UNDERSTANDING SALT MARSH RESILIENCE TO CHANGES IN EXTERNAL DISTURBANCE

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Presentation structure

- Paper 1

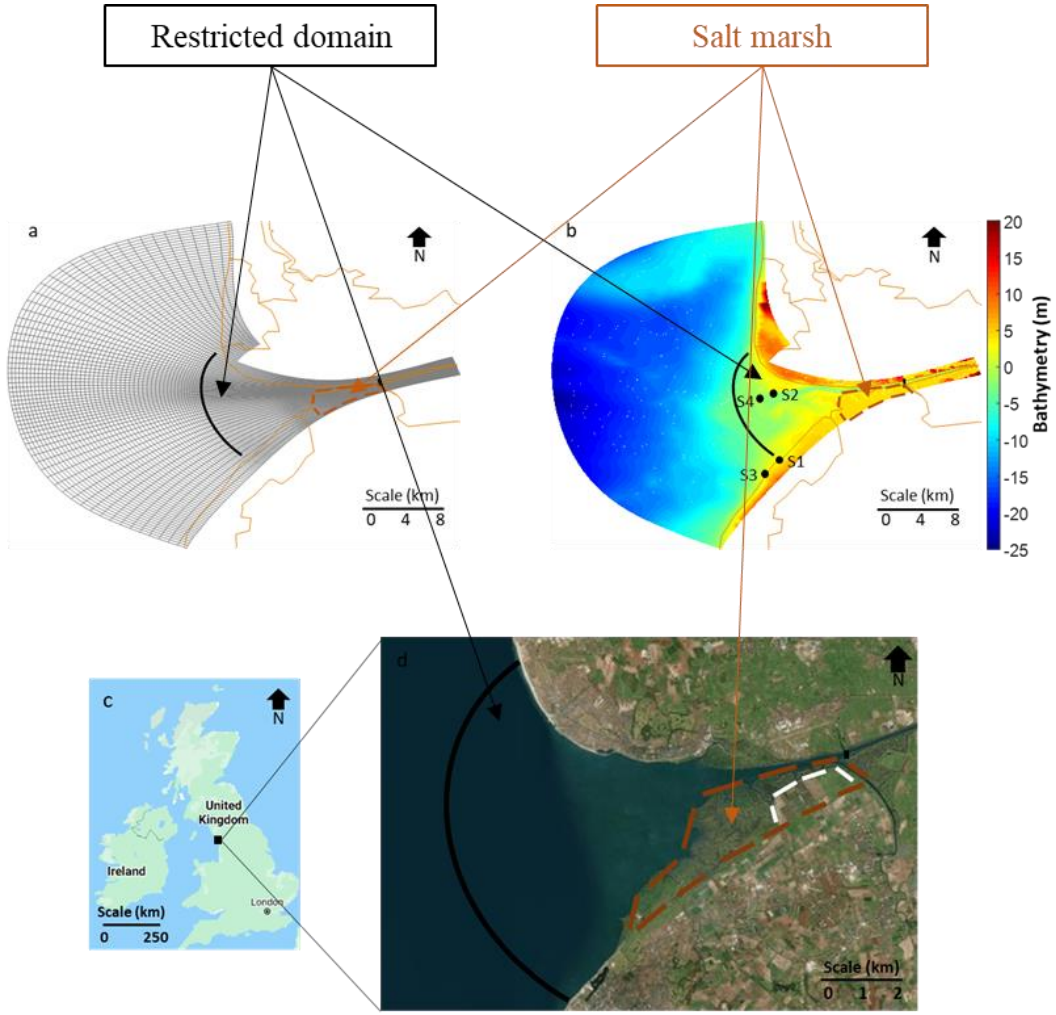
‘An integration of numerical modelling and paleoenvironmental analysis reveals the effects of embankment construction on long-term salt marsh accretion’

- Paper 2

‘Saltmarsh resilience to sea-level rise and increased storm intensity’

Case study - Ribble Estuary (North West England):

- One of the largest tidal flat - salt marsh complexes in Europe, part of which has been recently restored through managed realignment.
- Widespread anthropogenic interventions including embankment construction since 1810.
- Marsh accreting at a fast rate, previously thought to be linked to embankment presence favouring infilling.



‘An integration of numerical modelling and paleoenvironmental analysis reveals the effects of embankment construction on long-term salt marsh accretion’

Aim

Investigate the effects of embankment construction on long-term marsh accretion using a combination of paleoenvironmental analysis and numerical modelling.

