Title: Changes in Biogeochemical Cycling of N in a Wetland-Dominated Coastal Basin with River Reconnection

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Abstract

Coastal wetlands provide many ecosystem functions and services, such as carbon sequestration, aquifer recharge, flood protection, and wildlife habitat. One other ecologically important function is improving surface water quality through nutrient removal. Nutrient loads in the Mississippi River (MR) have increased historically, causing eutrophication and hypoxia in coastal LA. Also, Louisiana experienced ~4800 km^2 of coastal wetland loss between 1932 and 2016 due to high relative sea level rise and reduced sediment from MR due to levees. Thus, the 2023 LA Coastal Master Plan aims to restore Louisiana's degraded coastline through a series of restoration projects, including sediment diversions or river reconnection.

The Mid-Barataria Sediment Diversion Project is intended to reconnect MR sediment-laden water with the wetlands of Barataria Basin to nourish degrading marshes. However, the diversion will also deliver substantial nitrate (NO_3^-) to the basin, potentially negatively impacting water quality. We sought to quantify NO_3^- reduction rates for marsh and submerged sediments in Barataria Basin using intact soil cores receiving 2 mg N-NO_3 L^{-1}. In addition, 2 cm of mineral river sediment from a MR crevasse splay was placed over the organic marsh soil as an additional treatment to replicate sediment deposition on the marsh once the MR is reconnected. We hypothesized that NO_3^- reduction rates would decrease once mineral sediment is deposited on the organic marsh soil. For an aerobic water column, nitrate reduction rates for vegetated marsh, post-diversion marsh, submerged eroded marsh (fringe) and estuarine mud zones were 71.1 ± 2.7, 27.8 ± 4.5, 19.7 ± 1.2, and 13.0 ± 0.75 mg N m^{-2} d^{-1}, respectively. Thus, the post-diversion marsh NO_3^- reduction rate decreased by ~60% compared to current vegetated marsh. The marsh is only flooded 31-48% of the time, lessening the impact of the reduction. In fact, adjusting for flooding time, the submerged sediments will conduct a greater proportion of denitrification due to constant contact with surface waters. These findings can improve parameterization of water quality models used to project nutrient loading and fate more accurately across the basin under a scenario of an operating large river reconnection project. This research also highlight the need to consider overall hydrologic connectivity in predicting spatial rates of water quality improvement through denitrification.