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The dynamics of seaward margin of a Spartina alterniflora marsh on the coast under reclamation in Jiangsu Province, China, 1987-2017

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Conventional hard coastal engineering is increasingly challenged by changes in sea-level rise, storm surge, sediment supply, etc. Ecosystem-based defence provides a more sustainable solution, and managed realignments are practising in many locations. However, in coastal areas where land resources are scarce, ecosystem-based defence has to be fulfilled by approaches of managed reclamation, such as planning a rational width of intertidal zone and selectively preserving coastal wetlands. Managed reclamation benefits from understandings of the dynamics of salt-marsh extent.

Our study area is a Spartina alterniflora marsh unusually preserved on the coast under intense reclamation in Jiangsu Province, China. We analyzed 29 Landsat time series images from 1987-2016 in Google Earth Engine and our field survey data of 2017 to recognize the changes in seawalls, marsh extent and a main tidal channel in the 30 years. We infer the changes in position of marsh front are the result of complex interactions of endogenous and exogenous factors. Before 1999 in the early years after its introduction, S. alterniflora had low seed yields and the mudflat might have a low sedimentation rate too. The marsh outside the old seawall was narrow and underdeveloped, and plants remained in bare patches. In 1999 a new seawall was constructed and the reclamation progressed into deeper waters where S .alterniflora could not colonize. Hence the marsh disappeared for several years. During 2005-2009 S. alterniflora colonized again and its patches quickly joined together. The marsh front advanced seaward at a rate of 54 m/a. The expansion might be contributed to two reasons: 1) to the east the neighbouring coast was reclaimed on a large scale and an artificial island was built, shaping the study area into a half-open intertidal zone. The mudflat elevation accreted rapidly and reached the threshold for S .alterniflora to survive. 2) Clonal reproduction by the formation of underground rhizomes speeded up the propagation of S .alterniflora. From 2010-2016 the position of the marsh front remained stable. The marsh shifted from progradation to aggradation as the tidal channels on the marsh platform margin narrowed down substantially (the width decreased from $\sim$83m to $\sim$33m). Presumably the sedimentation rate on the mudflat slowed down again due to the changes in hydrodynamic forces and sediment supply, while the marsh platform kept growing upward as vegetation promoted the accretions of sediment and organic matter. In 2017, the marsh expanded abruptly once again with a front extension rate of 71 m/a, which might resulted from a second exceeding of the elevation threshold of S .alterniflora survival on the mudflat. No correlation was found between the changes in position of marsh front and declining sediment flux of the Yangtze River after impoundment of the Three Gorges Dam.

We suggest that with careful arrangements, reclamations can facilitate the formation of salt marsh in some locations. The reclamation cannot progress into an elevation too much lower than the survival threshold of a halophyte. Artificial replenishments of sediment, seeds and seedlings in selected locations can promote a rapid formation of salt marshes.