Results: paleoenvironmental analysis

- Accretion profile calculated using OSL shows that fast accretion precedes the beginning of embankment construction (c.a. 1810, Fig. 1).
- Multi-proxy down-core analysis shows gradual evolution of the system from sandflat to mudflat/salt marsh (Fig. 2) and correlates with the trend in accretion rate which shows a decrease from 1800 (Fig. 1) suggesting a natural evolution of the marsh system.
- Geochemistry correlates sediment from the marsh platform with sediments from the bed of the Irish Sea (Fig. 3), which is characterised by high quantity of mobile sediment, legacy of the Irish Sea Glacier.
- The fast accretion rates could be due to natural high sediment supply.

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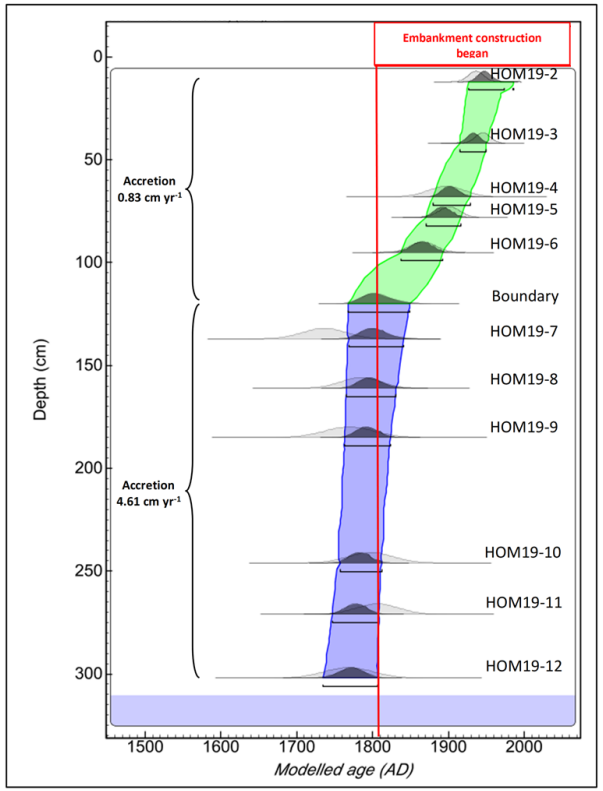

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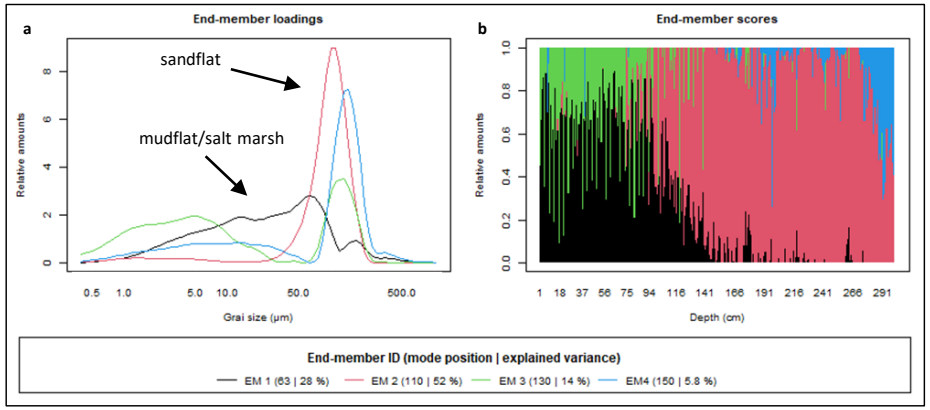

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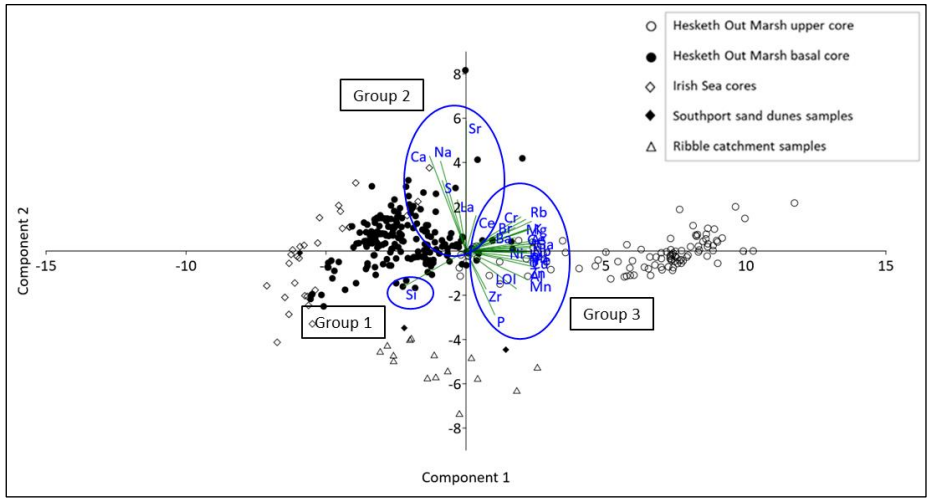

Pannozzo N., Smedley R., Chiverrell R., Carnacina I., Leonardi N. (2022), *Journal of Geophysical Research: Earth Surface*, 127: e2021JF006524.

