Does Climate-induced Black Mangrove Replacement of Spartina Change Wetland Soil Carbon Dynamics?

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The advancing impacts of climate change are reshaping coastal wetland ecosystems, with mangrove expansion into Spartina marshes, potentially creating significant changes in carbon and nitrogen cycles. Microorganisms play a critical role in these processes, driving the decomposition of organic matter and facilitating the cycling of essential nutrients. This study examines the microbial and enzymatic processes involved in carbon mineralization, highlighting how different types of carbon compounds break down from the various plant sources. Factors like soil moisture, bulk density, and nutrient availability, specifically organic carbon, nitrogen, and phosphorus are investigated for their influence on these dynamics. Additionally, the role of microbial communities in producing greenhouse gases, such as methane and carbon dioxide, and how redox conditions shape emission patterns will be discussed. Emphasis is placed on carbon cycling and how microbial mediation links these processes to the broader ecosystem. By integrating literature findings on microbial contributions to carbon and nitrogen fluxes in Spartina marshes and mangroves, this study offers insights into the complex biogeochemical functioning of these wetlands

Long-Term Water Quality Trends and Seasonal Drivers in the Western Mississippi Sound: A Remote Sensing and Machine Learning Approach

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Long-term water quality monitoring is essential for understanding and managing the health of aquatic ecosystems, especially as they face mounting pressures from climate change and increased human activities. This study investigates the long-term trends and seasonal drivers of water quality in the Western Mississippi Sound (WMS), a key estuarine ecosystem in the Gulf of Mexico, using a combination of field measurements and advanced remote sensing data. Field sampling was performed using an autonomous surface vessel equipped with sensors to measure key water quality indicators, such as chlorophyll-a (Chla), Colored Dissolved Organic Matter (CDOM), and turbidity, across the study area for model calibration and validation. Remote sensing data, particularly from Landsat and Sentinel-2 satellites, were used to derive predictor variables, including remote sensing reflectance and spectral indices. To ensure that the most relevant predictors were used in the analysis, multicollinearity analysis and advanced feature selection methods, such as recursive feature elimination and permutation importance, were applied. Among the machine learning (ML) models evaluated, the XGBoost algorithm was found to provide the best predictive performance. This model demonstrated a high degree of accuracy, achieving an R^2 of 0.96 and a root mean squared error (RMSE) of 0.38 μg/L for Chla, an R^2 of 0.97 and an RMSE of 1.81 Ppb for CDOM, and an R^2 of 0.95 and an RMSE of 0.52 NTU for turbidity. A robust time series for Chla, CDOM, and turbidity was generated using the XGBoost model, which was selected after a thorough evaluation of its predictive accuracy. To further analyze the temporal dynamics of water quality, generalized additive models were employed to examine trends and seasonal patterns in the data. The analysis revealed significant spatiotemporal variability in water quality parameters across the WMS. Chla concentrations showed clear seasonal peaks during the summer months, likely driven by nutrient availability, increased temperatures, and light levels, all of which promote phytoplankton growth. In contrast, CDOM levels were predominantly affected by freshwater inflows from rivers and rainfall, with higher concentrations observed during periods of heavy precipitation, while turbidity variability was shaped by these freshwater inputs in combination with wind-driven sediment resuspension. This study demonstrates the potential of integrating ML techniques with remote sensing data to enhance the monitoring and prediction of water quality in coastal and estuarine environments. By providing a detailed understanding of the temporal and spatial variability in water quality, the findings offer valuable insights into the impacts of climate change, human activities, and natural processes on aquatic ecosystems. This research contributes to coastal management by enhancing understanding of water quality dynamics, helping to inform strategies to mitigate the effects of climate change and human activities.

Evaluating the Impact of Urban and Agricultural Runoff Mitigation Utilizing Waste Valorization for Nutrient Absorption

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Urban and agricultural runoff contain nutrient loads that impact surrounding waterways and environmental systems. Nitrate, ammonium, and phosphate are classified as nutrient impairments around the state. During rain or irrigation events, fertilizers from lawns or croplands are transported to local tributaries where nutrients can accumulate. Best management practices for fertilizer application and runoff collection can be used to mitigate the loss of nutrients, but alternative options are being studied to absorb nutrients at the source. A diverse industrial landscape in Louisiana provides opportunities for the waste valorization of non-hazardous industrial waste (casting sands, fly ash, rice husk, sugar cane bagasse, etc.) to absorb nutrients before leaching into waterways. Each material used in the study has a chemical characterization to correlate nutrient uptake. This study conducts microscale isotherms to provide insight into the absorption and desorption dynamics of waste materials for suitable biosorbent material. After building the framework, the scale can be increased to see trends in nutrient absorption and feasibility for larger volumes of waste. The trials are ongoing, but preliminary results show materials with high irons and aluminum provide high sorption for phosphate, while cellulose-based water has the ability to absorb nitrate. The continued study will overlap chemical characterization components with microscale isotherms to determine the most suitable waste material composition for edge-of-field sorption. Linearity of the micro- and macro-scale trials will also be monitored to show large-scale applications for readily available non-hazardous waste.

The Hydrology and Water Quality Dynamics Associated with an Urban Beaver Pond Complex

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An urbanized Piedmont beaver pond complex (BPC) was hydro chemically monitored from June 2022 to May 2023 with water quality samples collected approximately every 10 days. Precipitation, discharge in Inflow and outflow streams and pond water levels were continuously measured to develop monthly water balances for the pond complex. Water samples were analyzed for dissolved total phosphorus (DTP), dissolved total nitrogen (DTN), dissolved organic carbon (DOC), nitrate (NO_3^-), ammonium (NH_4^+), ortho phosphorus (PO_4^{3-}), total suspended solids (TSS), and turbidity. In situ measurements for dissolved oxygen (DO), pH, water temperature, and specific conductance were made at the time of each sample collection. Mass balances were calculated for individual ponds and the BPC. Monthly residence time for the BPC ranged from 681 hours (June) to 10 hours (January). Anoxic conditions were not detected in any of the four beaver ponds over the course of the study. Significant retention of TSS (-53%), DTP (-72%), DTN (-44%), and NO_3^- (-63%) was found for the BPC. Statistically significant retention or export was not found for DOC (-10%), NH_4^+ (+2%), or DON (-16%). Ortho-phosphorous was rapidly taken up and was generally not detectable in surface waters within the BPC. The portion of inorganic N (NH_4^+ + NO_3^-) declined from 80% of inputs to 60% of exports at the catchment outlet.

Tidal Freshwater Wetland Research on The Santee Experimental Forest – Hydrology and Carbon Dynamics

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Despite the growing interest in “blue carbon”, there is relatively little information on carbon stocks and dynamics in tidal freshwater wetlands. As the only USDA experimental forest containing tidal forested wetlands, the Santee Experimental Forest (SEF) is in a unique position to contribute research to this important forest resource. With that goal, we established a field research facility encompassing multiple research sites along a gradient of tidal influence that include a freshwater tidal marsh, a freshwater tidal forested wetland, and a nontidal forested wetland, all located along the East Branch of the Cooper River and its tributaries, which are important inputs to the Charleston estuary. These sites are instrumented to monitor water level, temperature, conductivity and dissolved oxygen, and soil moisture, temperature, and oxidation reduction potential; stream flow and water quality are also measured in the tidal and nontidal reaches.
Previous research out of the SEF has shown that tidal freshwater streams can function as reservoirs to sustain higher water tables than in nontidal forested wetlands, creating wetter soils and likely affecting carbon dynamics. Other work has demonstrated the importance of microtopography in mediating greenhouse gas fluxes, with hollows typically being stronger sources of methane emissions. At each of the current research sites, CH_4 and CO_2 fluxes are measured monthly at three plots, at high and low tide in the tidal sites, and in both hummocks and hollows in the two forested sites where microtopographic variation is present. We now have one complete year of gas flux data along this tidal gradient, which further demonstrates the relationship between landscape position and greenhouse gas fluxes. We also analyze how these fluxes are impacted by water level, soil moisture, and degree of tidal influence, and discuss diffusive v. ebullitive CH_4 fluxes.

Stocks and Rates of Organic Carbon Accumulation in Freshwater Impoundments of Eastern Canada

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In Canada, freshwater impoundments or wetlands have been created to compensate for regional wetland loss and provide habitat for wildlife. Many of these impoundments were constructed by building dykes on agricultural fields, which in turn were created from historically drained salt marshes. These freshwater impoundments have been constructed since the 1970s, mainly in the provinces of New Brunswick and Nova Scotia. The impoundments are managed to maintain water levels year-round. They are generally dominated by open water filled with submerged aquatic vegetation that surrounded by stands of emergent vegetation, primarily cattail (*Typha angustifolia*). With no surface water flow, these systems accumulate highly organic sediments. Accurate estimates stocks and accumulation rates of the organic carbon (OC) within these ecosystems are needed to understand the extent to which they reduce the burden of atmospheric carbon dioxide. We are measuring the stocks rates of OC accumulation of 5 created wetlands, which vary in age from 11 to 53 years. Our work takes advantage of winter ice through which we core to obtain sediments from open water and emergent cattails. The OC stock is based on the concentration of OC the depth of the accumulated sediments and the cored volume. The rates of OC accumulation are calculated by dividing the total OC stock by the wetland age. The findings of our study will inform stakeholders about the most effective management strategies for this type of wetland creation and their role as a natural climate solution.

Evaluating Salinity Regimes and Material Exchange Across the Mobile-Tensaw River Delta

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Tidal freshwater forested wetlands can be extensive in large river deltas influenced by estuary and river flows. There is increasing concern about the fate of these wetlands due to sea level rise and other impacts along our coasts. The Mobile-Tensaw River Delta in southern Alabama is one of the largest deltas (~140,000 ha) in the United States. We update a study to better understand the Mobile-Tensaw River Delta and its relation to Mobile Bay. Nine continuous salinity/water level monitoring stations were installed and used to locate 47 plots (400 m^2) for tidal forest community surveys. A multivariate hierarchical clustering approach discerned five distinct communities based on canopy tree importance values. Using the water stations and other available data, a machine learning approach (i.e., deep neural network and a Hybrid Convolutional Recurrent models) was used to successfully model salinity affecting tidal freshwater forested wetlands. Based on model outputs, sites further from river channels showed significant daily salinity variability (range > 8 PSU), while those closer to the channels had less variability and lower salinity (range < 5 PSU). Across the study area, there was <10% probability that salinity will exceed 5 PSU across all the stations. Finally, to better understand connections between the Mobile-Tensaw River Delta and Mobile Bay, current and historical samples of bay sediments were analyzed. Bulk stable isotope ratios in sediments reflected terrestrial source dominance across MTRD sites (-30 to -28‰), with values increasing down Mobile Bay from north (-34 to -26‰) to south (-24 to 18‰). Preliminary analysis suggests seasonal and interannual differences were primarily driven by whether river discharge was low (<1200 m^3/s) or high (>2000m^3/s) 30 days prior to sampling. Our results depict a highly complex Mobile-Tensaw River Delta - tidal freshwater forested wetlands system and allow us to evaluate alterations expected with future sea level rise, river flows, and other changes.

Disentangling the Effects of Salinity on Coastal Forest Carbon Balance: from Genes to Landscapes

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Coastal forests are not usually considered part of blue carbon projects. However, a recent paper made the case that all coastal tidal wetlands should be considered blue carbon. Coastal forests store large amounts of carbon and are vulnerable to sea level rise and climate change. We have been studying the effects of salinity and flooding on carbon stores and fluxes from coastal forests across multiple temporal and spatial scales. Increased salinity and flooding alter emissions of greenhouse gases, and the direction and magnitude vary depending on their interactions. While most studies have found that methane decreases with increasing salinity, we have found that low salinity increases can lead to increased methane emissions. In microcosm experiments, sulfate did not change microbial community composition, or gene expression, while other cations in saltwater led to changes. Across landscapes, flooding, salinity, and elevation led to plant communities shifting from forest to marshes, creating ghost forests in the process. Snags that are common in ghost forests can facilitate the movement of CO_2 but also serve as sites of CH_4 oxidation. Microbial communities found in snags confirm their CH_4 oxidation potential. Using remote sensing, we have identified trajectories of change, which can be used to prioritize conservation and restoration practices in the face of climate change and sea level rise. Overall, we postulate that coastal forests can play an important role in the blue carbon space, but more information is needed on how changing water levels and salinity will alter greenhouse gas emissions and carbon stocks to fully account for the permanence of these systems. Protection of existing coastal forests provides many other ecosystem services beyond carbon storage, such as biodiversity habitat and storm surge protection, and should be promoted.

Belowground Resilience to Freeze Damage in the Texas Gulf Coast Marsh-Mangrove Ecotone

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Climate change forecasts predict increasing frequency and severity of disturbances such as hurricanes, droughts, and severe cold snaps. Biodiversity-ecosystem function (BEF) theory suggests that speciose systems may be more resilient to disturbance impacts, exhibiting faster recovery than low diversity communities. In coastal wetlands, recovery potential is closely linked to persistence of living belowground tissue. We leveraged a unique opportunity to examine this relationship by assessing the role of species diversity on belowground resilience following a strong cold snap on the Texas Gulf Coast (USA) in 2021. The study system was a long-term experiment in the marsh-mangrove ecotone that had maintained varying levels of plant diversity in ten large (24 m x 42 m) study plots since 2012, ranging from Avicennia germinans (black mangrove) monocultures to relatively speciose marsh-mangrove mixtures. Prior to the cold snap, plots with more than 35% mangrove cover had relatively low Simpson's diversity index scores ($1\text{-}D \leq 0.4$), reflecting mangrove dominance over a more speciose marsh assemblage. During a cold snap in February 2021, temperature minima were below -7°C for several hours, causing extensive (>90%) mangrove mortality. Four growing seasons (fall 2024) after the cold snap, we collected belowground biomass samples from five vegetation states within each plot: living Avicennia, living Spartina alterniflora, living Batis maritima, dead Avicennia, and bare ground. We separated live and dead root tissue based on texture, color, and buoyancy. There was 10x more living root biomass in samples from living vegetation states (Avicennia, Spartina, or Batis) than in bare vegetation samples. Samples from dead Avicennia had half as much living root biomass as those from living Avicennia. The living roots found in stands of dead Avicennia likely represented ingrowth from neighboring patches of Spartina or Batis. We extrapolated relative plot-level belowground biomass based on the coverage of each vegetation state in each 24 x 42 m plot. At this larger scale, the ratio of live:dead root biomass was strongly positively related to pre-freeze plant diversity levels, where plots that had been previously dominated by mangroves had very little living root tissue after the freeze. Only the two highest diversity plots had more living than dead root material, indicating relatively low root mortality in those high diversity assemblages. These results suggest that belowground biomass is not resilient to freeze damage, particularly in low-diversity assemblages. In areas with extensive Avicennia pre-freeze cover and post-freeze mortality, belowground biomass decomposition may lead to widespread subsidence and carbon loss. However, areas with higher pre-freeze plant diversity may be at somewhat lower risk of submergence and irreversible habitat loss.

GHG emissions from Wetlands in the Canadian Prairies: Impacts of Land-Use Change and Environmental Drivers

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Canada has aggressively adopted nature-based climate solutions, such as wetland conservation and restoration, to achieve its national greenhouse gas (GHG) targets. While these activities can sequester carbon and prevent the loss of wetland carbon stocks, there is considerable uncertainty in the estimates of achievable reductions due to the highly variable GHG emissions from these wetlands, particularly methane (CH_4). This presentation will share findings from an ongoing national-scale project focused on mineral soil wetlands, aiming to better constrain GHG emissions and understand their drivers. Through an extensive survey of wetlands in the Canadian Prairie Pothole Region, we demonstrate that emissions patterns of carbon dioxide (CO_2), CH_4, and nitrous oxide (N_2O) from aquatic habitats vary significantly between wetlands in cropland and those in perennial landcover. Wetlands in cropped landscapes exhibit double the aquatic diffusive emissions, primarily driven by CH_4. Our results indicate that CH_4 emissions are highly sensitive to land use, increasing with elevated phosphorus levels and lower sulfate content in cropped settings, despite higher organic matter content in wetlands within perennial landscapes. Additionally, our field surveys reveal that salinity constrains CH_4 emissions, and models that do not account for salinity overestimate CH_4 emissions by several orders of magnitude. Furthermore, these findings are corroborated by data from the first-ever deployment of Eddy Covariance flux towers in mineral wetlands of the Canadian Prairies. Overall, our results suggest that regionally specific emissions factors are more appropriate for national GHG inventory reporting and for evaluating the role of wetlands as nature-based climate solutions.

Evaluating Woody Plant Species and Their Associations with Salinity and Hydrology in the Mobile-Tensaw Delta

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Tidal freshwater forested wetlands (TFFWs) are understood to be ecologically diverse and important areas that are vulnerable to anthropogenic disturbances, including channelization, dredging, and climate-induced sea level rise. Despite their ecological significance, important knowledge gaps persist related to the role of tidal influence on TFFW communities. To address this gap, we surveyed 47 forest plots across the tidal gradient of the Mobile-Tensaw River Delta (MTRD) along the northern Gulf of Mexico using 400-m^2 circular plots to document canopy and midstory species composition and canopy tree diameters. We integrated species composition data with predicted salinity and digital elevation analysis to assess environmental influences on vegetation distribution. To develop the salinity model, we deployed nine sensor dataloggers across the tidal gradient to record hourly salinity, water level, and temperature from November 2022 to July 2024. Using these and other publicly available data, we developed a hybrid deep neural network model with a residual network technique to predict salinity dynamics at each forest plot over the previous 15-year period (2008-2023). Species composition varied significantly across the tidal gradient in response to two key environmental parameters: salinity and elevation. Distinct zonation patterns were observed in both the midstory and canopy layers, with more tidal species such as *Morella cerifera* and *Nyssa biflora* persisting in areas of higher salinity, while less tolerant species like *Ilex verticillata* and *Nyssa aquatica* were more prevalent in fresher, less tidal environments. Other species, such as *Taxodium distichum* and *Ilex verticillata*, were most prevalent in low-elevation forests prone to more prolonged flooding. Threshold analysis identified distinct change points in species composition along the salinity gradient, with the percent exceedance of 2 psu emerging as the most ecologically informative threshold at 13.9% (more tidal sensitive species) and 16.4% (more tidal-tolerant species) exceedance. Additionally, long-term average salinity thresholds corresponded with a transition from large tree-dominated forests at approximately 0.4 psu to shrub/scrub tidal zones near 0.8 psu, highlighting a critical shift in vegetation communities. Our findings highlight species-specific salinity thresholds and emphasize the vulnerability of MTRD forests to increasing salinity intrusion driven by sea level rise and anthropogenic modifications.

