Geophysical Research Abstracts
Vol. 16, EGU2014-11453, 2014
EGU General Assembly 2014

Salt marsh response to the effects of physical and biological processes

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Salt marshes are widespread features of the tidal landscape governed by the interacting physical and biological processes. These crucially important ecosystems provide valuable services and are currently threatened by the effects of increasing rates of relative sea level rise (RSLR) and decreasing sediment supply. Although a few studies have analyzed the biomorphological evolution of salt marsh systems, a complete understanding of the two-way feedbacks between physical and biological processes is still lacking. The temporal evolution of marsh elevation is governed by the balance between inorganic and organic accretion rates, and the rate of RSLR. Studies based on field observations and modeling suggest that, in equilibrium conditions, marsh inorganic accretion rates, and the related platform elevations, decrease with distance from the main creek whereas the organic deposition gradually increases. In order to analyze salt marsh responses to the effect of physical and biological processes, about 100 sediment samples were collected on the San Felice salt marsh, Venice Lagoon. For each sample, local coordinates, surface elevations and vegetation cover were detected, whereas inorganic and organic sediment content, together with grain size distribution, were determined and analyzed. Loss On Ignition (LOI) and a double treatment with H_2O_2 and NaClO, were used to estimate the amount of organic matter in each sample. Particle size analysis was carried out on the inorganic fraction with a Mastersizer that uses laser diffraction techniques to measure the grain size. Our results show that the San Felice salt marsh is characterized by a concave-up profile, as commonly displayed by marshes worldwide. Marsh elevation is highest along the boundary and decreases toward the inner marsh. The inorganic deposition, which is maximum along the marsh edge, decreases with distance from the channel network, because as water moves across the marsh, the velocity is reduced and sediment particles are deposited. In contrast, the organic deposition, dictated by local plant productivity, gradually increases with distance from the channel to balance the decrease in the inorganic deposition and to help the marsh surface to keep pace with current rates of RSLR. Interestingly, we note that the amounts of organic and inorganic sediment display non-monotonically trends. Furthermore, regardless of the method used, the amounts of organic matter show the same qualitative trend, although characterized by different values for a single sample. The grain size of inorganic sediment show a variable distribution between medium sand and clay. In particular, the grains along marsh portions adjacent to the channels are coarser and become gradually finer toward the inner marsh, according to the transport capability of the tidal flow and the decrease in the water velocity away from the main channel. In particular, we observed that the location of the channels is an important factor controlling patterns of inorganic and organic deposition. Our results also suggest that halophytic vegetation species largely contribute to tune marsh elevation and bring new insight on the spatial distribution of organic and inorganic deposition rates.