‘An integration of numerical modelling and paleoenvironmental analysis reveals the effects of embankment construction on long-term salt marsh accretion’

Results: numerical modelling

- Simulations run using Delft3D show that the sediment budget is lower when embankments are present (Fig. 4a), but dredging (undergoing in the estuary for 60 year) reduces the effects of embankments on the sediment budget (Fig. 4b).
- Why? Embankments presence enhances ebb dominance (i.e. sediment export) while channel dredging enhances flood dominance (i.e. sediment import) (Fig. 5).

Conclusions

Embankment construction can favour sediment export but in the Ribble Estuary the overall long-term accretion of the salt marsh might have been aided by natural high sediment supply and 60 years of continuous dredging.

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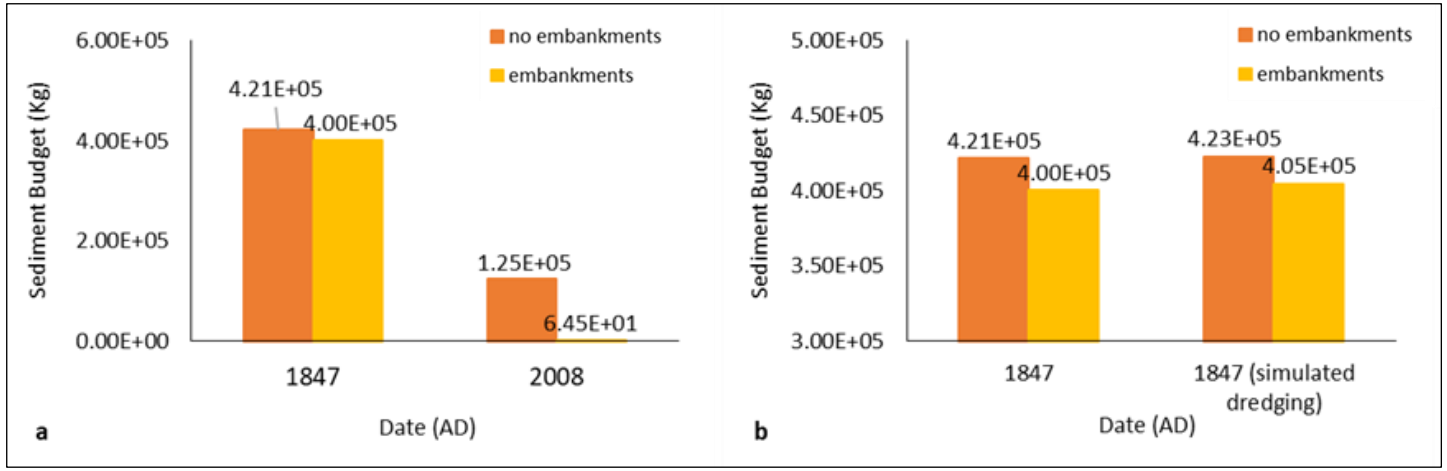

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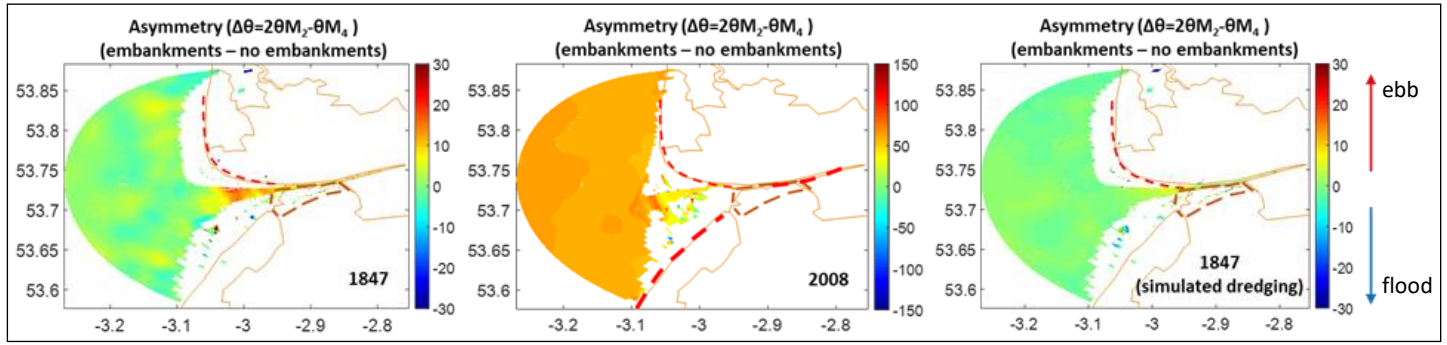

