Salt-marsh vulnerability and halophytic vegetation vertical migration in response to sea level rise: inferences from the Venice Lagoon

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Coastal marshes are important ecosystems that are disappearing at alarming rates. Improving current knowledge on salt-marsh response to changes in the forcing is a key step to understand and predict salt-marsh evolution, especially under accelerated sea level rise and increasing human pressure scenarios. Towards this goal, based on a field dataset of marsh morphology and halophytic vegetation vertical distribution collected from the San Felice marsh in the Venice lagoon (Italy) over a 20-year period (between 2000 and 2019), we quantitatively describe marsh-surface accretion and halophytic vertical migration rates.

Our results suggest that: 1) marsh accretion rate (R_{acc}) is strongly site-dependent and largely varies also in adjacent sites (R_{acc}, 1.7-4.3 mm/year), and large portions of the San Felice marsh have gradually been submerged by the increasing sea levels because marsh accretion rates were lower than the rate of relative sea level rise (R_{rsl}, about 4.4 mm/year); 2) in the last 20 years, all halophytic species migrated to higher marsh areas to survive, but they also lost elevation with the respect to mean sea level (MSL). Slight changes in halophyte cover were also observed, i.e., *Spartina* disappeared in 2006 and came back before 2013; *Salicornia* started to encroach the marsh in 2006. The upper migration and vegetation composition changes, however, did not change the species sequence with increasing elevation, which was maintained in the analyzed period. Our analyses also indicate that the frequency distributions of elevations (referenced to MSL in a long time trend) encroached by each species in different years are consistent with normal distributions. All these results bear important implications for better understanding the bio-geomorphic evolution of tidal environments.