Effects of accelerated sea level rise and variable freshwater discharge on water quality improvement functions of tidal freshwater floodplain forests

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Tidal freshwater floodplain forests (TFFF) exist at the nexus between terrestrial and marine influences and are among the most susceptible ecosystems to climate change, manifested as sea level rise and variation in freshwater input. Of coastal terrestrial ecosystems, TFFF are unique in that they provide water quality (WQ) improvement functions that may reduce nutrient loadings to and eutrophication of estuaries downstream. Using a combination of field measurements, manipulative experiments, geographic information systems (GIS) and simulation modeling, we will characterize the WQ improvement functions of TFFF and investigate how accelerated sea level rise (SLR) and varying freshwater discharge will alter their area and delivery of these functions. We hypothesize that:

I. Accelerated SLR during the next 100 years will reduce the area and, hence, delivery of WQ improvement functions from TFFF, through habitat loss and conversion as tidal marshes migrate inland.

II. Saltwater intrusion into TFFF will reduce denitrification and release inorganic N & P via de-sorption and increased anaerobic C mineralization, especially sulfate reduction.

III. Alteration of current freshwater (river) discharge regimes will influence the magnitude of impact from accelerated SLR: reductions in freshwater discharge will greatly reduce the area and delivery of WQ improvement function from TFFF, while increased freshwater discharge will offset some of the loss of water quality improvement functions caused by SLR.

IV. Thresholds exist within predicted ranges of SLR and freshwater discharge, after which TFFF area, ecosystem migration, and overall delivery of WQ improvement functions are markedly affected.

Water quality improvement functions (sediment deposition, N, P, organic C sequestration in soil, denitrification, inorganic N&P sorption/desorption) will be measured in TFFF of three rivers (Altamaha, Ogeechee, Satilla) of coastal Georgia (GA) and compared with measurements made in a degraded (i.e. currently experiencing saltwater intrusion) TFFF on the South Newport River. Soil cores from a TFFF will be transplanted into an oligohaline ($5^{o}/_{oo}$) marsh to test the effects of saltwater intrusion on denitrification, inorganic N&P desorption and soil respiration. A laboratory experiment will be used to test the effects of saltwater intrusion (0, 2 and $5^{o}/_{oo}$) and inundation (saturated, +10 cm) on denitrification, N&P desorption and C mineralization. The Sea Level Affects Marshes Model version 5 (SLAMM5) will be used to simulate changes in TFFF area and delivery of WQ improvement functions in response to inundation and saltwater intrusion caused by accelerated SLR and variable freshwater discharge during the next 100 years. Using National Wetland Inventory data, results will be scaled to the GA-SC coast.

Deliverables will include (1) characterizing WQ improvement functions of TFFF, ecosystems which are extremely susceptible to accelerated SLR and for which such data are lacking, (2) manipulative experiments to test the effects of saltwater intrusion and inundation on WQ improvement functions, (3) prediction of how SLR and variable freshwater discharge will interact to alter the area and delivery of WQ improvement functions at ecosystem and regional scales, and (4) advances to SLAMM5 that will allow for modeling the effects of both inundation AND saltwater intrusion in response to accelerated SLR and variable freshwater discharge that can be applied to other river-dominated coastal systems such as Chesapeake Bay, Hudson River and Gulf Coast rivers.