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3D structure of macropore networks within natural and de-embarked estuary saltmarsh sediments: towards an improved understanding of network structural control over hydrologic function

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Saltmarshes are globally important environments which, though occupying < 4% of the Earth's surface, provide a range of ecosystem services. Yet, they are threatened by sea level rise, human population growth, urbanization and pollution resulting in degradation. To compensate for this habitat loss many coastal restoration projects have been implemented over the last few decades, largely driven by legislative requirements for improved biodiversity e.g. the EU Habitats Directive and Birds Directive. However, there is growing evidence that restored saltmarshes, recreated through the return to tidal inundation of previously drained and defended low-lying coastal land, do not have the same species composition even after 100 years and while environmental enhancement has been achieved, there may be consequences for ecosystem functioning

This study presents the findings of a comparative analysis of detailed sediment structure and hydrological functioning of equivalent natural and de-embanked saltmarsh sediments at Orplands Farm, Essex, UK. 3D x-ray CT scanning of triplicate undisturbed sediment cores recovered in 2013 have been used to derive detailed volumetric reconstructions of macropore structure and networks, and to infer differences in bulk microporosity between natural and de-embanked saltmarshes. These volumes have been further visualised for qualitative analysis of the main sediment components, and extraction of key macropore space parameters for quantified analysis including total porosity and connectivity, as well as structure, organisation and efficiency (tortuosity) of macropore networks. Although total porosity was significantly greater within the de-embanked saltmarsh sediments, pore networks in these samples were less organised and more tortuous, and were also inferred to have significantly lower micro-porosity than those of the natural saltmarsh.

These datasets are applied to explain significant differences in the hydraulic behaviour and functioning observed between natural and de-embarked saltmarsh at Orplands. Piezometer wells and pressure transducers recorded fluctuations in water level at 15 minute intervals over a 4.5 month period (winter 2011-2012). Basic patterns for water level fluctuations in both the natural and de-embanked saltmarsh are similar and reflect tidal flooding. However, in the de-embanked saltmarsh, water levels are higher and less responsive to tidal flooding.