Examining Hydrological Changes, Nutrient Dynamics, and Cyanobacterial Blooms in Louisiana's Deltaic Estuaries Over a Decade

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Estuaries, including those in the northern Gulf of America, are undergoing profound alterations due to changes in climate and implementation of coastal restoration activities and these may lead to increasing frequency of harmful cyanobacteria blooms (CyanoHABs). The overall productivity of Louisiana coastal ecosystems are physically and biologically controlled by freshwater discharge from the Mississippi River, which affects the composition, diversity, and biomass of organisms at all trophic levels. Recent studies have shown that Lake Pontchartrain Estuary experiences high interannual variability in nutrients and phytoplankton community dynamics, mainly due to the effects of seasonal and episodic rainfall on hydrology, the timing, duration, and magnitude of Mississippi River water diverted into Lake Pontchartrain from operation of Bonnet Carré Spillway (BCS), as well as tributary discharges and saltwater inputs from tropical activity. Historically, the BCS has opened in 15 times since its construction in 1931 to protect New Orleans from flooding of the Mississippi River during seasons of heavy rain. Several previous BCS openings have been associated with CyanoHABs, and there is concern that more commonly occurring spillway openings due to alterations in seasonal patterns can foster more frequent blooms in the estuary that are capable of adversely affecting water resources for fisheries and human health. There are more than a decade worth of data on the estuary's water quality, CyanoHABs occurrence and toxin production. This presentation will evaluate the existing data and assess how weather/climate related drivers of Mississippi River freshwater input and transport, salinity intrusion, tropical activity, cold fronts, precipitation, drought, and shifting temperature regimes influenced the water quality of the estuarine water and drove trends in CyanoHAB formations. Lake Pontchartrain's tributaries are also critical criteria to characterize and predict the succession of dominant phytoplankton communities in the estuary. The understanding and prediction of CyanoHABs in Lake Pontchartrain Estuary will greatly attribute to the overall future health and understanding of not just Lake Pontchartrain but the connected estuaries and lakes as well.

Biogeochemical Impacts of Basalt Fiber Bags on Estuarine Sediment Microbial Activity

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Coastal ecosystems are becoming increasingly degraded, facing threats from erosion, sea level rise, and urban development. Aquaculture-grade plastic bags filled with oyster shells are commonly used as a nature-based solution to stabilize sediment, absorb wave energy, and support living shorelines. While favorable for their durability and low-cost, plastics can still degrade over time into secondary microplastics, which can be ingested by filter feeding organisms. Due to concern over the effects of microplastics on estuarine ecosystems and public health, coastal restoration practitioners are switching from plastic materials to more "environmentally friendly" materials. One of the most recent materials to gain popularity is basalt fiber bags, which are made from basalt rock that has been melted down and spun into fibers. However, little is known about the effects of basalt bags on biogeochemical cycling within estuaries. In this study, we will characterize the chemical composition of the bags and conduct controlled laboratory experiments to test the impacts of basalt on sediment microbial activity. Microcosm bottles will be prepared in replicates of 5 using study materials, site sediment, and water collected from the Indian River Lagoon in east central Florida, with controls consisting of only site sediment and water. Respiration rates, microbial biomass, and enzyme activity will be quantified under aerobic and anaerobic conditions to assess the impact of the materials on microbial activity. Basalt fibers are expected to increase microbial biomass, respiration, and enzyme activity. While inorganic, basalt fibers contain trace elements such as iron and zinc, which are necessary for microbial growth. Thus, we predict basalt fibers will result in an increase in microbial biomass, respiration, and enzyme activity. Microbes play a key role in the cycling of nutrients and carbon in coastal systems. These results will give restoration practitioners a better understanding of the potential impacts of basalt bags and assist decisions on appropriate use of this material.

Practitioner Guidance for Managing Iron Sulfur Compounds During Wetland Restoration

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Restoration projects are being implemented to address natural and anthropogenic threats to coastal wetlands, including sea level rise and historic landuse alterations. The US Army Corps of Engineers (USACE) and other organizations introduce dredged sediments into coastal environments to increase elevation and stabilize marsh platforms, and efforts to expand these beneficial uses are expected to increase in the coming decades. However, some dredged sediments either contain iron sulfide compounds [e.g., iron monosulfide (FeS) and pyrite (FeS2)] or form them after marsh sediment applications. Under aerobic conditions, such as drought, FeS and FeS2 can rapidly oxidize, generating acidity that can dramatically lower the soil pH, impact plant establishment, and threaten the success of wetland restoration projects. As a result, recommendations are needed to properly manage iron sulfide containing materials through project design, screening, monitoring, and adaptive management. Tools and techniques exist to evaluate dredged sediments for the presence of FeS and FeS2 prior to and following marsh sediment applications, and project design and construction approaches can minimize associated acidification risks. This presentation outlines a framework for properly identifying and managing sediments containing iron sulfide minerals while conducting wetland restoration projects. These technical recommendations provide dredged sediment beneficial use practitioners a decision support tool for the successful management of iron sulfide containing dredged sediments to increase the ecological function and sustainability of wetlands.

NUMAR 2.0: Advancing Soil Formation Modeling to Embrace Uncertainty in Marsh Environments

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Soil dynamics are a function of aboveground and belowground processes. Based on the recent modification to the Nutrient Mangrove (NUMAN) model to develop NUMAN 2.0, which adds robustness to the mass balance in cohort-based soil modeling approach, we developed NUMAR 2.0 (Numerical Marsh Accretion and Resilience) model specifically tailored for applications in marsh environment. We tested the model in six sites across salinity gradients in the Atchafalaya (active) and Terrebonne (inactive) deltaic basin. For analysis, we calibrated and estimated the self-packing densities of organic and inorganic matters, root distribution and root biomass at the surface, root turnover rates. The model offers an understanding of relative contributions to soil formation from different sources, as well as insights of root dynamics and its importance in soil development in coastal environments. Additionally, the model estimates the soil accretion rate, organic matter content, bulk density, organic carbon density, carbon sequestration, organic and inorganic matter density, and necromass. The simulation output aligns with the field measurements irrespective of the diversity across the deltaic marshes. Besides deterministic analysis, a probabilistic analysis was performed to capture uncertainty in the simulation output to understand the variability in soil dynamics. Five key parameters, namely: organic and inorganic matter loading rate on the surface, lignin in the live root biomass, root biomass and root turnover rates, were used according to their statistical distribution to propagate uncertainties in the Monte Carlo simulation outcomes. Since the organic and inorganic matter loading rates show strong correlations in all sites, a joint bivariate distribution has been utilized, and Gibb's sampler has been used for random sampling for these two input parameters in probabilistic analysis. This model was upscaled to do landscape simulation for the whole active and inactive basins using mainly Delta-X campaign's (a NASA Earth Venture suborbital mission) dataset. The model showed potential in applications and refinement.

New Ground: Evaluating Factors that Influence Creation of Blue Carbon Soils in Restored and Natural Mangroves in Southwest Florida

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Mangroves have lost much of their historic global extent because of human action. In recent years this trend of loss has slowed or reversed in some regions with growing recognition of the ecosystem services mangroves provide. Research has consistently shown that mangroves are amenable to restoration under the right conditions, including oabservations that restored mangroves are more likely to recover their historical function than are mangroves planted in locations where they were historically absent. However, evaluation of restoration success is often limited to measurements of aboveground biomass over 5 years or less. Building on previous work that has documented timeframes for mangrove recovery to mirror nearby natural mangroves, a major objective of this work is to evaluate how organic carbon (OC) can be used as a metric of restoration success using sites that were restored 19 – 41 years ago. This work evaluates rates and stocks of mangrove soil OC using data obtained from restored and natural mangroves from 24 plots at 4 sites in southwest Florida to evaluate temporal trends in mangrove soil building factors: differences in soil age, present day surface elevation, water inundation times, and nutrient stoichiometry of soil, water, and roots. Soil ages of restored sites were determined by identifying the Time 0 restoration horizon based on dry bulk density and loss-on-ignition demarcations between the sandy-shelly restoration substrate and organic-rich mangrove soils. All 24 natural and restored plots are being dated with Pb-210 to examine variable sedimentation and OC burial rates over time. Preliminary data, based on 18 of the 24 plots, show vertical accretion rates in restored plots that average 5.7 ± 2.0 mm y^{-1} compared to rates in the natural plots that average 3.2 ± 0.4 mm y^{-1}. However, greater accretion rates do not translate to higher OC burial rates; instead, average OC burial rates of restored soils were 121.21 ± 23.79 g m^{-2} y^{-1}, slightly less than the average for neighboring natural sites of 165.82 ± 23.71 g m^{-2} y^{-1}. Soil OC densities (which can be spatially up-scaled for stock estimates) of equivalent depths in the co-located restored and natural plots were mostly the same. However, when stocks were normalized to equivalent ages instead of depths, the two younger sites showed higher stocks in restored sites. Approximately 40 years after restoration, the age-normalized stocks were equivalent between restored and natural plots.

Carbon Sequestration in Wetlands on Military Installations: Assessing Soil Carbon Storage Potential

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Military installations often maintain large, relatively undisturbed wetland areas, providing a unique opportunity to assess the natural carbon storage capabilities of these ecosystems without the interference of urbanization or intensive agricultural practices. This project compares different wetlands found on military installations across the continental US studying the carbon stored within wetland soils. This research could offer valuable insights into the preservation of wetlands as a climate mitigation strategy

Tropical Wetlands as Nature-Based Solutions to Remove Pollutants from Stormwater Discharge and Wastewater Effluent in Urban Environments

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Natural wetlands are critical water quality regulators, especially in developing tropical countries. However, varying loads of stormwater discharge and wastewater effluent can severely compromise their self-purification capacity. This study investigated the impact of seasons and vegetation types on the retention of pollutants in tropical wetlands.

The Lubigi wetland is a large urban wetland in Kampala, the largest city of Uganda in Africa. We studied whether stormwater discharge and wastewater effluent from a nearby stormwater channel and a sewage treatment plant in the western part of the city get cleaned as they flow through the wetland. Throughout the year, the Lubigi wetland experienced high loads of dissolved and particulate nutrients from the Nsooba main channel and the Lubigi sewage treatment plant. Despite high pollution loads, the wetland removed ammonium-nitrogen, orthophosphate, and solids in both dry and wet seasons. Regardless of the significant pollution, the wetland removed ammonium-nitrogen, orthophosphate, and particulate nutrients during both seasons, achieving removal rates ranging from 50-60% for orthophosphate but only 20-40% for ammonium-nitrogen. Interestingly, the wetland mostly released nitrate and nitrite. This was likely due to the breakdown of organic matter and run-off from farming during the rainy season. Notably, nitrate and nitrite were mainly released during water passage through the wetland, most likely due to the mineralization of organic nitrogen and agricultural run-off during rainy events in the wet season. Overall, seasonal differences in pollutant loads and retention rates were minimal. Nutrient removal decreased as water flowed from areas with *Phragmites mauritianus* (a type of grass) to areas with *Cyperus papyrus* (a type of sedge). Median uptake rates decreased for NH_4-N, PO_4-P, and TN from -112, -3.8, and -127.6 g m^{-1} d^{-1} in the midstream reach with *Phragmites mauritianus* to +3.1, +0.04, and -2.3 g m^{-1} d^{-1} in the downstream reach with *Cyperus papyrus*, respectively. However, the sewage treatment plant's limited capacity and untreated stormwater discharge reduced the wetland's ability to clean water. The insufficient carrying capacity of the treatment plant and the release of untreated sewage into the wetland significantly impact the self-purification capacity of the Lubigi wetland and call for urgent actions to improve sewage management, restore degraded wetland areas, and increase the awareness of the various ecosystems the wetland provides for the local people. Our study highlights the need for better sewage management, restoration of degraded wetland areas, and increased awareness of the wetland's benefits to local people.

A Little Goes a Long Way: 1˚C Warming Alters Microbial Metabolic Potential in a Permafrost Peatland

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Warming-induced permafrost thaw is resulting in the northward expansion of peatlands. These wetlands are a potent source of greenhouse gases, primarily methane, and their expanded area is predicted to contribute an additional 0.13–0.24 °C to global warming by 2100. However, it is unclear how the warming predicted to occur over the next several decades (e.g., 1–2 °C) will affect the activity and composition of the soil microorganisms that mediate methane production and oxidation in peatlands. The objectives of this study were to determine if the soil microbial community and its metabolic potential were affected by six years of 1–2 °C warming in a northern peatland near the permafrost boundary. We hypothesized that warming would alleviate a bottleneck in microbial respiration by accelerating the fermentation of organic compounds and increasing the mineralization of nutrients from organic matter. The experimental site was located on the northern side of the north Great Xing'an Mountains (52°95' N 122°86' E) in the discontinuous permafrost zone. Field warming of approximately 1–2 °C was achieved through use of open top chambers (OTCs) made of colorless, transparent plastic composite material that passively warmed the internal area. Cores were taken from inside six OTCs and paired reference samples were collected from a nearby area with similar vegetation. The taxonomic composition and functional potential of the soil microbial community was evaluated using metagenomic sequencing and measurements were made of dissolved organic carbon (DOC) and pH. The results showed the abundances of genes for methane production increased with warming, alongside the abundance of methanotrophs. Nitrate reducing and sulfur oxidizing bacteria were also significantly more abundant in the warmed treatment relative to ambient conditions, indicating that the redox potential was above the level typically associated with methanogenesis in some parts of the soil environment. DOC significantly increased with warming and was accompanied by a decrease in pH, suggesting an increase in decomposition. The findings supported the hypothesis that warming accelerated the mineralization of organic matter. The potential for methanogenesis increased with warming, as did the abundance of competitors (e.g., denitrifying and sulfur oxidizing bacteria) and methanotrophs. Together, the results indicate that the metabolic potential of the soil microbial community in a northern peatland was sensitive to six years of 1–2 °C warming.

Global Review of Salt Marsh Change and Carbon Emissions

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Salt marshes are carbon dense coastal wetlands occurring globally. Historic and current salt marsh change is highly uncertain. The Landsat satellite record has enabled global scale change analysis of the last 40 years but has limitations. We aimed to understand carbon emissions from Land Cover Land Use Change (LCLUC) in salt marsh environments. Our previous work estimated global carbon emissions from salt marsh ecosystems from 2000-2019. We utilized the Landsat archive and Google Earth Engine to map change anomalies, including loss, gain, and recovery within the global salt marsh extent from 2000-2019. We estimated soil organic carbon at 1 m using the Coastal Carbon Atlas and assumed complete loss of that top meter. In that work, we estimated that net global losses resulted in 16.3 (0.4-33.2) Tg CO2e year−1 emissions from 2000 to 2019. Following that work, new regional and global maps of extent, change, soil organic carbon, and aboveground biomass have been published. These new datasets can improve our estimates of salt marsh extent, change, and emissions. Therefore, we present these advances in salt marsh mapping and their impact on modeling carbon emissions. We analyze the variability of these change mapping approaches in the Chesapeake Bay, exploring how the mapping approach affects carbon emissions. Finally, we highlight local approaches that could constrain carbon emission estimates from salt marsh change, including identifying the loss process and classifying plant functional communities with imaging spectroscopy. Remote sensing is critical for improving our understanding of the extent and change of the salt marsh ecosystem. Remote sensing is essential for monitoring salt marsh ecosystems. Methods are ready for implementation in global reporting frameworks such as Nationally Determined Contributions, the Kunming-Montreal Global Biodiversity Framework, and Sustainable Development Goals.

Biosolids Derived P in the St. Johns River Watershed: Implications for Legacy P Impacts

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Changes in state regulations in Florida in 2013 resulted in a shift of Class B biosolids applications out of watersheds in South Florida to nearby available areas, resulting in pasturelands of the Upper St. Johns River Basin (USJRB) receiving an additional 950 MT of phosphorus (P) annually from Class B biosolids. Watersheds in the USJRB with increased biosolids application exhibited concomitant increases in P export, while similar watersheds with negligible biosolids application showed no change in P export. A preliminary watershed nutrient budget indicated that export of a small percentage of the added biosolids P was sufficient to produce the observed changes in water quality. Immediate water quality impacts of increased P export have been observed in the headwater lakes of the St. Johns River, but the extent to which the additional P is retained in lake sediments and the expansive marshes of the St. Johns River is less understood. Attenuation of the P loading signal downstream from the headwater marshes indicated retention of P in soils and sediments. We anticipate that as watershed soils continue to export legacy P, a moving front of P-saturated soils will develop in the headwater marshes and floodplain of the St. Johns River and may continue to enrich downstream waters with P.

Significant Contribution of Wastewater Treatment Plants to Dissolved Carbon Loading in China's Major River Systems

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Rivers are essential to the global carbon cycle, serving as conduits for substantial carbon fluxes. However, with rapid economic development and population growth, rivers are now receiving vast quantities of wastewater, which includes significant amounts of dissolved carbon. The contribution of this carbon fraction to the watershed's overall carbon dynamics is often overlooked, as the proportion of dissolved carbon fluxes from wastewater to the total riverine dissolved carbon export remains uncertain and subject to change. Here, we review of previously published data with regard to effluent dissolved organic carbon and dissolved inorganic carbon concentrations, and estimated mass inflows of dissolved organic carbon and dissolved inorganic carbon from wastewater treatment plant effluents in seven major river basins of China. The dissolved inorganic carbon concentrations in effluent water generally range from 31.34 to 67.08 mg C/L (5th to 95th percentile), with a median of 44.23 mg C/L. In comparison, dissolved organic carbon shows a wider range from 2.91 to 17.08 mg C/L (5th to 95th percentile), with a median of 7.28 mg C/L. In China's seven major river basins, urban effluent contributes nearly 7% of the total DIC and 4% of the total DOC exports to rivers in the East Asian region. Effluents from these seven basins account for an average of 12% of the total DIC and 16% of the total DOC exports. These findings underscore the significance of effluent-derived dissolved carbon in both regional and global riverine carbon accounting.