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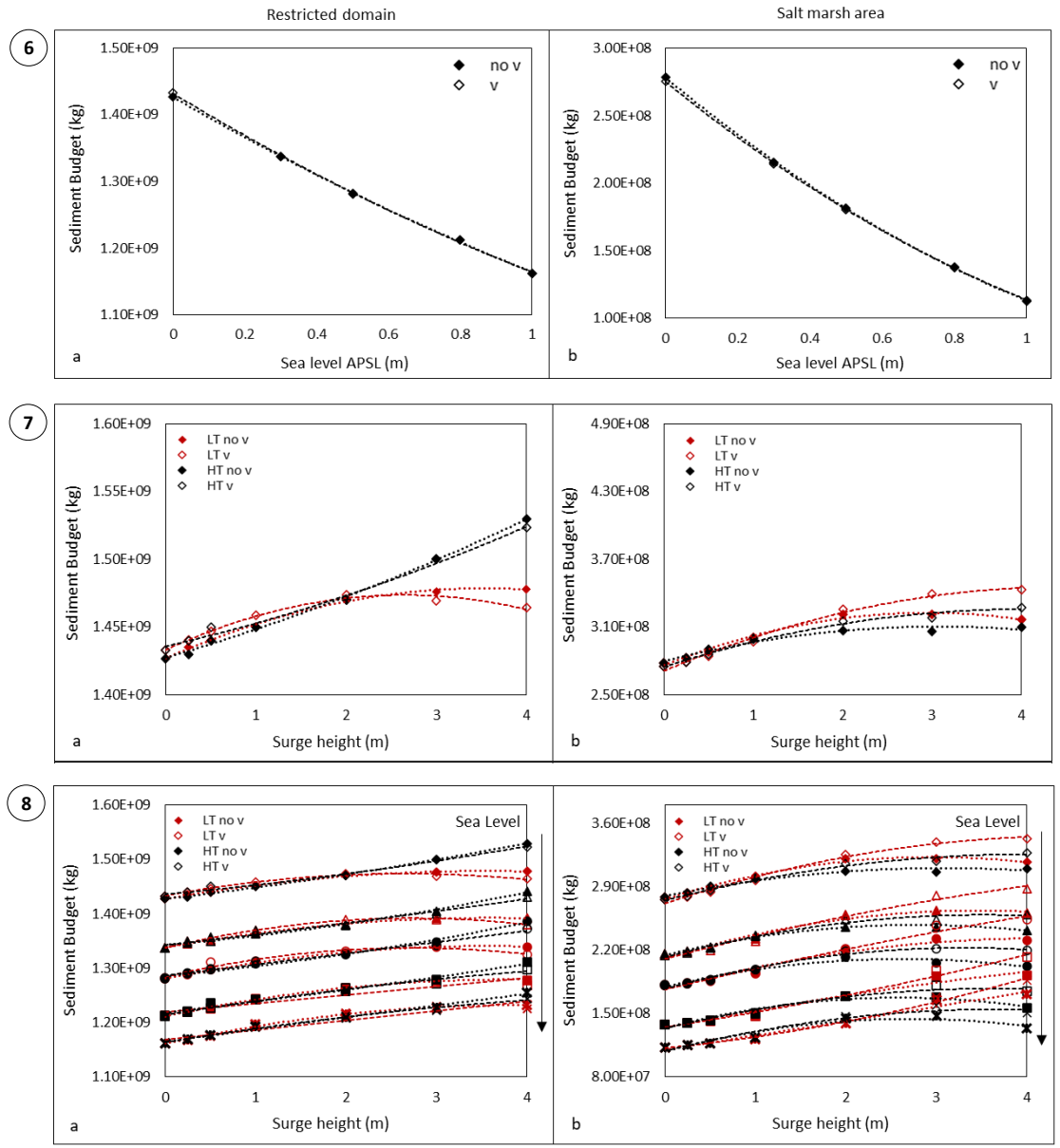
‘Saltmarsh resilience to sea-level rise and increased storm intensity’

Aim

Investigate marsh and estuary resilience under various storm surge and sea-level scenarios by using a sediment budget approach and the hydrodynamic model Delft3D.

