Geophysical Research Abstracts
Vol. 17, EGU2015-7475, 2015
EGU General Assembly 2015

Estuarine wetland evolution including sea-level rise and infrastructure effects.

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Estuarine wetlands are an extremely valuable resource in terms of biotic diversity, flood attenuation, storm surge protection, groundwater recharge, filtering of surface flows and carbon sequestration. On a large scale the survival of these systems depends on the slope of the land and a balance between the rates of accretion and sea-level rise, but local man-made flow disturbances can have comparable effects. Climate change predictions for most of Australia include an accelerated sea level rise, which may challenge the survival of estuarine wetlands. Furthermore, coastal infrastructure poses an additional constraint on the adaptive capacity of these ecosystems. Numerical models are increasingly being used to assess wetland dynamics and to help manage some of these situations.

We present results of a wetland evolution model that is based on computed values of hydroperiod and tidal range that drive vegetation preference. Our first application simulates the long term evolution of an Australian wetland heavily constricted by infrastructure that is undergoing the effects of predicted accelerated sea level rise. The wetland presents a vegetation zonation sequence mudflats - mangrove - saltmarsh from the seaward margin and up the topographic gradient but is also affected by compartmentalization due to internal road embankments and culverts that effectively attenuates tidal input to the upstream compartments. For this reason, the evolution model includes a 2D hydrodynamic module which is able to handle man-made flow controls and spatially varying roughness. It continually simulates tidal inputs into the wetland and computes annual values of hydroperiod and tidal range to update vegetation distribution based on preference to hydrodynamic conditions of the different vegetation types. It also computes soil accretion rates and updates roughness coefficient values according to evolving vegetation types.

In order to explore in more detail the magnitude of flow attenuation due to roughness and its effects on the computation of tidal range and hydroperiod, we performed numerical experiments simulating floodplain flow on the side of a tidal creek using different roughness values. Even though the values of roughness that produce appreciable changes in hydroperiod and tidal range are relatively high, they are within the range expected for some of the wetland vegetation.

Both applications of the model show that flow attenuation can play a major role in wetland hydrodynamics and that its effects must be considered when predicting wetland evolution under climate change scenarios, particularly in situations where existing infrastructure affects the flow.