Farm fields to wetlands: biogeochemical consequences and climate feedbacks due to sea level rise in coastal plain agricultural landscapes

Emily S. Bernhardt, PI
with
Marcelo Ardon, Postdoctoral Associate
Jennifer L. Morse and Kim Novick, Ph.D. Students

Department of Biology and the Nicholas School of the Environment and Earth Sciences
Duke University

Our overarching goal is to develop empirical relationships describing the effects of rising water tables and increasingly variable wetland hydrology on gaseous emissions and solute production from nutrient rich coastal plain ecosystems by addressing the following questions:

> ***Q1.*** *How does the timing, duration and magnitude of storms affect the magnitude and form of N and P exports from coastal plain ecosystems of contrasting land use?*
> ***Q2.*** *Are landscape "sinks" for inorganic N sites of long-term retention or zones of transformation and gaseous loss?*
> ***Q3&4.*** *How does hydrologic variation affect rates of greenhouse gas emissions? rates of nitrification, denitrification and the resulting $N_2O:N_2$ ratio of gaseous N efflux?*
> ***Q5&6.*** *How do patch and landscape level fluxes of dissolved and trace gas pollutants change during rapid alterations of water level?*

Research will be conducted withinTyrell County in eastern NC intensively within a 400 ha wetland mitigation project on a former agricultural field and less intensively within 2 surrounding preservation wetlands and an adjacent farm field under active cultivation.

To address these questions we will conduct high resolution solute sampling in association with storm events (**Q1**); conduct a landscape level $^{15}NH_4$ addition (**Q2**); determine variation in CH_4 and N_2O efflux across spatial and temporal gradients in water level (**Q3**); use small scale ^{15}N enrichments to assess the dominant source of N_2O and the $N_2O:N_2$ ratio across hydrologic gradients (**Q4**); collect high resolution solute and gas efflux data in association with a whole ecosystem hydrologic manipulation experiment (**Q5&6**).

Our goal is to collect empirical datasets that explicitly focus on characterizing temporal and spatial variability in solute and trace gas pollutant production, and to link this variation to environmental predictors through simple statistical models. These models should provide useful *qualitative* predictions about the likely direction of change for solute exports and biogenic trace gas production as a result of a hotter, more hydrologically variable future climate for southeastern coastal plain ecosystems. We intend to publish a series of manuscripts addressing the questions above, and to post the resulting datasets on the NCEAS Ecological Data Repository to allow free public access. In addition we are actively collaborating with hydrologic modelers to utilize the information gained here to help build, refine and test a linked hydro-biogeochemical model for fluvial ecosystems that should help us move towards *quantitative* predictions about ecosystem functional responses to climate change.