Stability Matters: A New Perspective on Wetland Soil Carbon

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Wetland and coastal ecosystems store a disproportionately large amount of global carbon (C) relative to their aerial extent, particularly in the soil. Over the past few decades, new empirical data on the spatial and temporal patterns of soil C across diverse wetland and aquatic ecosystems has improved management, conservation, and restoration efforts aimed at C sequestration for climate mitigation. However, most of these studies focus only on total C (or organic C) quantification, a property governed by soil organic matter (SOM) content. This metric fails to capture the diverse and dynamic nature of SOM, which is continuously processed, modified, and mineralized.

Our lab seeks a deeper understanding of SOM dynamics, asking: what controls which C compounds remain stored in the soil long-term, and which are lost? Within the conceptual framework of redox serving a central role in wetlands, we are critically evaluating the long-held assumption that the inherent biochemical properties of SOM lead to 'selective preservation' of more complex organic molecules. Rather, we have found broad evidence that organo-mineral complexes (termed mineral-associated organic matter, or MAOM) vary greatly in wetland soils and may be a key indicator of the vulnerability of SOM to mineralization. This presentation will introduce the concept and history of MAOM research in wetland soils, as well as present cutting-edge data on MAOM content and controlling factors across diverse wetland ecosystems. Our work highlights the importance of considering soil C fraction and form, rather than total C alone, when evaluating the climate mitigation potential of wetland soils.

Seasonality and Marsh Zonation Drive Carbon Sequestration Patterns in New England Salt Marshes

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Carbon sequestration by salt marshes plays an essential role in removing greenhouse gases from the atmosphere. However, the factors driving carbon uptake or release in salt marshes are still not well understood. Salt marshes exhibit inherent temporal and spatial variability in carbon fluxes, influenced by seasonal plant growth and species distribution gradients within the marsh. Current measurements of carbon fluxes are limited by a lack of year-round sampling and sparse data across the diverse plant communities within marsh ecosystems. To better capture these seasonal and spatial patterns, we conducted a regionally coordinated effort to measure CO_2 fluxes at National Estuarine Research Reserve (NERR) sites. We deployed low-cost, ultraportable greenhouse gas (GHG) sensor packages to measure vertical CO_2 fluxes in salt marshes at five NERR sites from Maine to Connecticut during five different periods throughout the year. These GHG sensors were deployed in the high and low marsh zones at 12-14 sites per estuary during the marsh dormant season (December and February), spring green-up (May), and peak biomass periods (July and August/September). Sensor accuracy was validated against a standard Picarro GasScouter instrument during the winter, spring, and summer months. The study revealed regional patterns in CO_2 fluxes across New England. Lower latitude marshes, from Connecticut to Massachusetts, were on average carbon sinks, with fluxes ranging from -6.6 to -11.5 mmol CO_2 m^{-2} h^{-1}. In contrast, the northern marshes in Maine and New Hampshire were slight carbon sources on average (0.3 to 0.8 mmol CO_2 m^{-2} h^{-1}), as the sampling periods captured more instances of carbon release. As one of the few studies to measure winter CO_2 fluxes in New England salt marshes, we found that dormant season CO_2 emissions averaged 2.6 mmol m^{-2} h^{-1}, a notable contrast to the growing season average of -10.3 mmol m^{-2} h^{-1}. A significant spatial pattern was observed between low and high marsh plant communities. Low marsh areas dominated by *Spartina alterniflora* (>50%) absorbed more carbon, with an average flux 8.4 mmol CO_2 m^{-2} h^{-1} lower than high marsh sites. Species-specific CO_2 flux differences were also evident, maintaining distinct low and high marsh patterns even in winter, when plant activity is minimal. This study highlights the importance of wintertime fluxes and the spatial distinctions between low and high marsh zones. This study also underscores the need for year-round, intra-marsh carbon flux measurements to accurately estimate carbon sequestration capacity, particularly considering climate-driven regional changes in temperature and seasonality.

Nitrogen Limitation of Mangroves Encroaching into Marshes Depends on Hydrological Positioning

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Coastal wetland plants such as mangroves and salt marsh grasses absorb nitrogen and abate estuary eutrophication. Increased nitrogen runoff to estuaries around the world has shifted the nitrogen limitation regimes of these plants, potentially threatening this nutrient sequestration. Tidal creeks and coastal waterways differentially deliver nitrogen to creek-adjacent plants and those in the interior wetland. However, we know little about how hydrological positioning on the landscape influences wetland plant nitrogen limitation and uptake. To fill this knowledge gap, we performed fertilization and ^{15}N labelling experiments at two sites in northeast Florida, USA and examined plant and soil responses. Six replicates of co-existing mangroves and marshes were fertilized with urea in the interior and creekside environments and compared with six replicates that were not fertilized (2 sites x 2 hydrological environments x 2 plant types x 2 treatments x 5 replicates). We found that interior mangroves (*Avicennia germinans*) and the marsh succulent *Batis maritima* grew more in response to nitrogen fertilization than plants on the creekside. Root productivity was higher for A. *germinans* and *S. alterniflora* in the interior, also indicating greater nitrogen limitation in this hydrological position. Nitrogen retention, as indicated by ^{15}N label, was higher in soils than plants at all locations and higher in soil in the creekside environment as compared to the interior portion of the wetland. Though mangroves and marshes on the creekside exhibited lower nitrogen limitation, it's possible that the silty soils along the creek may better bind nitrogen. Our findings will help managers in this region better value the nitrogen storage capacity of their coastal wetlands and will help ecologists and managers elsewhere to parameterize coastal wetland nitrogen budgets.

The Effect of Prescribed Burning on Nitrification-Coupled Denitrification in a Restored Chesapeake Bay Tidal Marsh

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Prescribed burning is a management practice commonly used in tidal marshes of the Southeastern and Mid-Atlantic United States to improve habitat for target species. It can stimulate biomass production of desired plants, remove invasive species, and prevent larger, more destructive burns. Tidal marshes are ecosystems of interest because they possess dynamic redox conditions that promote nitrogen cycling and therefore nutrient removal. The impact of prescribed burning on tidal marsh biogeochemical processes, especially nitrification-coupled denitrification, is understudied. The objective of this study is to investigate the effect of a prescribed burn on nitrification coupled denitrification in a restored Chesapeake Bay tidal marsh on Poplar Island, Maryland, United States. A prescribed burn was completed in March 2024 as part of an effort to combat marsh dieback by removing overwintering habitat for stem-boring insects and pathogenic organisms. The work presented here builds on a study of the response of vegetation, microbial, and insect communities to the prescribed burn. To measure sediment-water exchange of nutrients like ammonium and nitrate/nitrite, as well as dissolved nitrogen and oxygen gas, intact cores were collected from both burned and control plots. The cores were incubated under dark followed by light conditions. Soil porewater equilibrators were deployed in the same sites to measure concentrations of pore water nutrients such as ammonium, nitrate/nitrite, and sulfides within the rhizosphere. Two sites in each burn and control plot were established in three marshes ranging in age from 9 – 15 years, for a total of twelve study sites. These measurements were taken at two time-points in the growing season before the prescribed burn (July 2023 and October 2023) and two time-points in the post-burn growing season (July 2024 and October 2024). Pre-burn and post-burn sediment-water exchange rates and porewater nutrients were compared to investigate the impact of the prescribed burn on sediment biogeochemistry. To further understand environmental controls on the results, climate data like soil, water, and air temperature, as well as water level were also analyzed for both the pre-burn and post-burn growing seasons. The impact of marsh age was also investigated by comparing results between the three different marsh cells. Results from these analyses will be highlighted in detail in this presentation.

Can Mosquito Impoundments Be Leveraged to Treat Eutrophic Waters?

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Wetlands throughout the Indian River Lagoon have been impounded to control mosquitoes, which has hindered their natural hydrological connection to the estuary and subsequent ability to buffer nutrient loading. Herein, a pilot study was conducted to determine the nutrient removing potential of mosquito impoundments managed through Rotational Impoundment Management, to understand if the unique structure of mosquito impoundments can potentially be leveraged to provide an effective estuarine treatment wetland. This management regime increases water levels using a pumping system and closed culverts during the summer ('closed season') to decrease mosquito populations; in the cooler months (open season'), culverts are opened and water exchange with the estuary is restored. The initial phase of this project characterizes seasonal biogeochemical conditions in an impoundment. Soil cores and surface water samples were collected inside of the impoundment in the summer and off-season to compare internal nutrient dynamics. On a finer temporal scale, surface water samples were collected frequently over the course of a year at one inflow and two outflow sites, and tested for total nitrogen, ammonium, nitrate-nitrite, and total phosphorus. Furthermore, YSI EXO2 multiparameter water quality sondes were placed in-situ at the inflow and outflow sites each season to measure dissolved oxygen, pH, turbidity, temperature, salinity, chlorophyll-a, and fluorescent dissolved organic matter at 15-minute intervals. Under the current Rotational Impoundment Management regime, collected data suggests trends of increased nitrogen and phosphorus at outflows in the open season compared to the closed season. Significant water drawdowns in the open season due to Rotational Impoundment Management may accelerate aerobic decomposition and increase nutrient efflux. Continued long term monitoring will guide subsequent project phases to understand the overall ability for impoundments to mitigate the nutrient loading situation occurring in the Indian River Lagoon.

Uncertainty of Hydrological Processes on Greenhouse Gas Emissions from Urban Rivers

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Urban rivers are significant sources of greenhouse gas (GHG, including CO2, CH4, N2O) emissions, however, high regional or global uncertainties remain in urban riverine GHG fluxes due to the dual effects of natural and anthropogenic factors on rivers in urban areas. This study conducted systematic field monitoring and analysis on different urban rivers in Shanghai, a typical megacity in China, aiming to better understand the temporal and spatial variation characteristics of GHG and more accurately estimate the GHG fluxes of urban rivers. Our results demonstrated that urban rivers serve as hotspots for GHG emissions, with the annual average flux 141.61±104.18 mmol m-2 d-1 for CO2, 0.64±0.76mmol m-2 d-1 for CH4, 87.89±74.40 mmol m-2 d-1 for N2O, respectively. The three GHG emissions showed an overall downward trend from the year of 2011 to 2021. This result indicated a great relationship with the greatly improved eutrophication in the urban waters. However, the CH_4 ebullition fluxes from the water column accounted for approximately 99% of the total CH_4 flux, exhibiting significant temporal variations and a strong positive correlation with water temperature. This suggests that the accumulation of organic carbon in localized sediment areas may enhance the temperature sensitivity of CH_4 ebullition. In addition, the sampling rivers are affected by tidal cycles and the water-level fluctuation zone contribute 3%, 13%, and 17% of the annual emissions of N_2O, CH_4, and CO_2, respectively. Our results indicated that rainfall dilution caused by typhoon events, drainage from pumping stations, sediment disturbance, and high gas transfer coefficients resulted in GHG diffusive fluxes that were 1–2 orders of magnitude higher than those during non-typhoon periods. The CO_2-equivalent emissions across different rainfall events followed the order: typhoon period (3.93 g m-2 h-1) > post-typhoon period (0.89 g m-2 h-1) > heavy rainfall (0.33 g m-2 h-1) > no precipitation (0.29 g m-2 h-1) > light rainfall (0.25 g m-2 h-1). Therefore, future research should comprehensively consider the impacts of hydrological changes induced by both natural and anthropogenic factors on GHG emissions from river water bodies.

Assessing the Value of Constructed Wetlands as a Nature-Based Climate Solution: Insights from Southern Ontario

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Constructed wetlands (CWs) are created for wastewater treatment, biomass production, water storage and flood retention, and wildlife habitat. Vegetated CWs also can also sequester carbon (C) in their soils and potentially contribute to mitigation of anthropogenic greenhouse gas (GHG) emissions. Although research has quantified GHG emissions in some CWs, it is largely unclear whether these systems can help or hinder GHG emissions reduction efforts. In this study, we report the GHG fluxes from two CWs from Southern Ontario (Canada) vegetated primarily by *Typha latifolia*, one permanently flooded, and one temporarily flooded. Greenhouse gas fluxes (CO_2, CH_4, and N_2O) were measured seasonally using the static, dark chamber method. CO_2 emissions were significantly higher in the permanently flooded wetland when compared to the intermittently flooded system during all seasons except winter. The annual CO_2 emissions in the permanently flooded wetland was 170±121 mg m^{-2} hr^{-1}, while in the drier wetland the average annual CO_2 emissions were 94±52 mg m^{-2} hr^{-1}. Average CH_4emissions were >21 times higher in the permanently flooded wetland (10±19 mg m^{-2} hr^{-1}) than the seasonally flooded wetland (0.4±0.5 mg m^{-2} hr^{-1}). Methane emissions peaked during drier summer conditions at the seasonally flooded site, but during fall at the permanently flooded site. Winter CH_4 emissions under ice cover of the permanently flooded system were comparable to the summer values at the drier site underscoring the importance of measuring cold season emissions in constructed wetlands for robust annual GHG flux assessments. Nitrous oxide emissions were negligible. Our results suggest that hydrological control in CWs is essential to reducing their global warming potential wetland as reduced flooding in the fall and winter could lead to substantially lower CH_4 emissions.

A Seasonal Comparison of Decomposition Rates Across 5 Semi-Urban Mangrove Sites Spanning a Range of Soil Types and Tidal Regimes

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Decomposition rates of organic material vary with temperature, salinity, and oxygen availability, resulting in latitudinal and seasonal variation across sites. Although well-studied in terrestrial systems and in temperate wetlands, data on decomposition rates in tropical wetlands are sparse. The objective of this study was to determine how decomposition rates vary across semi-urban tropical mangroves using a suite of standardized substrate assays. Following protocols from the literature we deployed gel-filled ROMA plates, tea bags, and wood lamina to test the hypotheses that decomposition rates of these different substrates would co-vary across sites and across seasons. We selected 5 semi-urban mangrove sites in Panama that included carbonate and terrigenous soils, and macro-tidal and micro-tidal systems and replicated the assays across the wet and dry season. Rates of gel loss from the ROMA plates and weight loss from the teabags were generally similar across the sites but showed significant effects of and interactions between site and season as well as treatment (red vs. green tea or covered or open ROMA plate wells). Surprisingly the site with the highest loss of gel from the ROMA plates was different from the highest loss of weight from the teabags. Seasonal differences were associated with the variation of hydrological conditions across the sites.

Pyrite Oxidation and Formation During Dredged Material Wetland Creation: Poplar Island, Maryland, USA

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The beneficial use of dredged materials for wetland construction is increasing throughout the USA. The conversion of sediments to soils can have a number of consequences for wetland plant success and contamination of surrounding waters. The large island restoration at Poplar Island, Maryland USA utilizes fine grained sediments dredged from the Baltimore Harbor approach channels to create both uplands and tidal wetlands. The changing character of the sediment during drying - "crust management" – can be of concern. At Poplar Island, initial sediment drying and the subsequent oxidation of pyrite sulfur results in pH's that could hinder wetland plant success. Over time, pH's moderate and with the exposure of the soils to tidal flushing, pH's of ~ 6 present a minimal impediment to the growth of *Spartina alterniflora*, which had extremely high initial stem height and above-ground biomass due to high concentrations of pore water ammonium and iron-bound inorganic phosphorus. With time, the occurrence of high concentrations of iron oxides and the production of hydrogen sulfide in developing marsh soils produces iron sulfide minerals and releases iron oxide-bound phosphorus. This study contrasts with other observations of pyrite oxidation in wetlands that show pyrite oxidation inhibits fertility. The study approach, including analysis of iron sulfide minerals, pore water chemistry, and pH provided insights into the time course of pyrite oxidation and subsequent pyrite formation.

Nitrous Oxide and Methane Production and Emission in Wetlands Receiving Elevated, Agricultural Nitrate Loads

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Although wetland restoration is a promising strategy for reducing nonpoint-source nitrogen (N) loads, these systems can be significant sources of nitrous oxide (N_2O) and methane (CH_4). There is some concern that the widespread restoration of wetlands to intercept and reduce nonpoint source N loads could substantially increase emissions of greenhouse gases (GHG), in particular N_2O. Relatively few studies have quantified N_2O and CH_4 emissions from wetlands receiving elevated, nonpoint-source N loads, and those that do are limited to a relatively narrow range of loads. In addition, prior research has not adequately accounted for dissolved N_2O and CH_4 in water entering or leaving wetlands. These transport pathways represent largely unknown, but potentially significant, N_2O fluxes for wetlands receiving elevated N loads, and failure to consider dissolved N_2O or CH_4 in wetland inflows and outflows could result in a misrepresentation of overall wetland contributions to GHG emissions. This could be critical in the case of wetlands intercepting flows from agricultural tile-drainage systems, which can contain high concentrations of N_2O. Over 100 wetlands have been restored through the Iowa Conservation Reserve Enhancement Program with the explicit goal of intercepting and reducing N loads from tile-drained cropland. These wetlands total over 400 ha of pool area and intercept N loads from approximately 50,000 ha of primarily cultivated cropland. We studied subsets of these wetlands to evaluate their effectiveness at reducing agricultural, nonpoint source nitrogen loads, and to assess their effects on GHG emissions. For each wetland, in addition to measuring nitrate and total nitrogen loading and removal, we quantified N_2O and CH_4 production and emission as well as dissolved N_2O and CH_4 delivered with stream inflow and exported with outflow to downstream systems. Nitrogen loads to the wetlands were primarily in the form of nitrate, and all wetlands were effective at reducing both nitrate and total N loads. The wetlands were also highly efficient at denitrifying nitrate to N_2, with fractional yields of N_2O -N averaging less than 0.5% of total nitrate removal. N_2O emission rates were similar to reported rates from cropland, and CH_4 emission rates were similar to reported rates for restored depressional wetlands in Iowa. External loading and downstream export contributed very little to CH_4 fluxes for any of the study wetlands, which were overwhelmingly dominated by CH4 production and emission. In contrast, external loading and downstream export were major components of the N_2O budgets for all of the study wetlands. N_2O loads to the wetlands from inflow streams ranged from 11-61% of the total N_2O inputs, and N_2O export from the wetlands through outflow to streams ranged from 10-58% of the total N_2O outputs. These results underscore the importance of considering inflows and outflows when interpreting N_2O emissions from wetlands, particularly those systems that receive N_2O loads from agricultural drainage water.

Water Quality Time Series of Mississippi Sound: Insights from Satellite and Unmanned Aerial Systems Imagery, and Autonomous Surface Vessel Data

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In situ water sampling from manned boats provides accurate point-based measurements but lacks the spatial and temporal coverage required for comprehensive water quality management. In contrast, remote sensing offers broad-scale water quality observations with frequent revisit times. However, satellite data face limitations, such as cloud cover, which can result in extended periods without data, and insufficient spatial resolution for smaller water bodies. Unmanned aerial systems (UASs) can overcome these gaps, collecting ultra-high-resolution data beneath clouds. This research aims to generate a time series of water quality maps by integrating satellite and UAS imagery for effective management of small coastal systems.

