Biogeochemical Controls on Phosphorus in Urban-influenced Coastal Ecosystems

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Coastal river deltas are home to hundreds of millions of people worldwide and provide trillions of dollars of economic and ecosystem services each year. However, deltas are being degraded by human activities that cutoff their supply of sediments and remove protective ecosystems. As a consequence, low-lying coastal areas are vulnerable to flooding and landward migration of ocean water. Coastal degradation driven in part by urban flood control measures has resulted in substantial land loss along the Louisiana Gulf Coast. A 50-year effort is underway to preserve existing land through projects that include water and sediment diversions and marsh creation. Efforts to maintain or even rebuild the coast are expected to preserve habitats, support coastal industries, and buffer urban areas against hurricane damage and flooding; however, ecosystems that receive diverted river water may be impaired by excess nutrients from urban and agricultural runoff. To predict the future evolution of the Gulf Coast and its resilience to disturbance, it is critical to evaluate how nutrients are stored and processed across flooding and salinity gradients that represent current and future coastal ecosystems.

Phosphorus is a critical nutrient that influences plant growth and decomposition of organic matter by microorganisms; however, phosphorus binds strongly to soil minerals and can become limiting to ecosystem growth and function. Phosphorus binding to soil minerals and its release into solution are regulated by oxygen levels and salinity within soils, which are particularly dynamic in coastal ecosystems subject to tides and flooding. This project will evaluate phosphorus storage and mobilization in contrasting deltas on the Louisiana Gulf Coast where water management strategies have resulted in either growing or shrinking deltas. This work will explore the conceptual framework that urban flood control measures influence oxygen and salinity levels in coastal wetlands by altering sediment and freshwater inputs. These shifting regimes, which vary seasonally and are sensitive to sea level rise and storm surges, in turn regulate phosphorus binding to soil minerals. Findings from this research will inform Earth system models being developed to simulate coastal systems and will be particularly beneficial to efforts to improve model representation of phosphorus cycling.

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