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Salt-marsh sedimentation affected by storm surges and anthropogenic impacts

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Salt marshes are upper-intertidal landforms that support critical ecosystem services. They protect coasts, buffering wave activity and filtering inland water fluxes; store atmospheric carbon and provide also unique habitats for wildlife. However, accelerating sea-level rise and lowered riverine sediment input are challenging their survival and, thus, net losses in marsh areas observed worldwide are of concern. Moreover, many estuarine and lagoonal marshes are surrounded by coastal urban areas that increasingly need to be protected from flooding because of the effect of climate change. But the effects of human-induced flood regulation on salt-marsh morphodynamic evolution are still poorly investigated. Understanding the physical processes driving marsh sedimentation that let them keep pace with sea-level rise and how they are affected by human interventions is crucial to design conservation and management strategies.

To better understand the spatial and temporal sedimentation dynamics on salt marshes, we measured short-term sedimentation through field observation in the salt marshes of the Venice Lagoon (Italy), where a storm-surge barrier, known as Mo.S.E. system, has become operational since October 2020.

Sedimentation measurements carried out in the period October 2018-December 2021 show that more than 70% of yearly sedimentation accumulates during storm-surge conditions, despite their short duration. The different exposure to the action of tide and wind waves also controls the spatial sedimentation patterns that differ on channel- and mudflat-facing marshes, thus signing their topography. Owing to higher water levels and greater suspended sediment concentration, marsh sedimentation is mainly driven by enhanced inundation during storm surges, which need to be regulated to avoid extensive flooding in the close city of Venice. We quantified that the sedimentation reduction due to the lower marsh inundation in a flood-regulated scenario suffices to reduce the yearly sedimentation by more than 25%.

We conclude that storm-surge barrier operations have to be carefully managed to avoid affecting salt-marsh resilience to sea-level rise.