To generate water quality maps, remote sensing algorithms are developed by correlating in situ water quality measurements with remotely sensed data. While manned-boat collected in situ data is suitable for satellite imagery, algorithm development using UAS data requires finer-scale measurements. To address this, a solar-powered autonomous surface vessel (ASV) equipped with water quality sensors was deployed. Operating at 3 knots, the ASV recorded data every 1.5 meters, offering high-resolution observations critical for UAS applications.

Mississippi's oyster landings have declined significantly due to poor water quality, highlighting the need for a system that provides spatially explicit water quality data. Field campaigns were conducted over oyster reefs in the Mississippi Sound, combining data from multiple platforms. A MicaSense RedEdge MX multispectral sensor on an Inspire-2 drone captured ultra-high resolution (7.5 cm) imagery, while the ASV simultaneously collected water quality data. Above-water reflectance measurements were also obtained using a spectroradiometer from a manned boat.

UAS imagery was processed into remote sensing reflectance maps using the drone’s position, orientation, and field-of-view data. To minimize sun glint, mosaics were created with a custom software tool, Batch Mosaicker. Atmospherically corrected Satellite data from Landsat 8 and 9 Operational Land Imager, and Sentinel 2A and 2B Multispectral Imager were obtained from Google Earth Engine. Algorithms to estimate suspended particulate matter, turbidity, colored dissolved organic matter, chlorophyll-a, phycocyanin, total alkalinity, partial pressure of carbon dioxide, and salinity were developed using empirical and machine learning methods.

The algorithms were applied to imagery for a time-series analysis, exploring the impact of river discharges (Wolf, Jourdan, Pearl Rivers, and the Mississippi River via the Bonnet Carré Spillway) on water quality over oyster reefs. By integrating satellite, UAS, and ASV data, this study developed robust tools for assessing water quality dynamics and their influence on ecologically sensitive areas like the Mississippi Sound. This innovative approach offers valuable insights for managing and preserving coastal ecosystems.

Valuing Forested Wetland Ecosystem Services – Belle Pointe Coastal Mitigation Bank

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In 2023, Earth Economics partnered with Delta Land Services, a regional leader in coastal forested wetland restoration activities, to value the broader benefits of their work restoring coastal wetlands.

Delta began development of the Belle Pointe Coastal Mitigation Bank (BPCMB) in 2016. The 387.6-acre Wetland Mitigation Bank was previously agricultural land, which flooded frequently, requiring regular pumping to allow for farming. Annual sugar cane burns released smoke and ash, and seasonal agrichemical treatments exacerbated local community health.

Delta restored the site to coastal bottomland hardwood and coastal cypress swamp, with additional investments to support ecosystem services and biodiversity, such as protecting wetlands important for wading birds and waterfowl, removing non-native species, and purchasing an additional 187-acre wildlife corridor to connect to a nearby wildlife management area.

Restoring wetland ecosystems improves several ecosystem services of great social, economic, and environmental value to communities. Earth Economics found that restored forested wetlands provide $3 million in benefits each year — $1,813 per person to nearby residents and students. By permanently protecting the wetlands, the bank will create $101 million (USD 2021) in ecosystem services.

Reactive Materials for Enhanced Removal of Organic Micropollutants in Constructed Wetlands

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The presence of organic micropollutants in treated wastewater threatens the aquatic environment and impacts the quality of drinking water resources. While constructed wetlands are not primarily designed to remove organic micropollutants, they have been shown to effectively eliminate some of these compounds; however, they are less efficient at removing slowly degradable compounds. To overcome this, constructed wetlands can be enhanced by using reactive materials that stimulate abiotic and biotic degradation processes. Different substrates have been evaluated to enhance micropollutant removal efficiency, promote environmental sustainability, and improve cost-effectiveness. Iron (hydro)oxides and manganese oxides have been known for their high adsorption capacity and serve as electron acceptors under anoxic conditions. This research investigated the effects of manganese oxides and iron hydroxides as amendments in mesocosm-scale constructed wetlands, examining how their interactions with water-saturated (anoxic/anaerobic) and unsaturated (aerobic) filtration beds, as well as the presence of plants, influence the removal of organic micropollutants. Experimental vertical flow constructed wetlands were fed with artificial domestic wastewater containing 31 organic micropollutants at concentrations of 10 or 50 µg/L. Results showed that constructed wetlands exhibited an overall and more effective removal of most selected compounds, ranging from 87% to 95%, under unsaturated planted conditions. Under saturated planted conditions, the overall removal rates were lower, at 61%, 63%, and 77% for the constructed wetlands with manganese oxides, sand, and iron hydroxides, respectively. Minimal differences in the overall removal effects were identified between the amendments. Iron hydroxides and manganese oxides significantly enhanced compound removal under saturated and unsaturated conditions compared to sand-based wetlands. However, under unsaturated conditions, carbamazepine, diclofenac, fipronil, fluconazole, furosemide, hydrochlorothiazide, lamotrigine, and sulfamethoxazole were not effectively removed. Prominent examples of compounds reacting under saturated and unsaturated conditions with iron hydroxides are sulfamethoxazole (reduction by Fe(II)) and fipronil. Conversely, manganese oxides considerably improved the removal of diclofenac (abiotic oxidation) and, to a lesser extent, the removal of furosemide and hydrochlorothiazide. For carbamazepine, fluconazole, and lamotrigine, only a slight enhancement (within 10%) was observed in the CWs with iron hydroxides under saturated conditions. Further research will focus on the underlying mechanism and propose appropriate stimulation methods, such as electron shuttles. Apart from removing organic micropollutants, the constructed wetlands with iron hydroxides and manganese oxides improved the removal of phosphates (91%) compared with sand-filled constructed wetlands (42%).

Quantifying Spatial and Temporal Uncertainty in Coastal Carbon Dynamics in Louisiana

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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.

Porewater Salinity Response to Acute and Chronic Climate Disturbances Across Six Basins in Coastal Louisiana

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Coastal marshes are one of the most productive ecosystems on earth and provide many important ecosystem services – such as providing habitat and breeding grounds for many species, facilitating the carbon and nitrogen cycles, and protecting coastal areas from storms and other climate disturbances. Central to the function of these marsh systems is the structure provided by important vegetation, which can be sensitive to changes in porewater salinity. Both acute (flooding, storms, and drought) and chronic (sea level rise, erosion and land loss, and temperature change) climate events impact the hydrology of the coast and thus have the potential to influence porewater dynamics within the marsh. Comparing porewater data taken from a coastwide network of coastal monitoring stations (2007-2023) to indicators of climate disturbance (river discharge, relative sea level rise, change in marsh elevation, marsh vertical accretion, rainfall, flood percentage, and temperature data), this study examines the impact of these climate events on the porewater salinity in six basins in coastal Louisiana (Calcasieu, Mermentau, Vermillion, Terrebonne, Barataria, and Mississippi Delta). Results allow for the comparison of porewater response to climate disturbances in coastal basins with contrasting characteristics in the same geographical region.

A Decade-Long Trend in Dissolved Carbon Dynamics and CO_2 Fluxes in the Lower Mississippi River

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Rising global temperatures and shifting precipitation patterns have had a substantial impact on dissolved carbon dynamics, water temperature, and river discharge in recent decades, resulting in altered carbon transport and increasing greenhouse gas emissions from rivers around the world. The Mississippi River reflects worldwide trends with changes in dissolved carbon levels and carbon dioxide (CO_2) outgassing, highlighting its evolving role in the regional and global carbon cycle. Covering over 41% of the total land surface area in the contiguous USA, the Mississippi River is the largest river system in North America. Discharging approximately 520 km^3 of freshwater annually into the Northern Gulf of Mexico (NGOM) in the recent decade, the Mississippi River (MR) contributes significantly to carbon export and coastal food chain in the NGOM. This study investigated decade-long concentrations and mass fluxes of dissolved organic carbon (DOC), dissolved inorganic carbon (DIC), and CO_2 during 2015–2024 in the Lower Mississippi River. Monthly field measurements were conducted on partial pressure of riverine CO_2 (pCO_2), water temperature, dissolved oxygen, pH, chlorophyll-a, CDOM, and turbidity in the Lower Mississippi at Baton Rouge. River water samples were collected, and DIC and DOC concentrations were analyzed. CO_2 outgassing was calculated by analyzing the CO_2 exchange between pCO_2 in water and CO_2 in the atmosphere using a gas exchange coefficient. Over the past 10 years, DIC concentration in the Mississippi ranged from 9.57 to 41 mg/l with an average of 26 ± 5 mg/l, while DOC fluctuated largely from 0.15 mg/l to 14.20 mg/l with an average of 9.10 ± 4.6 mg/l. Annually, the river delivered a large quantity of DIC (12.25 – 15.90 Tg C) and DOC (3.95 - 4.90 Tg C) from dry to wet years. The Lower Mississippi River's surface water showed a large variation in pCO_2 ranging from 518 to 5911 µatm (mean ± sdt: 1869 µatm ± 1113), indicating continuous CO_2 supersaturation. CO_2 outgassing rates in the river varied largely from 0.57 to 56 mmol C m^{-2} hr^{-1} with an average 10.28 mmol C m^{-2} hr^{-1} ± 7.68, primarily controlled by seasonal temperature and hydrology. This long-term study is critical to understanding how continuous environmental shifts, such as rising temperatures and changed river flows, affect dissolved carbon transport and CO_2 emissions in the Mississippi River. By studying these trends over a decade, we can better forecast future changes in riverine carbon dynamics, assess their consequences for the global carbon budget, and improve management measures to limit climate change's effects on freshwater systems.

Documentation of Iron Monosulfide Improves Hydric Soil Identification in the Arid Western U.S.

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Wetlands in the arid western U.S. are especially valuable for providing ecosystem services including critical habitat for rare and endangered species, water filtration and storage, and flood abatement. However, important wetland areas have remained unregulated in the arid western U.S. due to issues with wetland identification caused by gaps in the knowledge of hydric soils. The identification of hydric soils in the arid west is typically challenging due to high concentrations of salts, high pH, and low organic matter accumulation. Iron monosulfide (FeS) concentrations are an important, commonly overlooked, soil morphological feature indicative of strongly reducing soil conditions (i.e., sulfate reduction). Insoluble, black-colored FeS concentrations have been observed in arid wetlands, however, field identification has been problematic due to the lack of information about their genesis. This presentation will discuss the processes involved in the development and expression of FeS in problematic soils of arid wetlands located in California, Colorado, Nebraska, New Mexico, Utah, and Wyoming. This research has contributed to improving our understanding of the identification, formation, and distribution of FeS in wetland soils, including the recent development of a new Field Indicator of Hydric Soil (Iron Sulfide – A18), applicable nationwide.

Below- and Above-Ground Microbial Carbon and Nitrogen Cycles in Congo Basin Peatland Forests and Grazed Savannas

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In the Congo Basin's peatland ecosystems, carbon (C) and nitrogen (N) cycles are crucial for sustaining biodiversity, productivity, and greenhouse gas balance. These peatlands act as significant carbon sinks and play a key role in nutrient availability, influencing plant growth, soil fertility, and microbial activities that support ecosystem health. Microbes driving biogeochemical processes control the distribution and quantity of C and N; however, limited knowledge of the microbial mechanisms behind CH_4 and N_2O emissions — especially the poorly understood aboveground roles in these forests — hampers accurate assessments of tropical peatlands' climate change impacts. This study aimed to identify the key processes in soil and plant microbial communities that control gaseous fluxes (CH_4, N_2O, and N_2) in the tropical peatlands of the Congo Basin. In March (dry season) and November (wet season) 2024, peat samples from the soil column (0–10 cm and 10–20 cm) and plant leaf (*Raphia hookeri* (palm), *Macaranga spinosa* (tree), *Guibourtia demeusei* (tree)) samples were collected along a tropical peatland forest transect and a grazed alluvial savanna in the Congo Basin. Quantitative real-time PCR and sequencing were used to assess the abundance and structure of bacterial and archaeal communities. Additionally, functional genes associated with N cycle processes—including denitrification (*nirK*, *nirS*, *nosZI*, *nosZII*), nitrification (bacterial, archaeal, and COMAMMOX *amoA*), dissimilatory nitrate reduction to ammonium (*nrfA*), and N fixation (*nifH*) — were measured. Methane cycle-related processes, such as nitrate/nitrite-dependent anaerobic CH_4 oxidation (n-DAMO-specific 16S rRNA), methanogenesis (*mcrA*), and methanotrophy (*pmoA*), were also analyzed. Furthermore, in situ soil CH_4 and N_2O emissions, potential N_2 emissions, and physicochemical parameters were measured. Soil total C and N concentrations, including nitrate and ammonium, were higher in forests, indicating more active nutrient cycling. This was reflected in soil gas emissions, with elevated N_2O emissions from forests and high CH_4 emissions in certain forest areas associated with high soil moisture. All sites displayed low potential N_2 emissions from soil. Soil microbial communities were influenced by pH, which was notably higher in savannas (around 5) than in forests (around 3.5). Preliminary gene analysis showed high abundances of archaeal nitrifiers and denitrifiers in forest soil, while bacterial nitrifiers were entirely absent. Fungal denitrifiers were abundant in both ecosystems. Regarding aboveground microbial activity, the most active community was found on the leaves of *Raphia hookeri*, while relatively the smallest microbial activity in nutrient cycles was observed on the leaves of *Guibourtia demeusei*.

Dynamics of N_2O Emissions from Amazonian Tropical Peat Forest and Partitioning N-Processes Using ^{15}N Isotopes

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Tropical peatlands are crucial for global nitrogen (N) cycling because they store large amounts of carbon and N. This study, conducted in November 2023, investigated the dynamics of N_2O emissions from Amazonian peatland forests in Peru. It focused specifically on two peatland forest sites in Iquitos: the *Quistococha* and *Zungarococha* forests. We conducted static chamber gas measurements to assess soil greenhouse gas (GHG) fluxes. Additionally, we took soil samples for physical and chemical properties and soil microbiome (DNA & RNA). In order to investigate the source processes for N_2O production and consumption, we applied ^{15}N isotopes as tracers in soil. Our results indicate that both forests exhibited different trends in soil GHG fluxes and N substrates. Quistococha had higher levels of soil nitrate and ammonium compared to Zungarococha, which correlated with increased N_2O emissions from Quistococha. A similar pattern was observed for CO_2 emissions, with Quistococha producing higher levels than Zungarococha. Contrastingly, Zungarococha had higher soil moisture levels, which aligned with its lower N_2O emissions. This forest also showed greater soil N_2 emissions, suggesting the potential for complete denitrification. However, this site was also a significant source of CH_4 emissions due to its higher soil moisture, which supports methanogenic activity. Overall, the two sites demonstrated distinct behaviors: Quistococha was a source of N_2O and CO_2, influenced by intermediate soil moisture. Zungarococha emitted higher levels of CH_4 and N_2 due to its high soil moisture conditions. The application of ^{15}N tracers increased soil N_2O emissions only in Quistococha, while we did not observe a significant increase in Zungarococha, suggesting that complete denitrification may be the dominant process there. This is further supported by ^{15}N isotopic mapping, correlating N_2O emissions with their source processes. The site preference values fall within the denitrification zone at Zungarococha and the nitrification zone, with some hybrid processes in Quistococha. The microbiome analyses show similar results, with denitrifying microbes dominating the Zungarococha soil and nitrifying microbes dominating the Quistococha soil.

Marsh Salinity and Water Level Dynamics Between the Mississippi River Levee System and Adjacent Coastal Marshes

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In recent years there have been significant environmental challenges to Southeastern Louisiana, including marsh browning, drought, and sea-level changes. This project seeks to examine salinity and hydrological dynamics across a marsh system spanning Barataria Bay to the Mississippi River. The primary focus is to understand how water levels, salinity fluctuations, and salinity gradients influence vegetation health and distribution. To achieve this, we plan to deploy 15 monitoring devices (Solinst Leveloggers and Sender 5 units) throughout Barataria Bay to measure temperature, water level, and groundwater salinity. These measurements will allow us to analyze pore water and surface water salinity. By integrating our collected data with information from Coastal Reference Monitoring System (CRMS) stations, which currently track pore water, surface water, and vegetation characteristics, we strive to develop a more comprehensive understanding of marsh hydrodynamics. Along with data collection, we will conduct a conceptual analysis of vegetative health in the areas surrounding our installations to further understand the effects on vegetation. We aim to develop a more comprehensive understanding of marsh hydrodynamics and surface-groundwater interactions. The analysis of water level data will provide insights into water availability during wet and dry periods, allowing us to solve challenges related to flooding, storm surges, and drought. Additionally, this data will shed light on its effects on vegetation and provide ideas for improved habitat control and management. By combining water level and salinity measurements, this project will contribute to a better understanding of freshwater, brackish, and saltwater environments.

Tracking Diurnal and Episodic Hypoxia and Impacts to Nutrient Cycling in a Shallow, Well-Mixed, Subtropical Estuary.

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In shallow, well-mixed and eutrophic estuaries, dissolved oxygen (DO) can cycle between anoxia and supersaturation over diurnal periods. This diel hypoxia contributes to feedback loops sustaining degraded water and sediment quality. Organic-rich sediments with high sediment oxygen demand contribute to hypoxia and vertical gradients for dissolved oxygen with lowest concentrations at the sediment water interface, even when the water column is well-mixed. Vertical gradients and highly variable concentrations of DO complicate efforts to quantify the extent and duration of hypoxia in these shallow, well-mixed systems. We deployed a network of >80 continuous monitoring stations to track concentrations of DO in the benthic boundary layer throughout the Indian River and Banana River Lagoons, Florida. This approach has captured diel and episodic hypoxic events that were otherwise not detected. During summer months, diel hypoxia throughout Banana River Lagoon contributes towards a decrease in nutrient removal efficiency and the assimilative capacity of this system. Combining data for sediment nutrient cycling under differing redox conditions with this high-resolution data for dissolved oxygen, we are better able to quantify feedback loops between eutrophication and hypoxia. These feedback mechanisms can lead to more frequent hypoxia even when nutrient loading remains unchanged and can contribute towards the decoupling of algae blooms from external nutrient loading.