Results: sediment budget

- Deposit decreases with an increase in sea-level (Fig. 6).
- Deposit increases when surge height (i.e. storm intensity) increases (Fig. 7). Trends slightly differ with different tidal range, storm duration and vegetation presence (see paper for all scenarios).
- When sea-level and surge scenarios are combined, there is an overall decrease in the magnitude of storm deposition with the increase in sea-level but the effects of high storm surges (>3 m) mask the effects of sea-level rise on the sediment budget (Fig. 8).



Pannozzo N., Leonardi N., Carnacina I., Smedley R. (2021), *Geomorphology*, 389 (4): 107825.
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Results: tidal analysis

- Why? An increase in sea level promotes ebb dominance and net sediment export (Fig. 9), while an increase in surge height promotes flood dominance and a net sediment import (Fig. 10).
- But the increase in sediment budget is more significant for the marsh platform than it is for the restricted domain, so...

Follow-up: ongoing

Analysing provenance and spatial variability of storm deposit through field and numerical investigations.

Conclusions

Sea level rise can threaten the stability of estuaries and salt-marshes by promoting sediment export but an increase in storm intensity can counteract this effect by promoting sediment import.

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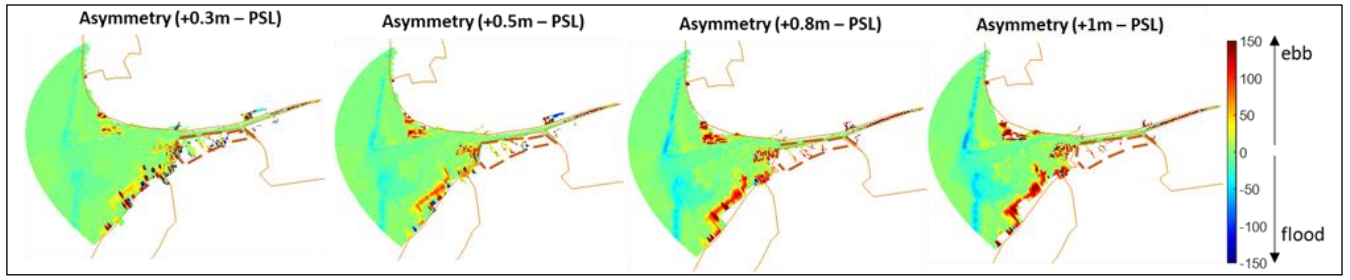

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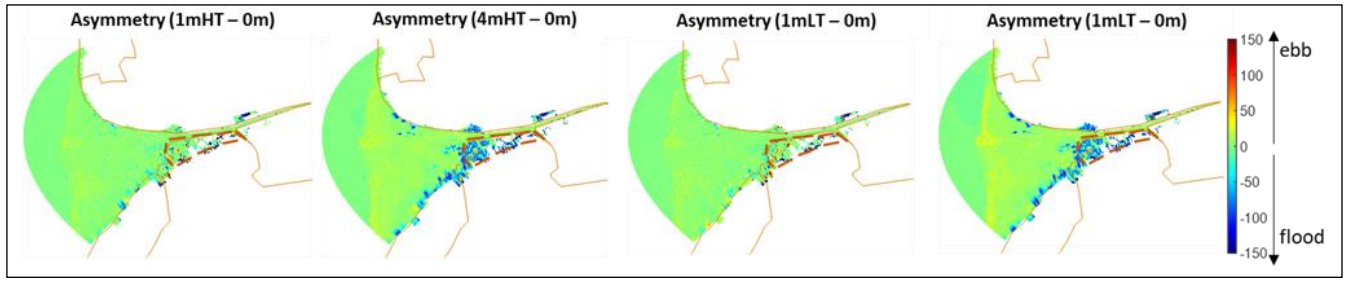

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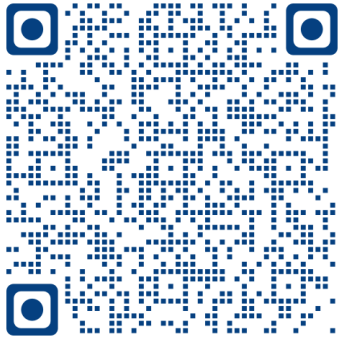

Questions?

BSG British Society for Geomorphology