Backbarrier and Sea Level Controls on Tidal Prism and Their Subsequent Impacts on Adjacent Barrier Islands

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Abstract

Along barrier island chains tidal exchange between the backbarrier and open ocean supports a unique saltwater and brackish water ecosystem within the bay and surrounding wetlands and is responsible for exporting nutrients to the coastal ocean. The volume of the reversing tidal flow dictates the size and number of tidal inlets and volume of sand sequestered offshore in ebb-tidal deltas. Inlet tidal prism is a function of bay size and tidal range and frictional factors within the conveyance channels. In a regime of sea-level rise mainland flooding, sediment influx, and the vertical growth of wetland vegetation control the evolution of the bay and its hypsometry, thereby affecting the tidal prism and morphological development of the tidal inlets and erosional-depositional patterns along adjacent barrier shorelines.

Future predictions of acceleration in sea-level rise will produce a condition whereby marsh surfaces are flooded more frequently and for longer periods of time. The effects that greater tidal inundation will have on sedimentation patterns, nutrient cycling, and growth rates of vegetation are largely unknown. However, existing studies indicate that a threshold will be reached whereby backbarrier marshes cannot sustain their vertical accretion to keep pace with a high rate of sea-level rise and therefore will be converted to intertidal and subtidal environments. Historical documentation of Barataria Bay in the Mississippi River delta demonstrates that positive feedbacks accelerate the conversion process due to increasing fetch that produces locally generated wave erosion of wetland shorelines.

In a scenario of wetland conversion to open water, tidal prism increases lead to an enlargement of ebb delta shoals at the expense of adjacent barriers islands causing shoreline erosion. Additionally, as the backbarrier hypsometry changes to a regime where bay area changes little throughout the tidal cycle, the hydraulic regime at the inlet becomes flood dominant. This tendency of net landward transport in the inlet channel coupled with increasing accommodation space due to marsh conversion to open water creates another sand sink that depletes the barrier sand reservoirs. Thus, the end product of accelerated sea-level rise is the conversion of marshlands to open water and the transfer of barrier sand to enlarging ebb and flood tidal deltas.