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Response of microbial biomass and activity in agricultural soil and dredged sediment to tidal inundation in managed realignment

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Growing concerns over the loss of saltmarshes due to rising sea levels has led to an increasingly widespread coastal management strategy across Europe known as Managed Realignment (MR). It involves the breaching of coastal defences to allow for tidal inundation of previously protected reclaimed low-lying agricultural areas. In some instances, dredged sediments are beneficially re-used to elevate low-lying areas before MR. During reclamation and drainage, salts will have leached out of the soil. Once re-connected with seawater, the top soil becomes periodically flooded and drained, making it susceptible to drying and rewetting, increased salinity and changes in soil saturation, with consequences for the microbial community and their activity. Studies have been conducted on freshwater wetlands experiencing increased salinity following seawater intrusion (Weston et al., 2006; Neubauer et al., 2013). However, the impact of salinity and drying and rewetting on microorganisms in drained agricultural soil systems following tidal inundation has received significantly less attention despite the crucial role microorganisms play in nutrient cycling, C mineralisation and saltmarsh plant productivity. This study aims to assess the response of microbial biomass and activity in agricultural soil and dredged sediment to salinity and drying and rewetting following tidal inundation.

Laboratory-scale experiments which simulate tidal inundation of agricultural soil and dredged sediment in MR sites were conducted. The soil and sediment were subjected to two conditions: (i) continuous flooding and (ii) drying followed by rewetting. The CO_2 release, C mineralisation rate and microbial biomass were measured under both experimental conditions. Results show a decrease in mineralisation in the soil and sediment which was initially very rapid but declined overtime to a relatively stable low baseline level. This pattern suggests the microorganisms adapted rapidly to increased salinity, possibly by synthesising osmolytes within their cells to adjust to the low osmotic potential in the soil porewater induced by salinity. However, there was a higher CO_2 release from the sediment compared to the soil, indicating a greater tolerance level to salinity by the microorganisms in the sediment compared to the soil. Following drying and rewetting, the microbial biomass in the soil increased while that in the sediment decreased, implying that the microorganisms in the soil were more tolerant of the changes in moisture content induced by drying and rewetting. A flush of CO_2 release was also observed from both the soil and sediment likely due to the mineralisation of (i) released osmolytes synthesised during drying, (ii) organic matter previously protected within soil aggregates but made available by drying and (iii) dead microorganisms that could not survive the drying period. In addition, the wider implications of these findings for MR is highlighted in this study.

References

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