Coastal Louisiana System-Wide Water Quality Characterization

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Through the Louisiana Coastal Protection and Restoration Authority's System Wide Assessment and Monitoring Program, water quality monitoring and nutrient sampling has been implemented coast-wide. The SWAMP water quality network leverages existing long-term water quality programs (Louisiana Department of Environmental Quality, Louisiana Department of Wildlife & Fisheries, and the United States Geological Survey) and includes a total of 120 discrete monthly water quality stations across Louisiana's coast, in addition to data collection platforms with continuous measurements. Water quality parameters include in situ measurements of turbidity, dissolved oxygen, water temperature, specific conductance and salinity as well as discrete water samples for laboratory analysis of nitrogen, phosphorus, silica, chlorophyll a, total suspended solids and volatile suspended solids. The repeated System Wide Assessment and Monitoring Program coast-wide water quality measurements are analyzed to document baseline conditions and characterize the variability in water quality constituent levels at multiple spatial and temporal scales. Relationships with bathymetry, abiotic changes, and the detection of changes that may result from a variety of sources, including large-scale restoration and protection projects, environmental disturbances, and other major drivers that impact the system, are also explored.

Enhancing the Design of Constructed Wetlands Along the Missouri River to Improve Nutrient Removal

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The U.S. Army Corps of Engineers (USACE) and local partners build and maintain a vast network of levees on U.S. rivers, including the lower Missouri. When levees are repaired, maintained, or realigned, significant amounts of fill material are collected locally from “borrow pits”. In some cases, these borrow pits have been converted to wetlands to provide habitat for wetland plants and animals. At one site, an agricultural drainage ditch was re-routed through a created wetland to improve water quality (primarily through nutrient removal) before the ditch discharges into the Missouri River. Currently, however, these wetlands are not being designed specifically for nutrient retention, and their water quality benefits have not been quantified. The goal of this research is to determine the potential water quality benefits of routing agricultural drainage through constructed wetlands in the lower Missouri River basin and help improve the design of these nature-based solutions. We monitored one year of water levels and water quality in the constructed wetland receiving agricultural runoff to quantify nutrient removal. We are using these data to develop watershed and wetland models to quantify long term performance, test different design alternatives, and provide recommendations for optimizing nutrient removal in these wetlands. Preliminary results show that the wetland is effectively retaining nitrogen and phosphorus, but wetland hydrology and nutrient removal are highly affected by Missouri River water level. The results of this work will help USACE prioritize locations for constructed wetlands and inform their design to enhance water quality benefits.

Sea Level Rise Alters Salt Marshes' Carbon Storage Capacity

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Accelerating sea level rise (SLR) is reshaping coastal salt marshes, vital ecosystems for long-term carbon sequestration. The Great Sippewissett Marsh in Cape Cod, Massachusetts, experiences an SLR rate nearly twice the global average, making it an ideal model to study SLR impacts on marsh vegetation and below-ground carbon storage in Northeast U.S. salt marshes. As SLR progresses, *Spartina alterniflora*, a low marsh species, increasingly encroaches upon high marsh zones historically dominated by *Spartina patens*. This shift creates a transition zone where high marsh vegetation is progressively supplanted by low marsh species. Although this vegetation replacement is evident, its implications for long-term carbon storage remain unclear.

This study assessed the carbon storage capacity along a transect extending from the low marsh across the transition zone to the high marsh. Below-ground biomass and soil organic carbon (SOC), as well as sediment accretion rates, were measured in replicated 30 cm sediment cores collected from each marsh zone. Our findings demonstrate that high marsh zones retain more stable sedimentary carbon than low marsh zones. Transition zone profiles of SOC revealed distinct stratification, with an upper layer (0-15cm), newly colonized by *S. alterniflora* resembling the low marsh, which had a lower SOC content. In contrast, the lower layer (15-30cm) retained the former high marsh traits, including higher SOC content. Estimates of the carbon burial rates varied significantly, with high marsh zones sequestering 116 gC/m^2/yr, considerably exceeding the 76 gC/m^2/yr of the low marsh.

The significant carbon storage gap between high and low marsh zones suggests that transition zones act less as intermediaries and more as discrete zones, decreasing carbon storage efficiency as they shift toward low marsh characteristics. These findings reveal a decline in carbon storage capacity as high marsh converts to low marsh under SLR, emphasizing the importance of considering plant zonation shifts when assessing salt marsh resilience and their role in climate mitigation amid accelerating sea level rise.

Dissolved Organic Matter Optical Properties in Treatment Wetlands: Associations with Plants, Soils, and Treatment Performance

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Dissolved organic matter (DOM) is increasingly recognized as an influential constituent in a wide variety of wetland biogeochemical processes. In south Florida, USA, the Everglades Stormwater Treatment Areas (STAs) are large treatment wetlands that remove phosphorus (P) from agricultural and urban runoff to protect the oligotrophic Everglades ecosystem. As is typical for wetlands, bioavailable P species are readily and effectively retained by the STAs. P exiting the STAs (total P ~10-25 ug/L) is primarily associated with DOM (operationally, dissolved organic P, DOP) and particles (particulate P, PP), which can be recalcitrant. This increases the difficulty of achieving the discharge P concentrations required by operational permits. DOM quantity (as dissolved organic carbon, DOC) and character (as optical properties, including specific ultraviolet absorbance at 254 nm, SUVA, and spectral slope of absorbance between 275-295 nm, SS_{275}), and DOP concentrations were measured in two mesocosm-scale experiments and a full-scale STA (STA-3/4), to understand process limitations on P reduction from surface waters. In these studies, two main ecosystem types were represented at each scale: organic, muck soil colonized by submerged macrophytes, and calcareous limerock substrate colonized abundantly by periphyton. Differences in DOM character and DOP concentration between ecosystem types may occur from: 1) enzymatic hydrolysis of DOM by periphyton, leading to more thorough depletion of P from the DOM pool; 2) differential internal DOM/DOP generation; and 3) photolysis partially impaired by DOM compounds with high UV absorbance, associated with certain sources. At both mesocosm and field scale, the limerock/periphyton ecosystem type was associated with lower DOP concentrations and optical properties of the surface water indicative of smaller, less-aromatic DOM molecules (lower SUVA, higher SS_{275}) than the muck/macrophyte systems. Notably, P-acquiring enzyme activity was generally elevated in limerock/periphyton systems. DOC concentrations did not differ between ecosystem types, so the calculated DOM C:P ratio (DOC/DOP) was higher in the limerock/periphyton systems, suggesting that the DOM pool was more P-depleted. The mesocosm studies included additional treatment groups involving muck soil under a surficial limerock gravel 'cap', with and without macrophytes. These groups tended to have intermediate DOP concentration and DOM optical properties between the limerock/periphyton and muck/macrophyte end-members. We hypothesize that muck/macrophyte ecosystems generate DOM with structural properties that reduce the bioavailability of the associated DOP. Conversely, the smaller, simpler and more P-depleted DOM in limerock/periphyton systems was associated with lower DOP concentrations. These findings provide insight into the biogeochemical process-bases for achieving low P concentrations often observed in limerock/periphyton systems in the Everglades STAs.

Assessing Aquatic Macroinvertebrate Communities in Wetland Reserve Easements in the Mississippi Alluvial Valley

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Nutrient and sediment runoff into wetlands affects water quality and biota and some taxa are particularly sensitive to stressors (e.g., nutrient enrichment). Aquatic macroinvertebrate communities, for example, may be especially impacted in watersheds with predominately agriculture land use, such as the Mississippi Alluvial Valley. The Agricultural Conservation Easement Program - Wetland Reserve Easements, a conservation program administered by the Natural Resources Conservation Service, aims to restore wetlands and mitigate loss. Thus, to assess restoration success, we examined abundance and diversity of aquatic macroinvertebrate communities of Wetland Reserve Easements in Mississippi and Louisiana. We sampled macroinvertebrates from 36 sites (4 crop fields, 5 historic wetlands, and 27 Wetlanchd Reserve Easements) once between March and May (i.e., spring) 2024 and from 19 sites (3 crop fields, 1 historic wetland, 15 Wetland Reserve Easements) once in August (i.e., late summer) 2024. Identification of macroinvertebrates collectively totaled 12,546 individuals and 22 unique taxa. Shannon's Diversity and Simpson's Diversity Indices were used to estimate diversity in these aquatic systems. We found no differences between historic wetland and Wetland Reserve Easement sites ($P > 0.05$), but there were differences between crop and historic wetland sites, and crop and Wetland Reserve Easement sites. No differences were detected in late summer or between different landcover types (emergent wetlands and bottomland hardwood forests). To further investigate differences in invertebrate abundance and richness, we modeled the potential impact of water quality parameters and site type. Water depth had the greatest association with both invertebrate abundance and richness in spring, while water temperature had the greatest influence on abundance in the late summer season. We also modeled community composition between site types, and crop sites were most dissimilar from Wetland Reserve Easement and historic wetland sites. Invertebrate assemblages in spring differed by site type and by landcover types. We found no effect between site types and invertebrate communities for the late summer sampling period. Water depth appears to be a primary driver of abundance and richness of aquatic macroinvertebrates. Additionally, landcover types may influence invertebrate assemblages, where, for example, we found the order Sphaeriida to comprise 24% of invertebrates found in bottomland hardwood forests and only 2% of invertebrates in emergent wetlands. Our results indicate similarities in abundance and diversity of aquatic invertebrates between historic wetlands and Wetland Reserve Easement sites, indicating the successful establishment of macroinvertebrate communities following restoration.

Lateral Carbon Flux from a Saltmarsh: Implications for Coastal Acidification and Carbon Budget

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Saltmarshes are biogeochemical hotspots storing carbon in sediments and in the ocean following lateral carbon export. This transfer of carbon and alkalinity from the land to the ocean represents an important process in the global carbon cycle. Here, we measure lateral carbon fluxes – import and export of carbon via tidal channels – in a saltmarsh in the Barataria Basin in Louisiana and evaluate the impact factors on lateral carbon fluxes. We hypothesized that porewater carbon export is an important process for blue carbon loss which contributes significantly to lateral carbon flux. To test this hypothesis, environmental parameters such as salinity, temperature, pH, dissolved oxygen, fluorescent dissolved organic matter, as well as carbon concentrations, including dissolved inorganic carbon (DIC), dissolved organic carbon (DOC), and total alkalinity (TA) concentrations were measured since 2021 for lateral carbon flux calculations. Radon concentrations were measured continuously for over 24 hours during five field trips to evaluate porewater carbon export. Our preliminary results showed that porewater carbon exports contributed significantly to lateral carbon fluxes. Lateral carbon fluxes mirrored the water flux pattern, and positive (ebb-directed) lateral carbon fluxes were mostly driven by higher carbon concentrations during ebb flow associated with porewater drainage versus flood flow. Lateral flux of DIC was generally higher than TA flux, which has significant implications for coastal acidification and carbon budget. This exported TA represents a long-term carbon sink in the ocean while the ratio of TA/DIC impacts the carbonate chemistry of coastal waters.

Surface DOC Fuels Belowground Respiration in a Neotropical Peatland

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Tropical peatlands are vital to global carbon (C) cycling, yet the factors influencing carbon dioxide (CO_2) and methane (CH_4) emissions, particularly from below the surface, remain poorly understood. This study investigated the sources and processes governing C emissions from deep layers in a Neotropical peatland along Panama’s Caribbean coast. We hypothesized that: 1) surface-derived organic matter transported down through the soil profile is the primary C source for respiration at depth, and 2) high lignin content results in hydrogenotrophic methanogenesis as the predominant CH_4 production pathway throughout the profile.

To test these hypotheses, we used radiocarbon isotopes to determine whether deep CO_2 and CH_4 production originates from modern organic material or ancient peat, and stable C isotopes to identify the dominant CH_4 production pathway. Peat organic chemistry was analyzed using 13^{13}13C solid-state nuclear magnetic resonance spectroscopy (NMR). Our findings reveal that deep peat respiration products shared radiocarbon signatures more similar to surface dissolved organic carbon (DOC) than to deep solid peat, despite stable peat chemistry from surface to deeper layers. Radiocarbon dating indicated that deep peat at the study sites ranged from 1200 to 1800 years BP. These results suggest that surface-derived C, likely transported as DOC, is the primary source of gas production at depth.

Carbohydrate content did not vary significantly with depth, whereas lignin—the dominant compound, comprising 55-70% of C—tended to increase. This pattern suggests preferential retention of lignin rather than selective decomposition of carbohydrates. Stable isotope signatures of the respiration products confirmed that hydrogenotrophic methanogenesis, rather than acetoclastic methanogenesis, is the primary pathway for CH_4 production across the peat profile. These findings highlight that even typically decomposition-prone compounds, such as carbohydrates, are preserved in these deep tropical peat layers, underscoring the role of anaerobic, waterlogged conditions in conserving C within tropical peatlands.

Redox Biogeochemistry at High Temporal Resolution in a Freshwater Delta

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River deltas are hydrologically complex systems that experience changes in water level with river stage, tides, wind, and other forcings. Variable water levels generate heterogeneity in soil redox conditions over space and time, affecting microbial respiration, nutrient solubility, and greenhouse gas fluxes. This work explores how redox potential and water chemistry vary with hydrology in Wax Lake Delta (WLD), an actively growing freshwater delta in coastal Louisiana. Environmental sensors measuring water level, pH, conductivity, temperature, soil moisture, and soil redox potential at 15 min intervals were installed along two elevation transects spanning supratidal to subtidal zones on proximal and distal portions of Mike Island within WLD. Soil pore water was collected and analyzed for pH, conductivity, oxidation-reduction potential, base cations, nutrients, dissolved organic and inorganic carbon, major anions, and minor and trace elements. Water depth relative to the land surface varied with seasons and tides, and tidal variation (~30-40 cm) was more pronounced near the distal portion of the island. Soil redox potential was persistently reducing at all depths in subtidal soils and in deeper (>20 cm) supra- and intertidal soils. In shallow supra- and intertidal soils, redox potential fluctuated with the tides when the water table was near the surface or became persistently oxidizing during the summer as water tables fell. Dissolved Fe concentrations were high (up to 1.3 mmol L^{-1}) and strongly correlated with redox potential ($r = -0.75$, $p < 0.001$), indicating that Fe cycling may buffer redox conditions in this system. Water from shallow soils and/or soils in supra- and high intertidal zones were more oxidizing and had higher pH and higher concentrations of SO_4^{2-}, NO_3^-, and select trace elements. Water from deeper soils and/or soils from low intertidal and subtidal zones tended to be more reducing, acidic, and saline with higher concentrations of base cations, phosphate, Si, DIC, DOC, and reduced metals (Fe, Mn). Dissolved phosphate, As, and Si strongly correlate with dissolved Fe, indicating the potential for Fe oxidation and reduction reactions to regulate their solubility. These results indicate that redox conditions in WLD were more variable near the soil surface and at higher elevation sites that are periodically unsaturated, and that redox potential and water chemistry respond rapidly to changes in water level. Supratidal and high intertidal zones may represent areas of dynamic biogeochemical transformation driven by fluctuating redox conditions.

An Analysis of Long-Term Everglades Stormwater Treatment Areas Performance Using Structural Equation Models

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Phosphorus (P) retention in Stormwater Treatment Areas (STAs) is influenced by various external and internal variables, making it necessary to employ multivariate techniques to understand the complex relationships among them. This study used 14 years of monthly data from four STAs (STA-1E, -1W, -2, and -3/4) to achieve the objective of exploring the factors influencing long-term STA performance and function related to P retention. Structural Equation Model (SEM) with predictive variables of inflow total P (TP), total nitrogen (TN) and calcium (Ca) concentration, hydraulic loading rate (HLR), and water pH and temperature was applied to evaluate similarities and differences among individual STA performance. The SEM results suggested an improvement in the operational performance of STAs over time. All models explained a substantial portion of the variation in retention rate of TP ($R^2 > 0.63$), but only a small portion of the variation in outflow TP concentration ($R^2 < 0.24$). Notable differences were observed among the four STAs. The relationship between inflow and outflow TP concentration differed among the STAs. Furthermore, inflow TN concentration was positively correlated with the TP retention rate in STA-1W, and outflow TP concentration in STA-2, while the co-precipitation of P with Ca likely played a critical role in STA-3/4. These findings highlight the complexity of P removal in STAs and emphasize the need for site-specific management strategies. Further studies should consider incorporating long-term observation of key vegetation and soil variables (e.g. vegetation coverage and soil TP content, etc.) to inform more effective approaches to optimize P removal and enhance the performance of STAs in water treatment and ecosystem restoration efforts.

Measurement of Greenhouse Gas Flux Across a Hydrologic Gradient in Louisiana Coastal Freshwater Forested Wetlands

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Wetlands cover 3 to 8% of the global land surface but account for more than 20% of global methane emissions and store up to half of terrestrial soil carbon. Wetland carbon pools and greenhouse gas (GHG) fluxes are impacted by anthropogenic activities such as changes to hydrology and sediment transport. This research focuses on quantifying GHG emissions from freshwater forested wetlands (FFW) across a gradient from healthy to degrading to emergent wetlands or open water. By quantifying gas emissions from forested wetlands across a hydrologic and vegetation gradient in FFW, this study aims to provide critical data for the Coastal Master Plan (CMP) Integrated Compartment Model, which is the primary analytical tool for assessing potential CMP projects. Twelve FFW study sites were chosen at CRMS stations around Lake Maurepas, comprising four healthy wetlands, four degrading wetlands, and four transitioning to marsh or open water (degraded). Methane, carbon dioxide and nitrous oxide emissions were measured at each of the 12 sites using static chambers. We deployed five inverted 3.5-gallon buckets on sleeve bases positioned on floating Styrofoam rings, depending on water levels. Gas samples of chamber headspace were collected at intervals of 0, 15 minutes, 30 minutes, one hour, and two hours after deployment. Gas concentrations were measured using a gas chromatograph. Methane flux averaged 0.72±1.51, 1.82±1.83 and 3.41±2.43 mg/m^2/hr from degraded, degrading and healthy forested wetlands, respectively. Methane flux from healthy wetlands was significantly higher than from degraded wetlands ($F=2, 36$; $p=0.007$) and was positively correlated with percent time flooded ($r^2=0.482$). Carbon dioxide flux averaged 47.59±24.26, 54.96±19.12, and 43.28±21.10 mg/m^2/hr from degraded, degrading and healthy forested wetlands, respectively, and there was not a significantly difference detected among wetlands ($F=2, 20$; $p=0.513$). Nitrous oxide flux was negligible (>0.01 mg/m^2/hr) at all sites.

