Methods & Data

Model	**FESOM-C** (Finite volumE Sea ice-Ocean Model – Coastal, Androsov et al., 2019)[1]		
Grid	Unstructured grid, max resolution 2m at wetting-drying zone		
Time horizon	Reference (current time), LSLR & HSLR projections for 2050		
Forcing	Tidal forcing based on tpx09		
Mean SLR scenarios	based on regional values of IPCC[3] projections for RCP 2.6 (LSLR) and RCP 8.5 (HSLR)		
	REF (*0 cm*)	LSLR (*13 cm*)	HSLR (*19 cm*)
Bathymetry change	based on and provided by Becherer et al. (2018)[2]		

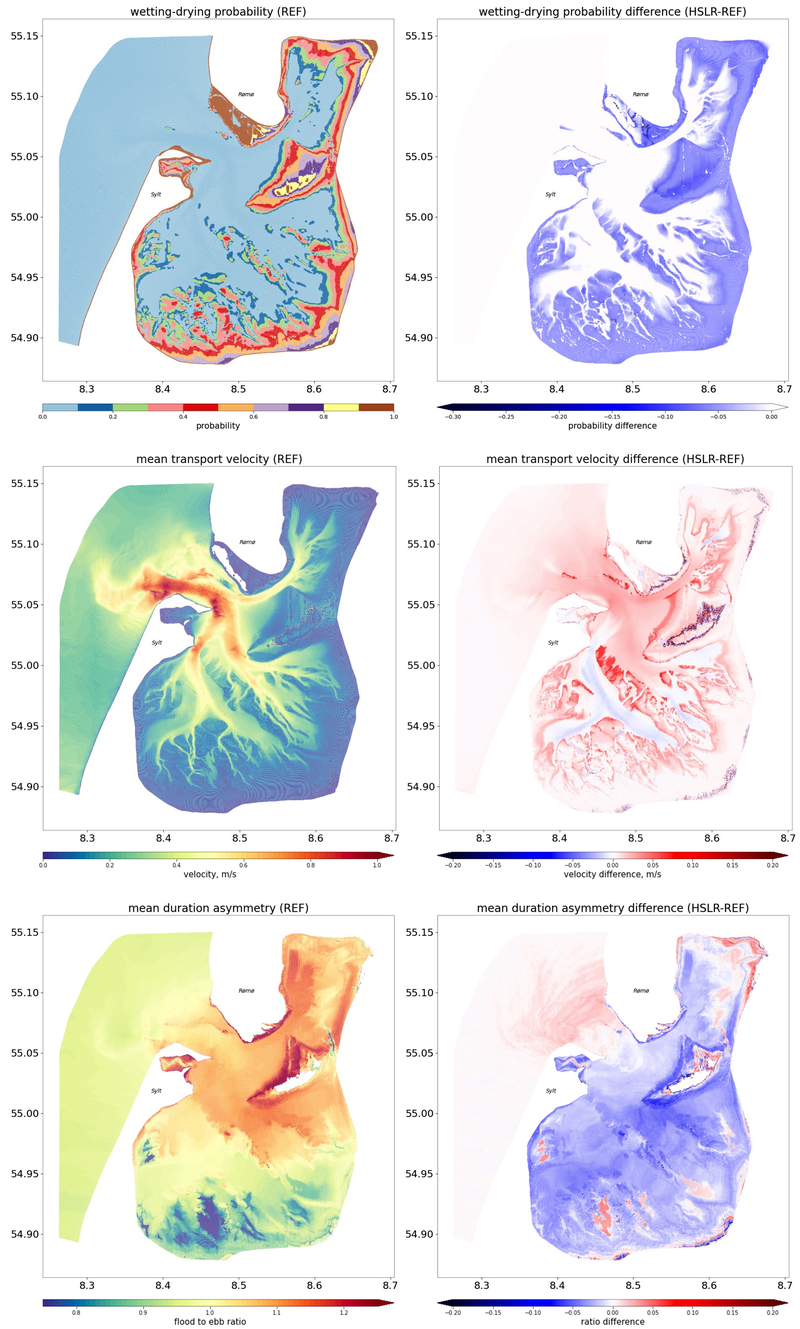

Fig 3: Wetting-drying probability (first row), mean transport velocities (second row), and flood-to-ebb tidal duration asymmetry (third row). The left panels show the values for the REF scenario and the right panels show the difference between the HSLR– REF scenario.

Results

	REF	Δ (LSLR – REF)	Δ (HSLR – REF)
intertidal zones areas & percentage	*285.52·10⁶ m²* *(47.4%)*	*– 13·10⁶ m² (4.6%) ↓* *(–2.2% of total area)*	*– 21·10⁶ m² (7.4%) ↓* *(–3.4% of total area)*
mean transport velocities in the main channel & the subtidal flats	*1.18 ms⁻¹*	*– 3.1 cms⁻¹ ↓*	*– 4.5 cms⁻¹ ↓*
	1.07 ms⁻¹	*+ 9 cms⁻¹ ↑*	*+ 12 cms⁻¹ ↑*
mean flood & ebb durations	*5h 42′ & 6h 3′*	*5h 44′ & 6h 1′*	*5h 45′ & 6h 0′*

Key points

- Intertidal areas are decreasing:
  - up to −3.4% (21·10⁶ m²) by 2050, and
  - up to −13.9% (84·10⁶ m²) by the end of the century.
- Current velocities in the main channels are decreasing, whereas they continue increasing in the tidal inlet. This pattern points to changes in transport pathways and possible changes in local erosion rates.
- Shifts in the tidal asymmetry indicate an overall transition towards a lagoon-like system as SLR accelerates.

Conclusion & Outlook

These findings underscore the importance of understanding the complex interplay of the hydrodynamic processes. For a holistic understanding of the SLR impact, the transport pathways will be studied further and all the results will be linked to geomorphological and habitat change.

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