Drivers and outcomes of salt marsh erosion

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Salt marshes are widespread features of tidal landscapes and exert a primary control on the ecomorphodynamic evolution of these environments, delivering valuable ecosystem services. Among the latter, salt marshes furnish a shoreline buffer between the mainland and the sea, dissipating waves and mitigating erosion during storms, filter nutrients and pollutants, serve as an organic carbon sink, and provide diverse ecological habitats.

The sustainability of most of the modern salt-marsh systems worldwide is threatened by increasing anthropogenic pressures, as well as by changes in climate forcings. Particularly, the dramatic decrease in marsh extent, observed worldwide during the last centuries, has long been ascribed to the combined effects of rising relative sea level and sediment starvation. However, even though both those processes may cause the drowning of extensive salt-marsh areas, recent studies have demonstrated that the great majority of salt marshes worldwide are being lost due to the lateral erosion of their margins. If on the one hand the lateral retreat triggered by wind waves is recognized as a primary driver for salt-marsh lateral retreat, on the other hand it still remains questionable whether different local soil properties (e.g., water content, dry bulk density, organic matter content, inorganic grain size) and vegetation cover actively affect the resistance, and ultimately the erosion, of salt-marsh margins.

Here we investigate, by means of numerical modelling combined with field and laboratory analyses, how the interplays between incoming wave power, ecological features, and soil properties influence the erosion rates of salt-marsh margins in the Venice lagoon (Italy).

We show that lateral erosion rates of salt marshes are primarily controlled by the incoming wind-wave power, mediated by the presence of different halophytes, whereas significant influence of soil properties is observed.

Erosion rates are reduced in marsh edges colonized by particular associations of halophytic vegetation species, and along gently sloped and irregular margins facing very shallow tidal flats. Conversely, erosion rates are enhanced in cliffed margins exhibiting smooth planform morphologies, which are typically stricken by strong wind waves.

By clarifying the interactions between the dynamics and functional shapes of salt marsh edges,
our observations might be valuable for the conservation and restoration of salt-marsh landscapes, especially in the face of a globally changing climate.