Water Chemistry in Isolated Pools along an Urban Ephemeral Stream in South Central Texas

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Ephemeral streams flow following precipitation and recede in < 24-48 hours. In this study, isolated pools (n = 12) in the upper section of Leon Creek in South Central Texas were sampled along 1.5 km of an ephemeral stream in San Antonio for water chemistry. Drought periods are common in the study area and surface water is limited to isolated pools. Sampling occurred weekly (n = 107) from June 2021 to June 2023 with pools exhibiting varying hydroperiods and surface area. The objectives of the study were to monitor weekly changes in water quality, chlorophyll concentrations, and hydroperiods in the isolated pools weekly in a subtropical subhumid climate. Variables measured in each pool, if water was present, included temperature, pH, conductivity, turbidity, dissolved oxygen, suspended solids, organic carbon, total nitrogen, and oxidation-reduction potential. Chlorophyll a and phycocyanin concentrations were measured as surrogates of algae and cyanobacteria biomass. Sediment organic matter (%) and canopy cover (%) were also measured at each pool. During the study, flow was documented 16.8% (n = 18) of the time when all pools connected. The hydroperiods of pools varied from < 2 weeks to 11 months in 9 pools, while 3 pools retained water over the duration of the study. Multiple regression was used to select the significant variables ($P < 0.05$) that best predicted chlorophyll a, phycocyanin, hydroperiod, and seasonal differences among pools. The best predictors ($F = 12.6$, df = 5, $P < 0.001$; $r2 = 0.60$) of chlorophyll a concentrations were pH, NTU, organic carbon, total nitrogen, and precipitation. Phycocyanin was best predicted ($F = 14.6$, df = 3, $P < 0.001$; $r2 = 0.49$) over the study period by pH, organic carbon, and precipitation. Pool hydroperiod was best predicted ($F = 13.3$, df = 6, $P < 0.001$; $r2 = 0.66$) by season, pool, temperature, ORP, sediment organic matter, and mean depth. Seasonal differences among pools were associated ($F = 23.7$, df = 6, $P <0.001$; $r2 = 0.78$) with temperature, pH, conductivity, dissolved oxygen, ORP, canopy cover, and precipitation. Non-metric multiple-dimensional scaling (NMS) resulted in a 2-dimensional model with axis 1 and 2 accounting for 0.80 and 0.16 % of the variation. Overall, the pools exhibited distinct clusters from each other. Area (m2) and mean depth (m) were positively associated with longer pool hydroperiod. Pools with canopy cover < 5% were positively associated with chlorophyll a, phycocyanin, dissolved oxygen, and a pH > 8.5. Pools off the main creek channel < 0.5 m in depth were associated with higher sediment organic matter, organic carbon, total nitrogen, and lower ORP. The pools in this study exhibit cyclic but variable changes in water quality. The pools experience short periods of homogenous water quality and low chlorophyll concentrations during flow, but once flow and water levels recede, water quality changes and varies among pools until the next flow event which can be as long as 5-6 months.

Denitrification and Microbial Processes in Dredge Material Created Wetlands

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Louisiana's coastal wetlands are rapidly disappearing due to a combination of subsidence, sea level rise, and lack of sediment input. These marshes provide many valuable ecosystem services, including improvement of water quality via nitrate removal, where soil microbes convert bioavailable NO3 to gaseous forms under anaerobic conditions. Artificial marsh creation is one restoration strategy being used to combat these losses. As a relatively new strategy, little is known about the long-term success of created marshes in terms of the trajectory of ecosystem services. This study investigated the impacts of marsh creation on biogeochemical cycling in a brackish marsh on the north shore of the Lake Pontchartrain estuary in Lacombe, Louisiana. Cores were collected from two types of created marsh: a confined marsh surrounded by containment dikes and an unconfined marsh where dredged sediment was allowed to flow freely. An adjacent natural marsh was used as a control. Samples were also analyzed for general soil characteristics, including bulk density, moisture content, organic matter, total N, total C, total P, inorganic P, and microbial biomass N. Intact 10 cm cores underwent a seven-day incubation after the water column was spiked to 2 mg L-1 N to measure the nitrate removal rate. The denitrification rate was not found to be significantly different between the confined marsh (43.7±15.2 mg N m-2 d-1), unconfined marsh (53.9±19 mg N m-2 d-1), and natural marsh (65.0±39.6 mg N m-2 d-1). Additionally, there was no significant difference found in important indicators of biogeochemical cycling, including organic matter, total carbon, and microbial biomass N, between the confined and natural marshes, although all were lower in the unconfined created marsh. These results indicate that the water quality function of newly created marshes is quick to develop, despite the longer timeframe necessary for the accumulation of organic carbon. Overall, dredge material created marshes appear to be as effective at nitrate removal as their natural counterparts, making this a viable restoration strategy for mitigating water quality concerns.

Typha Seedling Growth Models Provide Improved Assessment of Treatment Wetland Performance Limitations

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A novel bioassay technique shows promise for assessing the contribution of soil legacy nutrients to wetland water quality. An ex-situ assessment based on plant growth responses better explained variation of phosphorus removal performance among several full-scale treatment wetlands within the Everglades Stormwater Treatment Area (STA) network compared to traditional soil parameters (soil TP). Rather than using chemical extractions to characterize plant-available P or other soil constituents individually, the growth response of *Typha* seedlings under controlled conditions was used to compare soils.

Typha growth metrics, including leaf length, biomass dry weight, tissue P content and biomass P, increased with soil fertility (P, N, micronutrients, organic matter content) over a range of wetland soils. Expected positive correlations were observed between soil P and *Typha* tissue P. When air-dried leaves from the bioassay *Typha* plants were submerged in low-nutrient surface water, a substantial portion of the P mass in dried leaf tissues was readily lost through leaching under dark laboratory conditions: 18-34% from live leaves and 19-41% from standing dead leaves was leached within 24 hours. The mass of P lost through leaching and the resulting dissolved organic P (DOP) concentration in the leachate also increased with tissue P and were therefore proportional to soil fertility.

Typha seedling growth was well-described by a four-parameter logistic model, and the assayed soils supported a range of modeled growth-rate coefficients. Water column P concentration data from the field-scale systems from which the soils were obtained were consistent with several growth response metrics, in particular with modeled growth-rate coefficients, supporting the hypothesis that the internal phosphorus loading rate (iPLR) via plant-mediated translocation of wetland soil P to the water column is an important factor affecting outflow P concentrations in the STAs. Further, iPLR may be influenced by multiple soil factors that are best represented by an integrated biological assessment of soil nutrient availability. The technique shows promise for identifying soil conditions with increased potential for P return cycling (iPLR) to the water column, which for STAs can reduce treatment efficiency.

When and Where can Coastal Wetland Restoration Increase Carbon Sequestration as a Natural Climate Solution?

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Coastal wetlands are hotspots of carbon sequestration, and their conservation and restoration can help to mitigate climate change. However, there remains uncertainty on when and where coastal wetland restoration can most effectively act as Natural Climate Solutions (NCS), leading to net cooling impacts. Here, we review the fundamental requirements for coastal wetland restoration to benefit climate and discuss key uncertainties. To be effective as NCS, coastal wetland restoration projects will lead to net cooling benefits that would not occur without action (additionality), will be implementable (feasibility), and will remain over management-relevant timeframes (permanence). We stress that a system-wide approach may be necessary, rather than basing cooling benefits only on changes that occur within project boundaries, to address uncertainties in additionality and permanence with coastal wetland landscape dynamics. Due to the need for NCS over the next few decades, we also stress that methane responses may be necessary to include in coastal wetland restoration planning and monitoring. We summarize the minimum data required to make a binary decision on whether there is a net cooling benefit from a management action, noting that these data are more readily available than the data required to quantify the magnitude of cooling benefits for carbon crediting purposes. To illustrate these points, we compare restoration outcomes in two distinct settings, one with large amounts of data (San Francisco Bay-Delta, California, USA) and one without data (St. Johns River, Florida, USA). By focusing on the minimum data required to support coastal wetland restoration as NCS, actions can be implemented at the scale required to significantly contribute to addressing the current climate crisis.

Soil Amendments to Reduce Phosphorus Leaching from Biosolids-Impacted Soils in the St. Johns River Basin

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Any biosolids that can be diverted from landfill/incineration and beneficially-reused via land application is a net benefit to society. However, preserving surface and groundwater quality is of paramount importance. In the case of many contaminants and contaminated environments, soil amendments can be applied to reduce the mobility and bioavailability of the contaminant. Recent work has reported an increase in downstream phosphorus (P) correlated in time with increasing biosolids additions within the upper St. Johns River basin. Here, we investigate the ability of a suite of potential soil amendments to reduce P leaching from high-P, high-Ca "legacy" soil with a history of biosolids application from a rangeland within the St. Johns River basin. Candidate sorbents, including aluminum (Al), calcium (Ca), and iron (Fe) DWTRs (Drinking Water Treatment Residuals), pine biochar and a commercial reference product (CRP; a blend of several different chemical components), were selected based on preliminary research and a review of performance and practical concerns related to the usage of these materials. This investigation includes consideration of two potential methods of amendment application: permeable reactive barrier (PRB), where the amendment is applied in a layer beneath the soil to be treated and "Add/Mix", where the amendment is mixed into the soil. Results to be reported include those from two different column studies. In Column Study 1, P leaching is examined in high-P, high Ca soil amended with a fresh biosolids addition but also with sorbents in both PRB and Add/Mix configurations. In Column Study 2, P leaching is again examined in high-P, high Ca soil but without fresh biosolids addition, using a larger volume of leachate intended to remove more P from soil columns, and with unimpacted (relatively low-P, low-Ca) soil treatments for comparison.

Are Wetlands a Carbon Sink or Source? – From Microbes to the Globe

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Wetlands play a crucial role as global CO_2 sinks due to their high primary productivity and low decomposition rates. However, they are also significant sources of CH_4, a greenhouse gas with a radiative forcing 25 times greater than that of CO_2 on a molar basis. The net carbon balance of wetlands — whether they act as a sink or a source—is determined by the interplay between these opposing processes, which are strongly influenced by water level fluctuations. Despite their importance, the mechanisms governing these processes across different spatial and temporal scales remain poorly understood.

In this study, we quantified CO_2 and CH_4 fluxes in a freshwater marsh in Korea using an eddy covariance flux tower. To analyze these fluxes, we employed two complementary approaches. First, we examined microbial community structure and abundance through high-throughput sequencing and real-time qPCR, using these data to model soil organic carbon decomposition. Second, we developed a model to simulate CO_2 and CH_4 fluxes based on the CLM-FATES framework. Additionally, we constructed a machine learning-based model incorporating hyperspectral data and solar radiation to successfully simulate gross primary productivity. Our annual assessment revealed that the marsh functions as a net carbon sink, sequestering approximately 450 g CO_2-eq m^{-2} yr^{-1}, even when CH_4 emissions are accounted for.

Leveraging Watershed Wetlands to Optimize Phosphorus Management Strategies in Lake Erie Basin

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Wetlands offer a natural solution to mitigate nutrient loading in water bodies such as Lake Erie, where excessive phosphorus (P) drives harmful algal blooms (HABs). Constructed and restored watershed wetlands play a critical role in reducing nutrient loads, but their effectiveness can vary based on soil characteristics, hydrology, vegetation, and management practices. To optimize P retention, this study combines three years of field monitoring and mesocosm experimentation to develop and evaluate adaptive nutrient retention strategies based on adjusting hydroperiods, vegetation management, and amendment usage. Across both field and mesocosm settings, results show a consistent reduction of dissolved P concentrations by >50% from influent to effluent waters, with removal efficiency improving with increased hydraulic residence time. Mesocosm experiments demonstrate that varying hydraulic loading rates and hydropatterns can increase P removal efficiency by up to 37%, nearly tripling mass of P retained compared to standard, static pumping regimes. Release of P through natural senescence or the harvest of vegetation at the end of the growing season was minimal (5-7x less) compared to the amount retained by the mesocosm system during a single pumping event. At the demonstration site, wetland soils have acted as a sink for phosphorus. Spatial and temporal variability in P storage is linked to inundation patterns and landscape gradients, highlighting the interplay between hydrologic dynamics and ecological structure. Current efforts are concentrated on analyzing the results of scaled P-sequestering technologies deployed in strategically vital areas of demonstration site, aiming to extend wetland lifespan and optimize P capture and permanent removal. These findings demonstrate a scalable approach to long-term monitoring and adaptive management that optimizes nutrient retention in watershed wetlands, improving regional water quality and mitigating HABs in Lake Erie basin.

Removal and Retention of Copper and Zinc in a Constructed Wetland Over 20 Years

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The A-01 constructed wetland treatment system (CWTS) was designed to remove metals (primarily copper) from the effluent of the A-01 National Pollution Discharge Elimination System (NPDES) outfall at the Savannah River Site, Aiken, SC. This research investigated metal removal, distribution and retention in the A-01 CWTS over a period of 20 years. The findings are important for ensuring continued metal sequestration in the A-01 CWTS over time, providing management guidance for constructed wetlands, and investigating changes in metal remediation effectiveness as a wetland ages. During 20 years of operation, systematic water and sediment sampling validated the wetlands' performance. After passage through the treatment cells, Cu concentrations were well below permit limits during all years of operation, often falling below 10 µg L^{-1}. Cu removal has been consistent over time, averaging about 80% despite large changes in influent Cu concentrations. Copper and Zn were rapidly removed from the water and held in the sediments shortly after the water entered the treatment wetland. Average removal of Zn from water by the wetland system was 52 and 65% in 2004 and 2020, respectively.

Generally, the highest concentrations of Cu and Zn were found in the sediment from the first cell in each pair of cells suggesting that most of the Cu and Zn in the A-01 effluent were bound to the sediment quickly. Diffusive gradients in thin films (DGT) measurements of Cu and Zn in the sediments were much lower than bulk sediment concentrations. These results suggest that most of the Cu and Zn in the A-01 CWTS sediments were not bioavailable, hence not toxic to aquatic organisms, as a likely consequence of adsorption to sediment particles and complexation with organic and inorganic substances.

Mangrove Ecosystem Response to a Historic Snow Event on a Coastal Louisiana Barrier Island

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The coastal wetland landscape is shifting across Louisiana due to subsidence, hydrologic changes, and climate-induced warming. With respect to mangroves (*Avicennia germinans*), the frequency and severity of winter freeze events has decreased in recent decades allowing for their expansion into saline marshes. However, coastal Louisiana is still susceptible to winter storm events that can reduce mangrove extent and expansion. This was made apparent on January 22nd, 2025 when a historic snowfall event blanketed coastal Louisiana, followed by sub-zero air temperatures at or near the threshold for mangrove leaf damage and mortality. Snowfall and freezing temperatures were observed across Terrebonne basin, all the way out to the barrier islands. We sought to understand the impact of this winter storm on mangrove extent and ecosystem processes, particularly vertical carbon fluxes, on Whiskey Island of the Isles Dernieres Barrier Island Refuge, a hotspot for mangrove expansion that has experienced multiple restoration efforts, including the creation of 318 ha of wetland in 2009. Using high-resolution satellite imagery and decreases in the normalized difference vegetation index (NDVI) following the Jan 22 storm, we estimated 90% (108 ha) of mangroves experienced leaf mortality on Whiskey Island. We recorded a minimum air temperature on Whiskey Island of -5.2 ^{o}C on Jan 22, followed by minimum temperatures of -3 ^{o}C for 3 subsequent days. To compare how leaf mortality affected net ecosystem production (NEP), we conducted measurements of CO_2/CH_4 fluxes at the ecosystem-scale by placing n = 4 live trees and n = 4 freeze-affected trees (<1.5 m height) separately, inside a closed-chamber system and conducted light and dark measurements to estimate gross primary production (GPP) and total ecosystem respiration (ER_{tot}), respectively (NEP = GPP – ER). We further partitioned ER_{tot} for tree (ER_{tree}) and soil (ER_{soil}) with concomitant measurements of soil-only CO_2/CH_4 fluxes. We took additional ancillary measurements of aboveground tree biomass using previously derived allometric equations, *in situ* porewater measurements at a depth of 30-50 cm of temperature including porewater salinity, oxidation-reduction potential, and pH, and collected porewater samples from underneath each tree for lab analysis of porewater constituents. Measurements were conducted on March 18 and April 10, 2025. Results of ecosystem-scale CO_2 measurements indicate a reduction in GPP for freeze-affected trees, while ER_{tot} was greater for live trees, likely the result of relatively higher soil surface elevation. NEP indicates the location of live trees were a carbon sink, removing -6.79 ± 4.1 μmol CO_2 m^{-2} s^{-1} from the atmosphere, while freeze-affected trees were a small carbon source, releasing 0.23 ± 0.07 μmol CO_2 m^{-2} s^{-1}. Continued measurements of NEP will indicate the magnitude of lost carbon uptake (“recovery debt”) during the growing season as a result of this severe winter storm.

Assessing Salt Marsh Greenhouse Gas Fluxes by Planting Treatment Across Salinity and Elevational Gradients

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Management interventions involving sediment addition are applied to tidal marshes to raise the marsh elevation, reduce inundation frequency, and support wildlife habitat and carbon-based functions. Sediment addition alters marsh salinity and inundation regimes which are both linked to carbon cycling. The response of greenhouse gas emissions to sediment additions, however, is understudied. We leveraged a recent sediment addition project that created 14 experimental hummocks (mounds of sediment that varied from 1.15 - 1.71 meters above sea level) that were planted with different native grass species combinations and densities in Stratford, Connecticut (USA) to investigate how carbon gas fluxes varied along elevational and salinity gradients, and vegetation type. We quantified CO_2 and CH_4 emissions (2023, 2024) and net ecosystem exchange (2024) using static flux chambers from 140 plots subjected to varied sediment addition depths and planting treatments. We observed positive methane emissions across most plots with high variation (median = 15.22 mg/m^2 per day; range = -8.47 to 3993.88 mg/m^2 per day), but emissions were not significantly correlated to gradients of salinity, elevation, or planting treatments. In contrast, CO_2 emissions were positively correlated with elevation and negatively correlated with salinity. The relationship between salinity and CO_2 emissions also varied among planting treatments, which may be linked to the observed positive correlations among species diversity, total vegetation cover, and CO_2 emissions. We are in the process of analyzing carbon emissions and net ecosystem exchange data from the third growing season post-restoration (2024), which will provide more information about temporal heterogeneity in carbon fluxes and whether the carbon sink strength varies among plots. Our preliminary findings suggest that CO_2 emissions from experimental hummocks were influenced by elevation, salinity, and vegetation communities, whereas CH_4 fluxes were net positive but not well explained by studied parameters. Results will be synthesized to inform salt marsh carbon storage considerations for future conservation interventions involving sediment addition.

