EGU21-1639, updated on 16 Jul 2021
https://doi.org/10.5194/egusphere-egu21-1639
EGU General Assembly 2021

Coastal flooding protection will change salt-marsh sedimentation dynamics

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Coastal wetlands lie at the interface between submerged and emerged environments and therefore represent unique yet delicate ecosystems. Their existence, resulting from complex interactions between hydrodynamics and sediment dynamics, is challenged by increasing rates of sea-level rise, lowered fluvial sediment input as well as an increasing anthropogenic pressure. The future survival of these peculiar morphologies is becoming even more complicated, because of the construction and planning of coastal defence structures designed to protect urban areas from flooding. Important examples are the flood protection systems built to protect New Orleans (USA), the river Scheldt Estuary (The Netherlands) and Venice (Italy). In this context, understanding the physical processes on which coastal marshes are grounded and how engineering measures can alter them is of extreme importance in order to plan conservation interventions.

To understand marsh sedimentation dynamics in flood-regulated environments, we investigated through field observations and modelling the effect of the storm-surge barrier designed to protect the city of Venice, the so-called Mo.S.E. system, which has in fact become operational since October 2020.

Sedimentation measurements in different salt marshes of the Venice lagoon carried out in the period October 2018-October 2020 show that more than 70% of yearly sedimentation accumulates during storm-surge conditions, despite their short duration. Moreover, the sedimentation rate displays a highly non-linear increase with marsh inundation intensity, due to the interplay between higher water levels and greater suspended sediment concentration. Barrier operations during storm surges to avoid flooding of urban areas will reduce water levels and marsh inundation. Therefore, we computed sedimentation in a flood-regulated scenario for the same observation period, using the relation we obtained between tidal forcing and sedimentation rate. Our results show that some occasional closures during intense storm surges (70 hours/year on average) suffice to reduce the yearly sedimentation of the same order of magnitude of the relative sea-level rise rate experienced by the Venice lagoon during the last century (2.5 mm/y).

We conclude that storm-surge barrier operations can dangerously reduce salt-marsh vertical accretion rate, thus challenging wetland survival in face of increasing sea-level rise.