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Global Change Impacts on Wetland Vulnerability to Sea Level Rise

Tidal wetlands must either increase in elevation or convert to open water as sea level rises. Increase in elevation occurs through sequestration of inorganic and organic matter in soils, a process governed by complex biotic and abiotic interactions. Forecasting the future of tidal wetland ecosystems requires knowing how much sea level rise wetlands can tolerate, and how this limit will respond to changes in climate, nutrient loading and other perturbations.

I will present results from a series of experiments performed at the Smithsonian's Global Change Research Wetland, designed to understand the response of tidal wetlands to global change factors such as elevated carbon dioxide, nutrient enrichment, and sea level rise. Elevation change in the peat soils at this site is dominated by biotic processes such as plant production and decomposition. Elevated carbon dioxide doubled the rate of elevation gain, while anthropogenic nitrogen caused a decrease in elevation. The ecosystem-level response to these two perturbations was strongly mediated by the response of individual plant species. Because the two dominant plant species tended to respond strongly to one of the factors and not the other, the combination of elevated carbon dioxide and nitrogen cancelled each other and the overall ecosystem response to elevated carbon dioxide itself was minimal. The data suggest that tidal wetland ecosystems respond quite differently depending on levels of plant diversity or the presence of invasive species.

Wetlands that keep pace with sea level rise sequester soil carbon at very high rates. This fact has inspired the conservation community to encourage preservation, restoration or creation of tidal wetlands for their carbon sequestration services. Accelerated sea level rise may actually increase soil carbon sequestration if wetlands can tolerate increased flooding. However, tidal wetlands also emit methane, completely offsetting soil carbon sequestration at salinities greater than about 20 parts per thousand. Elevated carbon dioxide increases methane emissions at the same time that it increases soil carbon sequestration. Progressive experimental designs and improved models are needed to understand how the balance between carbon sequestration and methane emissions is affected by factors such as sea level rise, eutrophication, elevated temperature, and invasive plant species.

In conclusion, my work suggests that elevated carbon dioxide will increase tolerance of brackish and mangrove ecosystems to sea level rise; nitrogen eutrophication will decrease tolerance of sea level rise in low sediment environments; and plant species composition will be a major constraint on soil elevation responses to sea level rise. The extent to which these changes will mitigate or exacerbate radiative forcing is a matter of some debate and requires additional effort.