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Variability in the erosion response of vertical sections of salt marsh sediments exposed to tidal flat conditions

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Salt marsh ecosystems are important for supporting biodiversity, sequestering carbon and providing natural coastal protection. Evidence for their existing and potential future loss through marginal erosion is therefore of concern. However, the factors governing spatial variability in the rates of erosion at salt marsh margins – including between creek banks within individual salt marsh sites – remain relatively poorly understood. Accurate prediction of changes to the marsh edge, and thus marsh areal extent, requires more complete understanding of the dynamics and mechanisms occurring at exposed marsh fronts.

In this study, we present observations of the responses of vertical sections of marsh substrate exposed to tidal flat conditions, during a field experiment over a six-month period. Vertical sections were extracted from natural and restored sites at two salt marshes in the UK: Northey Island, eastern England, where sediment is fine-grained, and Hesketh Out Marsh West, north-west England, where sediment is typically sand/silt-dominated. The study specifically investigates the role of different sedimentology and downcore substrate properties, including lamination and rooting structures, on observed change in the exposed vertical sections. Images captured in the field are analysed using structure-from-motion photogrammetry and used to create 3-D models of surface change. This is coupled with laboratory testing of downcore sedimentary characteristics, such as particle size distribution and organic matter content.

The study finds that within-core and between-core variability in substrate response to erosive forcing appears to be partly related to variability in sedimentology. Sediment from sand-dominated layers, such as those found in the cores extracted from Hesketh Out Marsh West, was more rapidly and consistently (i.e. across the sediment cores) removed than clay-silt rich sediment. This grain-scale sediment removal resulted in specific morphological responses, whereby 'chunks' of substrate were lost, creating cavity areas further exposed to hydrodynamic forcing. Intrinsic biophysical characteristics, including sediment type and the presence of vegetation structures, can impact vertical connectivity within salt marsh substrates. Observations of structural change in the vertical sections over the six-month study period suggest that reduced downcore connectivity in restored salt marsh substrates results in increased desiccation, cracking and bulk sediment removal. An improved understanding of how such intrinsic substrate properties impact marsh

front dynamics will facilitate more accurate predictions of marsh evolution and potential ecosystem service provision under future conditions.