EGU22-13407
https://doi.org/10.5194/egusphere-egu22-13407
EGU General Assembly 2022

Flood-regulation promotes salt-marsh drowning and enhances loss of geomorphic diversity in shallow tidal embayments

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Flood-regulation systems and storm-surge barriers are increasingly adopted to protect many coastal cities worldwide from the flooding hazard related to rising sea levels. Eminent examples include London, the Netherland, New Orleans, St. Petersburg, and Venice. Regulating the propagation of surges and tides, barriers will also change sediment transport, thus modifying the morphological evolution of estuarine systems nearby the protected urban areas. However, how the morphodynamic evolution of tidal environments will be affected by flood regulation is still an unresolved question.

We investigate the effect of the recently-activated storm-surge barriers designed to protect Venice (Italy) from flooding on the morphological evolution of the Venice Lagoon, combining numerical modelling and field data.

Artificially reduced water levels affect the interaction between tide and waves, enhancing sediment resuspension on tidal flats. Accumulation of resuspended sediments on salt marshes however is hindered by the reduced flooding intensity owing to lower water levels, thus potentially undermining marsh ability to keep pace with rising sea levels. Simultaneously, eroded sediments tend to accumulate within channels, thus mining water exchange and increasing dredging costs.

Over longer (i.e., seasonal) timescales, we suggest that although barrier closures reduce net sediment export toward the open sea, this does not point to preserving the characteristic lagoonal morphology, hindering salt-marsh accumulation and promoting tidal-flat deepening and channel infilling. Hence, the operation of flood barriers can trigger an important loss of tidal landforms, negatively impacting the conservation of shallow tidal environments and the ecosystem services they provide.