Quantifying Spatial and Temporal Uncertainty in Coastal Carbon Dynamics in Louisiana

***Shawn M. Doyle**, Hoonshin Jung, and Tim Carruthers*
The Water Institute, Baton Rouge, LA, USA

Coastal swamps, marshes, mangrove forests, and other “blue” carbon ecosystems are among the most efficient natural carbon sinks on Earth. Efforts to restore and conserve coastal wetlands are thus gaining interest from commercial and government stakeholders as a nature-based solution to offset greenhouse gas emissions and generate revenue through carbon credits to incentivize coastal restoration projects. However, the commercial viability of blue carbon crediting is currently challenged by various uncertainties in quantifying current and future net greenhouse gas fluxes in coastal wetlands. To better understand the drivers of uncertainty and inform new research needs and management decisions, we conducted a Sobol's sensitivity analysis to identify the most influential parameters and assumptions affecting net carbon flux estimates in coastal wetlands. Our analysis examined uncertainties across multiple spatial and temporal scales, considering factors such as the fate of soil carbon from marsh erosion, methane and nitrous oxide emissions, and changes in plant productivity, among others. We found that the relative importance of many of these uncertainties varies spatially and temporally. For instance, carbon flux estimates are highly sensitive to uncertainties related to methane and nitrous oxide emissions in fresh and intermediate salinity wetlands or in saline wetlands with extensive mangrove coverage while brackish wetlands and saline saltmarsh carbon fluxes are more sensitive to uncertainties in annual plant growth. However, in areas prone to coastal erosion and land loss, these sensitivities to methane and nitrous oxide emissions and uncertainty in plant growth can become small compared to the fate of the eroded soil carbon stores, especially over longer time scales. By quantifying the contribution of individual uncertainties and their interactions to the overall uncertainty in net carbon flux estimates, our study provides valuable insights for policymakers and researchers seeking to address critical knowledge gaps and data needs within coastal ecosystems. Understanding and addressing these key uncertainties will be crucial for the commercial viability and successful implementation of blue carbon crediting programs which can help incentivize future coastal wetland conservation and restoration efforts.