The fate of nutrients in coastal freshwater systems: Examples from Wax Lake Delta and the Great Lakes

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Nutrient inputs at coastal interfaces can be difficult to constrain where groundwater and river water mixes with ocean or lake water. My research aims at improving the assessment of nutrient loads in challenging coastal systems. In this talk, I present findings from two case studies. I present estimates of groundwater discharge, a previously unaccounted source of nutrients, to the Great Lakes coast using high-resolution geospatial analysis. By integrating land use data, I also identify areas of the coast that are vulnerable to high nutrient loads from groundwater. My analysis shows that almost one-third of Lake Erie's United States coastline is vulnerable to contamination from groundwater nutrient sources. By collecting field measurements at a vulnerable beach site, I show that the nitrogen load from groundwater exceeds 1 gram/day/meter of coastline, which constitutes a small but non-negligible source to Lake Erie. In the second case study, I use mesocosm to measure nitrate removal rates in a coastal wetland in Wax Lake Delta, Louisiana. Results suggest that summertime nitrate removal kinetics are highly correlated with a widely available remotely-sensed vegetation index (NDVI). Heavily vegetated, submerged levees at intermediate elevations in the delta are thus predicted to be the most reactive habitats. Numerical simulations of reactive nitrate transport in Wax Lake Delta and six synthetic deltas suggest that nitrate removal may be intrinsically limited in river-dominated deltas to a small fraction of the incoming nitrate load. Removal increases with delta topset gradient, and smaller, high-sitting deltas remove more nitrate than larger, low-lying deltas. From a management standpoint, nitrate removal efficiency can be improved by designing river

diversions to build steeper deltas. Steeper deltas are created by accessing coarser sediments in river diversion projects. However, manmade deltas alone cannot remove most nitrate discharging to the sea. Policy that addresses the nitrate load upstream is necessary to further reduce coastal nitrate loading.