Linking Impacts of Climate Change to Carbon and Phosphorus Dynamics Along a Salinity Gradient in Tidal Marshes

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Tidal freshwater marshes are often located in areas experiencing intense urbanization pressure, yet they provide valuable services to coastal ecosystems by acting as water quality filters (removing nutrients and sediments), sequestering carbon [C] and phosphorus [P], serving as nursery habitat for fishes, and buffering storm and flood waters. A climate change stressor that is unique to tidal freshwater systems is the intrusion of salt water into environments that have historically been dominated by freshwater flows. The investigators especially are interested in how the increase in SO_4^{2-} concentration associated with salt water intrusion will affect the biogeochemical interactions that govern the cycling of C and P in tidal freshwater marshes and how it will affect the flux of elements between marshes, tidal waters, and the atmosphere.

The investigators will implement a novel, three-phase approach to determine changes in tidal marsh metabolism (e.g., CO_2 and CH_4 gas fluxes and SO_4^{2-} reduction), C and P sequestration (sediment deposition and burial), sediment P speciation, and porewater chemistry at sites along a low-salinity transitional gradient in the Delaware Estuary. Phase 1 consists of field observations (as a space-for-time substitute) to assess current ecosystem services provided by tidal freshwater and low salinity marshes, and allow the investigators to predict how these services may change as a result of salt water intrusion. Phases 2 and 3 provide a more detailed look at specific biogeochemical processes that impact cycling of C, P, and S. In Phase 2, laboratory experiments using marsh cores exposed to low salinity levels (< 5 psu) will be conducted to study the short-term (weeks to months) impact of increased salinity on marsh sediment C and P biogeochemistry. Phase 3 involves large-scale manipulations in the field (reciprocal transplanting of cores between tidal freshwater, oligohaline, and mesohaline marshes) to examine longer term (~1-2 yr) ecosystem-level responses of marshes to elevated salinity.

This research will improve the assessment of how ecosystem services provided by tidal freshwater marshes are likely to respond to predicted changes in climate-induced sea level rise and salinity. It is expected that a small increase in salinity in tidal freshwater wetland sediments will increase rates of decomposition (but decrease rates of C burial and emissions of the greenhouse gas CH_4), and cause a release of sediment-bound P from the soils. The results from this project can be used to improve existing climate change forecast models and will allow appropriate management to moderate the impacts of future climate change in low salinity tidal marshes.

EPA Grant Number: R832222