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Wetland transitions and loss in coastal Louisiana under scenarios of future relative sea-level rise

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Coastal Louisiana encompasses a vast expanse of wetland ecosystems that are subject to a number of historic, ongoing and future stressors including natural and human indices subsidence, hydrologic alteration and eustatic sea level rise. Predictions of future eustatic sea level rise indicate an uncertain future for coastal marsh survival. Model simulations conducted for the 2017 Louisiana Coastal Master Plan enabled assessment of land loss drivers under assumed future conditions reflected in three scenarios: low, medium and high. Output data generated by the Integrated Compartment Model, consisting of several integrated models reflecting hydrologic, vegetative and morphological change, were post-processed to diagnose the causes of conversion of wetland to open water for 50-year future simulations. Wetland conversion to open water was determined by wetland type (e.g., fresh, brackish salt) according to threshold conditions for marsh collapse associated with excess salinity (fresh wetlands) or inundation (non-fresh wetlands). Historic marsh edge erosion rates were projected into the future which also resulted in conversion of wetland to open water.

Across all basins and scenarios, loss is much lower in the first 10-15 years of the simulation than in later decades. This reflects the current status of the wetlands and their ability to withstand stressors that cause land loss in the model such salinity penetration into fresh wetlands or excessive inundation. As sea-level rises over the 50-year simulations, especially in the medium and high scenarios, loss increases as salinity increases in the lower estuary and stage increases. Marsh edge erosion dominates loss in many basins in the early decades. Loss proceeds until the land mass is lost entirely; thus, in some basins edge erosion is very low in later years of the simulation

In several instances sudden loss of fresh wetlands is associated with specific simulations years with increased salinity; the high salinity was not associated with incursion from the Gulf. Rather it is associated with very dry summer conditions (low precipitation and high evapotranspiration) combined with relatively low river inflows. While the specific coincidence of these conditions in the 50-year simulation is a result of how model boundary conditions combine, it illustrates the sensitivity of freshwater wetlands to drought conditions. Gradual changes in water levels and salinity over the simulation period lead to changes in vegetation distribution and areas which are fresh in the initial condition change in many areas to more salt tolerant species. In many areas, for the medium and high scenarios, inundation loss of saline marsh dominates. Saline marshes have a slightly lower threshold for inundations loss than brackish marshes and in areas in later decades of the 50-year simulation, the brackish marsh zone is reduced in size due to conditions that change vegetation rather than those that produce loss.

This analysis shows that for coastal marshes spanning the estuarine gradient, transition in wetland type as a result of gradual change in relative sea-level can influence the effects of other factors such as salinity stress and inundation in determining the future distribution of wetlands.