Greenhouse Gas Fluxes in an Active Delta Across a Sediment Organic Matter Gradient

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The goal of this project is to evaluate GHG fluxes, including nitrous oxide, carbon dioxide, and methane, in an active delta across a sediment organic matter gradient, which is due to different delta evolutionary stages. These values are significant because they contribute to the continuous effort to qualitatively describe the biogeochemistry of wetlands, especially those in Louisiana, impact on greenhouse gas emissions. I hypothesized that if there is more organic matter, then GHG fluxes will increase because microbes use organic matter for energy to perform reductions and seasonality will create GHG flux variation along an organic matter concentration gradient because warmer temperatures increase biological reactions. Measurements were taken at two sites on Mike Island within Wax Lake Delta. One site was identified as the high organic matter site at the older, northern end of the island and the other site was classified as the low organic matter site on the southern, newer part of the island. LICOR trace gas analyzers were used to take continuous measurements of each gas. Other supplementary measurements include surface and porewater samples that are analyzed for nutrients (NO_2, NO_3^-, NH_4^+, PO_4^{-3}), pH, conductivity, salinity, and temperature as well as redox conditions. The preliminary results support a significant difference between summer and winter for both carbon dioxide and methane. In the summer, carbon dioxide averaged 5.22 μmolm^{-2}s^{-1}and 1.25 μmolm^{-2}s^{-1} in the winter. Methane averaged 590.32 nmolm^{-2}s^{-1} in the summer and 40.02 nmolm^{-2}s^{-1} in the winter. Overall, exclusively by month, there was no difference in emissions between sites except in September, October, and March.

Seasonal Variabilities in Sources and Transport of Dissolved Organic Carbon from a Rapidly Eroding Coastal Estuary in Mississippi River Delta Plain

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The fate of soil organic carbon loss from eroding coastal wetlands is an important and unaccounted component of the global carbon cycle. A large fraction of this soil organic carbon upon erosion is released as dissolved organic and inorganic carbon (DOC and DIC) to adjacent water bodies while the rest is lost to atmosphere as CO_2. In this study, we investigate the seasonal concentrations and transport of DOC in Barataria Basin in Louisiana, USA, bordering northern Gulf of Mexico (nGOM). This basin is currently undergoing one of the highest land-loss rates in the US. Seasonal measurements of DOC, DIC and colored dissolved organic matter (CDOM) were carried out during winter, spring, summer, and fall of 2020-2021. The average DOC in the Barataria Basin varied between 7.78 mg/l in winter and 10.41 mg/l in spring, whereas the average DIC varied between 2582.47 uM in fall, and 1553.26 uM in winter. Humification index and statistical analysis suggests a strong influence of terrigenous organic matter input in the northern part of the bay. The seamless creek-to-ocean SCHISM 3D model validated by data from the east coast and the coast of GOM was implemented in this study to compute the discharge rate at the Barataria Pass followed by assessing the seasonal DOC transport. The DOC export was highest in spring, estimated at 2.01×1011 mg/day and translated to approximately 4.3×1013 mg on an annual basis. This study highlights the importance of DOC export from small estuaries, which should be incorporated in ocean carbon budget on a global scale.

Developing a Framework for Remote Water Quality Sensing of Nutrients from Urban Wastewater Effluent

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Urban wastewater treatment facilities collect water from populated areas and remove pollutants before discharging it into surrounding ecosystems. Many Louisiana wastewater treatment facilities utilize pond acreage for longer detention time to treat effluent instead of standard anaerobic and clarification processes. Due to the open nature of these facilities, weather events impact microbial processing causing facilities personnel to use more resources to meet discharge total maximum daily loads. Remote water quality sensing can provide real-time data for decision-making on energy optimization, chlorine dosing, and nutrient loads in discharged effluent. The study monitored inflow and outflow water to trace increased water quality metrics of nitrate, ammonium, temperature, conductivity, turbidity, pH, and dissolved oxygen to assess the pond's stability. Using deployable positions analytical sensors, hourly optical sampling provided data that was correlated to external weather factors (temperature, rainfall, etc.). The real-time data sets promote proactive responses for facility personnel to prevent reactive adjustments that can increase the cost of treatment. The preliminary data from this study shows fluctuation in microbial processing of nutrients and dissolved oxygen consumption when temperatures change rapidly, including cooling effects from large rain events. Nitrate and ammonium concentrations show variability in inflow while consistent trends of both nitrogen species in outflow indicate adequate pond processing regardless of initial concentration. The readily available data set is shared with the facility for operational changes and will be used to forecast best practices in microbial seeding and chlorine dosing to meet future industry goals. The remote system serves as a template for affordable, real-time monitoring solutions for wastewater effluent processing in urban watersheds.

Understanding the Bacterial Community, and Their Response to Nutrients in Little Washita River Experimental Watershed Reservoirs, Oklahoma, USA

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Over the last few decades, the Little Washita River Experimental Watershed (LWREW), located in central Oklahoma, USA, has experienced a loss of flood storage capacity due to sedimentation. However, limited information is available on the accumulated sediment's quality and microbial composition. This study analyzed the sediment samples collected from three reservoirs (cropland, forest, and grazing) of the LWREW to determine the nutrient dynamics, identify the dominant microbial communities, and evaluate the relationship between nutrient levels and microbial composition. The results showed that extractable concentrations of Ca, K, Mg, Mn, NH_4-N, NO_3-N, Na, and Zn varied with land use types and sediment depth. Additionally, sediments from all reservoirs exhibited alkaline pH ranging from 8.01 to 8.69. To characterize the bacterial communities, 16S rRNA gene sequencing was conducted, yielding 35355, 27830, and 36391 high-quality sequences from the grazing, forest, and cropland reservoirs, respectively. The results indicated that proteobacteria emerged as the dominant phylum across all land use types, followed by Bacteroidetes in forest sediment and Actinobacteria in grazing sediment. Thus, these microorganisms might play essential roles in multiple biogeochemical processes and environmental resilience.

Extreme Changes in Water Level and Nutrient Loading Can Shift Freshwater Coastal Wetlands from Nutrient Sinks to Sources

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Global change drivers, such as drastic alterations in water levels and nutrient loading, have the potential to transform coastal wetlands from nutrient sinks into nutrient sources. Elevated water levels in coastal systems can lead to wetland plant mortality, triggering increased nutrient mineralization and export. Additionally, flood-induced anaerobic conditions can enhance denitrification and promote phosphorus release via iron reduction. In the Laurentian Great Lakes of the USA, extreme lake level rises can interact with other change drivers, such as invasive species and increased nutrient inflow from the surrounding landscape, to significantly alter nutrient dynamics and ecosystem functions. Unraveling the complexities of these interactions is challenging, but simulation modeling offers a powerful approach to complement field observations. We utilized MONDRIAN, a process-based computational model, to simulate the interactions of individual plant species with environmental factors. Our in-silico experiment assessed the impact of water level fluctuations on coastal wetlands under six hydrological scenarios: a control (normal seasonal variation) and five disturbance treatments characterized by extreme flooding (reflecting observed Great Lakes conditions) lasting 1, 2, 3, 5, and 10 years, with water levels reaching thresholds that induced emergent plant mortality. Additionally, we simulated seven nutrient input levels, focusing on nitrogen (N) and phosphorus (P), ranging from low (4 g N m^{-2} yr^{-1}, 0.5 g P m^{-2} yr^{-1}) to extremely high (96 g N m^{-2} yr^{-1}, 24 g P m^{-2} yr^{-1}). Three plant community scenarios were also evaluated: native plants only, a Phragmites australis monoculture (a common invasive species), and P. australis invasion into a pre-established native community. This comprehensive experimental design resulted in over 1,000 MONDRIAN simulation runs fully crossing water levels, nutrient inputs, and plant community scenarios. Our results revealed that during extreme flooding, coastal wetlands shifted from nutrient sinks to sources, driven by reduced plant uptake, increased denitrification, and phosphorus desorption. The magnitude of this shift was influenced by both flood duration and nutrient input levels, with higher nutrient inputs amplifying nutrient release during extreme water levels. However, wetlands generally reverted to their nutrient sink state within one year after water levels returned to normal. While these patterns were broadly consistent across plant community scenarios, some community-specific trends emerged, particularly in the presence of P. australis. These findings underscore the critical role of hydrologic regimes in regulating nutrient dynamics within coastal wetlands and highlight the potential impacts of climate-driven changes in water levels, nutrient loading, and invasive species on shifting wetlands from nutrient sinks to sources.

Blue Carbon Stability: Spanning Across Geographical Boundaries

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Coastal wetlands have been attributed to being a crucial carbon sink in terms of the global carbon budget. Compared to tropical rainforests, coastal wetlands can store 3-5 times more carbon per area and sequester atmospheric carbon dioxide at a rate 10 times faster. Coastal wetlands are often referred to as “blue carbon ecosystems” due to their unique ability to efficiently and effectively function as a carbon reservoir. Despite there being large amount of research and resources quantifying soil carbon pools in coastal wetlands, it is important to acknowledge that not all soil carbon has the same fate. Investigating both the quantity and quality of soil carbon in coastal wetlands provides the ability of accurately predicting how much carbon will remain in the ecosystem and out of the atmosphere. One pool of soil organic matter that is continuously referred to as one of most stable pools of organic carbon in mineral associated organic matter. Mineral associated organic matter is organic matter that is adsorbed to mineral surfaces, and this chemical interaction protects the organic matter from mineralization. While the pool is heavily research among terrestrial scientists, there is limited research investigating its role in coastal wetlands. This research investigates the proportion of soil organic matter that is in the mineral associated organic matter pool and compares natural wetlands to restored wetlands that have been restored with the addition of dredged sediment across five geographically different locations in the United States. While we predict that the restored wetlands will have a lower quantity of soil carbon than their reference sites, we do expect the restored sites to have a higher proportion of their total carbon in the mineral associated organic matter pool due to the dredged sediment providing more mineral content to form mineral associated organic matter.

Nitrogen Mineralization Rates Vary along a Hydrologic Connectivity Gradient

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Freshwater wetlands serve as control points for biogeochemical processing from local to watershed scales and often reduce downstream nitrogen (N) export. Mineralization is a crucial process in wetland N cycling as it impacts the bioavailability of inorganic N compounds through the conversion of organic constituents to reactive forms. Inundation regimes in wetland systems alter N mineralization by regulating soil organic matter (SOM) availability through changes in redox conditions and substrate decomposition. However, with increasing anthropogenic pressures and climate change impacts, it is unclear how these changes will alter N mineralization processes. To address this uncertainty, we are quantifying seasonal N mineralization rates across three wetlands that range from groundwater to surface water dominated wetlands (i.e., hillslope, riparian, and floodplain wetlands). In each wetland, we measured *in situ* N-mineralization (net nitrification, ammonification, and total N mineralization) along the upland to wetland transition using ion-exchange resin cores. We measured the inundation regime using continuous measurements of wetland water level. To evaluate potential drivers of N mineralization rates across landscape positions, we measured SOM quantity and soil moisture at measurement site. Initial results indicate that within wetlands, N mineralization rates are highest in the transitional zone between the wetland and upland position. Across wetlands, initial results suggest higher N mineralization rates in the floodplain and riparian wetlands when compared to the hillslope wetland. Our results link landscape position, inundation regime, and N mineralization rates, highlighting the role anthropogenic pressures and climate change will have on N biogeochemistry in freshwater wetlands.

Assessing the Seaweed *Ulva's* Carbon, Nutrient, and Contaminant Profiles as a Potential Agricultural Soil Amendment

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Seaweed, often considered a nuisance in shellfish farming operations due to excessive growth and encroachment, holds untapped potential for improving agricultural soil quality as a possible valuable source of carbon and nutrients. The systematic quantification of carbon content, nutrient profiles, and the presence of contaminants in seaweed biomass necessitates further research and analysis. This study proposes a comprehensive monitoring framework aimed at assessing the seaweed genus *Ulva*'s carbon and nutrient uptake capacity, with the assumption that this knowledge can provide valuable insights into its potential as a soil amendment for enhanced agricultural productivity. Moreover, we seek to evaluate how *Ulva* removal from aquatic ecosystems affects water quality. *Ulva* biomass from partner shellfish farms are harvested and processed for contaminant analysis, ensuring its suitability for soil application at each *Ulva* application rate. Further laboratory techniques and quantitative models are employed to quantify carbon and nutrient removal by *Ulva* from marine ecosystems and to assess the extent to which these removed elements are effectively incorporated into agricultural soils, accounting for other sources of inorganic matter such as sand. Time series analyses are then conducted to identify trends, seasonal patterns, and other spatiotemporal dynamics in nutrient concentrations. This analysis aims to deepen our understanding of the carbon and nutrient sequestration potential of *Ulva* species, with the ultimate goal of developing efficient, climate-smart strategies and long-term frameworks for its large-scale integration into agricultural systems to improve soil health and crop productivity. Findings are to be disseminated to farming operations and meant to provide valuable insights into the benefits of seaweed as a regional approach that can feasibly offer sustainable solutions using resources available within the local context.

Tradeoffs in Nutrient Retention and Greenhouse Gas Fluxes in Restored Agricultural Wetlands

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The return of ecosystem services within restored agricultural wetlands is a major goal of the USDA Agricultural Conservation Easement Program. In the Mississippi River basin, nutrient retention by floodplain agricultural wetlands is an important restoration focus to reduce nutrient transport to the Gulf of Mexico and help mitigate Gulf hypoxia. Nutrient retention in restored wetlands is well documented; however, wetlands can release nutrients during inundation and be a significant source of greenhouse gases (GHG). This study aims to identify potential tradeoffs in nutrient sequestration and GHG production under different wetland restoration practices. We are collecting seasonal measurements of nutrient and GHG flux rates across dominant restoration practices in three WREP easements in west Tennessee using soil core flow-through incubations. Initial findings show that during flooding, nitrogen and phosphorus are being retained in all habitats, with lower variation in retention in the shallow groundwater compared to what occurs at the soil/floodwater interface. The highest denitrification rates occurred in areas that dry between floods and contain herbaceous vegetation. The greatest GHG production occurred in areas that were continuously inundated between floods. Tradeoffs with N_2 flux and GHG fluxes happened, as higher nitrous oxide (N_2O) rates occurred when N_2 rates were higher. Methane (CH_4) fluxes were unrelated to N_2 or N_2O fluxes, or soil oxygen demand, but were correlated to preflood soil moisture for both surface water and shallow groundwater, suggesting soil water content increased CH_4 production across habitats. Given these potential tradeoffs in nutrient and GHG fluxes, gaining a better understanding of the soil and vegetation conditions that optimize each nutrient and gas flux rate is critical to meeting multiple restoration goals, and creating restoration designs and hydrology management strategies that target specific ecosystem services.

Post-Hurricane Wood Debris Management Practices: Soil Particle Size Influence Carbon Thermal Stability

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Hurricane Michael resulted in a massive deposition of wood debris on the forest floor at Chipola Experimental Forest. The wood debris was managed through drum chopping and prescribed fire. However, it remains unclear how these management practices influence soil particle size, carbon (C) content, and thermal stability. Therefore, this study determined the influence of wood debris drum chopping and prescribed fire on carbon concentration and soil C thermal stability based on bulk and fractionated soil. The soil was fractionated according to particle size, which included <250 μm, 250-500 μm, and 500-2000μm. Carbon thermal stability was determined by multi-element scanning thermal analysis (MESTA), and C concentration was determined using a CN analyzer.

The bulk soil C concentration significantly decreased along the soil profile, with the highest C concentration in the topsoil in all three treatments ($P<0.0001$). However, the 0-2 cm depth (topsoil) exhibited significantly higher C concentration after a fire compared to baseline and drum chopping ($P=0.0031$). It is evident that after the prescribed fire, the C concentration exhibited a 300% increase within the 0-2 cm depth. Generally, the R400 index decreased with increasing soil depth. After soil fractionation <250 μm, soil particles exhibited the highest R400 index in the topsoil compared to 250-500 μm and 500-2000μm particle sizes in all treatments. For 250-500μm particles, the R400 index decreased from 0.68 in the baseline to 0.45 after drum chopping, and this pattern persisted after the fire, suggesting a decrease in soil C lability. This study indicates that management practices employed on debris management that have the potential to alter soil particle size distribution could also potentially influence the lability of C.

Drivers of Spatial and Temporal Patterns in Methane Emissions from a Brackish Coastal Wetland

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Coastal wetlands are dynamic ecosystems, meaning that rates of biogeochemical cycling and thus greenhouse gas emissions can be not only spatially variable, but also temporally variable, presumably in response to episodic changes in inundation, salinity, temperature, or nutrient availability. While episodic events may have a disproportionate effect on annual-scale greenhouse gas emissions, we have a limited understanding of their relative frequency, magnitude, and duration as well as the underlying biogeochemical mechanisms. We also have a limited mechanistic understanding of how climate stressors interact with biological components, including vegetation, to regular greenhouse gas emissions. This constrains our ability to both fully represent greenhouse gas dynamics in biogeochemical and Earth systems models as well as develop carbon budgets. To address these gaps, we have been measuring methane (CH_4) emissions from long-term field experiments and companion mesocosm experiments using both static and automated chamber systems. The field experiments are located in Smithsonian's Global Change Research Wetland, a brackish high marsh on the western shore of the Chesapeake Bay. At this site, CH_4 emissions are typically higher from plots dominated by the grasses *Spartina patens* and *Distichlis spicata* compared to plots dominated by *Schoenoplectus americanus*, but in recent years this pattern has shifted. Fluxes increase with soil warming and longer periods of inundation but decrease as salinity increases; salinity appears to be a stronger control on the magnitude of CH_4 emissions than soil temperature. Despite this, our ability to forecast CH_4 emissions gets substantially worse as soil temperature increases, regardless of which forecast model is used. On a temporal basis, the highest CH_4 emissions occur on falling tides, as the water level drops back down to the soil surface. Surprisingly, initial results indicate that CH_4 emissions can have strong diurnal cycles with the highest emissions occurring at night, but that pattern also varies between years. Temporal analysis of the short-term effects of inundation, nitrogen loading, and heat waves on episodic CH_4 emissions is ongoing. Overall, these data illustrate that understanding the dynamics of CH_4 emissions from coastal wetlands requires assessing the effects of multiple drivers and how they interact across multiple scales.

Tropical Storms, Sea-level Rise, and Drawdowns Affect Carbon Accumulation and Elevation Gain in Coastal Marshes

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Coastal wetlands can offset some subsidence and sea level rise via vertical accretion. We used 137Cs dating to compare 55 years of accretion between an impounded marsh and an un-impounded marsh in coastal Louisiana. The un-impounded marsh had five times more accretion. In the un-impounded, accretion was related to organic accumulation whereas mineral accumulation was related to bulk density. In the impounded marsh, accretion was related to mineral accumulation and bulk density. We attributed those differences to managed prolonged drainage events since ~2005 in the impounded marsh that we studied.

We compared our estimates to earlier 33-year estimates using 137Cs from the same un-impounded marsh. Those estimates were slower for accretion, mineral accumulation, and organic accumulation. We estimated that accretion would have had to accelerate 68%, organic accumulation had to accelerate 11%, and mineral accumulation had to accelerate 7-fold after 1998 for us to observe the rates that we estimated. We attributed those differences to increases in flooding by tides and/or tropical storms since 2000.

We also compared our estimates to earlier 33-year estimates using 137Cs from two nearby impounded marshes. Impoundment effects varied widely, which precludes broad statements about effects of impoundment on accretion. None-the-less, evidence is accumulating that Moist-soil management on organic soils in the coastal zone compromises accretion processes and reduces elevation via soil organic matter oxidation and compaction. New research is suggested on highly organic soils to identify plant species that foster accretion, and fire and water level management that promotes those species.

Sand Pine Needle Decomposition: Carbon Composition and Nutrient Release Post-Hurricane

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In terrestrial ecosystems, litter decomposition plays a significant role in the ecological processes influencing nutrient cycling and carbon dynamics. However, very little is known about the influence of decomposition on carbon (C) composition and nutrient release. Therefore, this study aimed to investigate the decomposition of sand pine (*Pinus clausa*) needles. The study determined the C composition and the subsequent nutrient release. Litter was collected from the field using litter traps. After the litter was air-dried, it was deployed back to the field using litter bags; the litter bags were retrieved sequentially from the field after 0, 1, 2, and 6 months. The study employed 13C Nuclear Magnet Resonance (NMR) to determine C composition. Nitrogen (N) concentration was determined using a CN analyzer. The results indicated a progressive mass loss of litter over time (P=0.000155); cumulatively, 33% of initial mass was lost within the first six months. Cumulatively, C (P=0.000137) and nitrogen (N) (P=0.000126) release increased significantly, and cumulatively, 40% and 23% were lost within six months, respectively. The litter N concentration did not change significantly. However, the concentration increased from 3.93-4.63 g kg-1, and the C:N ratio ranged between 113-132 over the six months. The 13C NMR indicated the dominance of O-Alkyl C in the initial litter and a gradual decrease in the O-alkyl and a gradual increase in Alkyl C and carboxyl C as decomposition progressed. The short-term results suggest the dominance of N immobilization, and the C and N released could be emanating dominantly from fragmentation and mass loss. However, the progression of this ongoing study to the spring and summer months could change the trajectory of both C and N releases.

Storage and Release of Biosolids P on Poorly Drained Sandy Florida Rangelands Receiving Biosolids Application

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Previous soils-based biosolids research in the Upper St. Johns River Basin (USJRB) has focused primarily on comparisons of Class B biosolids to chemical fertilizers, highlighting the slower release and therefore positive nature of biosolids phosphorus (P) recycled via surface application to sandy rangelands. A watershed-level analysis concluded that repeated applications of biosolids increased P export to receiving water bodies, increasing eutrophication. This called into question the role of sandy USJRB Spodosols as a sink/source of biosolids-derived P. Two USJRB cattle ranches were instrumented to measure surface and groundwater concentrations of P across two growing seasons. The A horizons (0-15 cm) of select fields were sampled to determine soil-bound P along with Aluminum (Al), Iron (Fe), and Calcium (Ca). Select soils were also used to construct column experiments, isolating the vertical leaching component of these systems to better understand P loss from the topsoil. The more complex 3-D movement of high-P concentration groundwater was explored to gain insight into subsurface P transport. The utility of Soil Storage Phosphorus Capacity, a P risk tool that ratios soil P to soil Fe+Al, was explored in light of unexpectedly high soil Ca and the resulting strong Ca-P statistical correlations. Together the findings from these ranches demonstrates that P leaching from soils receiving biosolids application and transport in the shallow groundwater are likely substantial vectors of the overall P transport that was outlined in the watershed study.

Tropicalization of Temperate Wetlands: Projections of Mangrove Range Expansion

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Tropicalization is a term used to describe the transformation of temperate ecosystems by poleward-moving tropical organisms in response to warming temperatures. In North America, decreases in the frequency and intensity of extreme winter cold events are expected to allow the poleward range expansion of many cold-sensitive tropical organisms, sometimes at the expense of temperate organisms. In coastal wetlands, warming winters are expected to allow the range expansion of mangrove forests, which can then outcompete and replace salt marshes. The transition from grass-dominated marshes to woody plant-dominated mangrove forests has the potential to impact biogeochemical cycling and some of the ecosystem goods and services provided by coastal wetlands. To better anticipate and prepare for these impacts, there is a need to advance understanding of potential future changes in mangrove distribution and wetland ecosystem properties in response to warming winters. This presentation will synthesize recent efforts to: (1) quantify climate-ecological relationships across the mangrove-marsh transition zone in the southeastern United States; and (2) use these relationships to project future changes in mangrove distribution and wetland ecosystem properties under alternative future climate scenarios. Our results show where and to what extent climate change, in the form of winter temperature warming, could transform coastal wetlands from grass-dominated marshes to woody plant-dominated mangrove forests in the southeastern United States. We discuss the potential impacts of mangrove range expansion on biogeochemical cycling and wetland ecosystem goods and services.

Monitoring Contrasting Belowground and Aboveground Processes as Drivers of Methane Dynamics in Dominant Tropical Peatland Vegetation Communities

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With the current rise in atmospheric methane, understanding the contribution of wetlands and peatlands to methane emissions is crucial, as they are considered significant sources, particularly in South America. Peatlands are heterogeneous ecosystems with complex interactions between hydrology, vegetation, topography, climatology, nutrient availability and peat properties. These variables configure and determine the different methane dynamics and fluxes and their variation at different spatial scales. How these different components of the ecosystem interact, defining the peatland and the methane fluxes within it is currently poorly understood. To accurately analyze and model how peatlands contribute to methane emissions, it is necessary to understand the role of each component. The hydrological regime, depending on the main water source, divides them into minerotrophic and ombrotrophic, depending on whether the peatland is mainly fed by surface water flows or by rain, respectively. This different hydrology also determines the type of flooding of the peatland, its nutrient availability and can influence the ecosystem productivity and the dominant vegetation. Peruvian peatlands can be dominated by different types of vegetation, being the most abundant palm-dominated peatlands in the aguajales or palm swamps, represented by the palm trees like the aguaje (*Mauritia flexuosa*), aguajillo (*Mauritiella armata*) or huasaí (*Euterpe precatoria*). Peatlands can also be dominated by hardwood trees like *Platycarpum loretense* or *Tabebuia* insignis and *T. incana*, forming the pole forests called varillales. These different types of vegetation are expected to generate different methane fluxes, with palm trees associated with higher stem methane emissions than hardwood trees. As peat is made by partially degraded organic material, these vegetation types will generate a different chemistry in the peatland. Our objective is quantifying the variability of methane dynamics in South American peatlands at spatial and temporal scale, assessing environmental drivers across contrasting vegetation types and nutrient regimes. We will establish an intensive methane monitoring network across four sites spanning nutrient availabilities and vegetation types. The characterization of the peatland includes the monitoring of above and belowground processes such as the different methane fluxes, the hydrology, ecosystem productivity and properties of the peat, as well as the role of trees in methane transport. A vertical profile of the methane emissions through the stem of the tree will also be implemented to more accurately understand the fluxes generated and expected. To conduct these analyses, we will use a modification of the Global Ecosystem Monitoring network protocol to establish a series of intensive monitoring sites. This monitoring will take place throughout dry and wet seasons to provide a better understanding of the effect of seasonality and the differential relevance of each process in methane dynamics under different flooding. The plots were set during the first trimester of 2025, and the variables will be checked on a monthly, seasonal and annual basis, adapting the periodicity to each variable; allowing for a comprehensive monitoring of the peatland dynamics and an accurate identification of the role of each process at different across time in the different peatlands.

Tracing Nitrogen Pathways in Coastal Wetlands: The Role of MAOM in a Changing Landscape

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Coastal wetlands play a critical role in carbon sequestration and water quality improvements, capturing 20–30% of the total carbon as soil organic matter (SOM). However, in Florida, these vital functions face threats from two major environmental changes: nitrogen (N) enrichment and the conversion of marsh grass to mangroves. Nutrient eutrophication has significantly impacted Florida's coasts, exacerbating public health issues such as harmful algal blooms and marine fauna die-offs. While N addition can both stimulate and hinder plant growth — affecting wetland subsidence and elevation — the shift from herbaceous marshes to woody mangroves adds further complexity to SOM dynamics.

This study explores the relationship between SOM composition and these environmental changes, focusing on particulate organic matter (POM) and mineral-associated organic matter (MAOM). POM is more labile and responsive to environmental shifts, while MAOM, bound to fine soil particles like silt and clay, is more stable and serves as a long-term carbon and nitrogen reservoir. Although carbon has consistently been shown to be stable when incorporated into MAOM, the persistence of nitrogen remains less understood. Therefore, this research aims to investigate the fate and stability of nitrogen within the MAOM pool, examining how nitrogen addition and the marsh-to-mangrove shift impact microbial substrate lability and MAOM formation.

Field sampling will be conducted at the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), where marsh and mangrove ecosystems coexist, offering a unique comparative landscape. A 15N pulse experiment will trace short- and long-term nitrogen incorporation into MAOM. The study design involves two vegetation types (mangrove vs. marsh) and two nutrient treatments (N-fertilized vs. control), with five replicates per category, resulting in four plot types: fertilized marsh, control marsh, fertilized mangrove, and control mangrove. The plots will be enriched with a 15N tracer, and 5 cm diameter x 30 cm deep soil cores will be taken from treated plots at 0, 3, 6, 9, 12, and 24 months post-15N addition. These cores will be sectioned into 15-cm increments and analyzed for MAOM content and 15N composition. Short-term data will reveal immediate N demand under various conditions, while long-term data will provide insights into N retention, turnover, and the impacts of N enrichment and mangrove dominance on nutrient cycling.

We hypothesize that mangroves will sequester more added N than marshes due to greater plant N demand, leading to higher MAOM incorporation in marsh plots. Broader impacts of this research include informing wetland management strategies aimed at enhancing carbon sequestration and mitigating eutrophication through targeted conservation of ecotonal wetlands. Understanding these processes will support the development of adaptive policies that optimize the ecological services provided by Florida's dynamic coastal systems.

Ebullitive and Diffusive Greenhouse Gases from Flooded Impoundments of New Brunswick and Nova Scotia (Canada)

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In the 17th and 18th centuries, Acadian settlers dyked and drained salt marshes along the Bay of Fundy in Eastern Canada, transforming them into agricultural fields. Over the last 50 years, impoundments have been created by building dykes to contain freshwater. These impoundments are freshwater wetlands underlain with agricultural soils developed from tidal marsh sediments, making them potentially unique wetlands. This study examines 5 impoundments, ranging from 15 to 54 years since their creation. The impoundments are primarily fed by precipitation, and their water levels are maintained throughout the year with weirs. Assessment of their value as Natural Climate Solutions, i.e., their impact on climate, requires measurement of greenhouse gas fluxes from their waters. Greenhouse gas fluxes were measured in the open water areas of the impoundments using the headspace equilibrium method and inverted bubble traps, for diffusive and ebullitive fluxes, respectively. Sampling occurred monthly from August to November 2024, and in February 2025 (beneath the ice), representing 3 distinct seasons. Total CH_4 and CO_2 emissions ranged from -0.9 to 373 and -676 to 1566 mmol/m^2/d, respectively. Diffusive N_2O emissions ranged from -334 to 0.4 *u*mol/m^2/d. Approximately 46% of CH_4 emissions were through ebullition which is a low ratio compared to previous studies, likely due to the presence of submerged macrophytes affecting the rates of ebullition. Dissolved greenhouse gas concentrations in the winter were significantly related to impoundment age, presumably a result of greater accumulated organic matter in the older impoundments. Concentrations and fluxes of greenhouse gases correlated to environmental variables air, water, and soil temperatures, and pH.

Aerial Image Analysis of Changes in Wetlands between 2019 and 2023 in the Barataria and Breton Sound Basins of Coastal Louisiana

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Loss of marshlands in the Mississippi Delta plain of Louisiana threatens the future of the region's economy, one which is heavily reliant on coastal wetland resources. This study builds on previous remote sensing investigations over the Barataria and Breton Sound Basins to make increasingly detailed assessments of changes occurring in coastal wetlands of southern Louisiana from both human extractive activities and repeated hurricanes. We set out to answer two scientific questions: 1. What are the bio-geophysical nature and the areal extent of changes in coastal shorelines and wetlands of the Barataria and Breton Sound basins over the past four years of intensive hurricane activity? 2. How have marshland/water boundaries in the probable impact areas of the Mid-Barataria and Mid-Breton sediment diversions recently changed in the landscape of water and wetland-covered patches? High-resolution (< 1-m pixel size) imagery, acquired and processed by the United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP), was acquired from 2019 to 2023. Landscape metrics for ten equal-interval classes of NDWI were computed using the FRAGSTATS program. Class-level indices from FRAGSTATS were used to quantify the densities and spatial configuration of patches, providing a variety of metrics for the geometry, complexity, and aggregation levels of the wetland- versus water-covered patches across the study area. Analysis over the past four years (2019 to 2023) using the normalized difference water index (NDWI) from NAIP images revealed that there has been a widespread increase in relatively deep-water coverage (and corresponding losses of marshland coverage) since 2019 over most of the Barataria and Breton Sound Basins. Scouring of formerly shallow water cover and widespread erosion of brackish and fresh marshland shorelines followed the storm surges of Hurricanes Zeta (2020) and Ida (2021). There has been an extensive increase in relatively deep-water coverage (and corresponding losses of land coverage) since 2019 over most of the marshlands and shorelines of the Barataria and Breton Sound Basins in southeastern Louisiana. Heightened fragmentation of marshland edges and interior pond features based on patch metric analysis implied that different types of damage inflicted on coastal wetlands of southeastern Louisiana from tropical storms can be characterized using aerial remote sensing.

Implications of Phosphorus Loading Pathways on Harmful Algal Blooms in a Coastal Estuary

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Internal phosphorus (P) loading in shallow eutrophic lakes can drive the formation of harmful algal blooms (HABs). Understanding the spatial distribution of P across a watershed can assist in predicting and mitigating these HABs. This study constructed a watershed-scale budget for P throughout Lake Pontchartrain Estuary in southeastern Louisiana, USA. The estuary regularly experiences HABs across its heavily populated north shore. This study presents a comprehensive P sediment distribution map of the sediment and a calculation of the externally loaded components of riverine P. Our goal was to assess the relative proportion of internally loaded P from lake sediments vs watershed-derived P, which was a majority contributor of P to the estuary. Monthly water quality samples were collected from six of the estuary's main tributaries for total suspended solids, dissolved and particulate P in organic and inorganic forms, and ambient water quality parameters. Additionally, the sediment bed in 0-5 and 5-10 cm increments across 160 stations of the 1,631 km^2 estuary was sampled and analyzed for moisture content, bulk density, loss on ignition (organic content), total P, carbon, nitrogen, and inorganic and organic P. Results indicated total P in lake sediment ranged from 5.67-757.31 mg kg^{-1} (median= 408) and was primarily inorganic P (93% of TP on average). Sediment P was concentrated in the fine-grained silty southwestern to central portions of the lake (129- 757 mg kg^{-1}, median=460), the direct area of influence of the large-scale Bonnet Carre Spillway, introducing sediment and nutrient-rich Mississippi River water into the estuary. The north shore sediments were predominantly sandy and included the lowest levels of total P ranging between 5.67-481.68 mg kg^{-1} (median 264). While north shore sediments likely contributed to a lower internal P loading, they received a significant flux of bioavailable P from the lake's tributaries. The SRP concentration from the northern tributaries averaged 0.04 mg L^{-1} over a 5-month study period, with SRP as the primary P form accounting for roughly 80% of the total riverine P fraction. These findings suggest that P loaded by the Bonnet Carre Spillway is buried in lake sediment to be released if water column P concentrations drop. Soluble P loaded through the northern tributaries is a likely source of nutrients contributing to HAB occurrence along the north shore, indicating runoff management throughout the northern tributaries may help reduce the HAB occurrences.

Quantification of Belowground Biomass and Sediment Accretion in Mangroves of Different Coastal Environmental Settings of the Costa Rican Pacific Coast

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The adaptation of intertidal ecosystems such as mangroves to anticipated accelerated relative sea level rise is dependent on net increase of sediment surface elevations and forest migration inland. Ecosystem models developed to simulate trajectories of ecosystem adaptations have determined that rates of soil formation are most sensitive to surface sediment (organic and inorganic) deposition and subsurface organic production by mangrove roots. Mangrove belowground biomass contributes to soil organic matter accumulation, while mangrove litter has minor contribution due to export and annual decay. In addition to belowground biomass production, inorganic sediment loading is also a key contribution to soil formation and accretion. Incorporating necromass (dead root mass) into model simulations enhances soil formation estimates, as this component represents a substantial portion of the soil's refractory organic matter pool. However, it is frequently neglected in field studies, impeding our comprehension of its contribution to mangrove soil formation. Mangrove belowground bio- and necro-mass allocation (total belowground mass) and vertical accretion may vary both among and within coastal environmental settings in response to geomorphic forcings and gradients in resources (nutrients), regulators (salinity, sulfate) and hydroperiod (flooding frequency, depth and duration). Carbon allocation by mangrove total belowground mass and soil formation rates vary according to coastal geomorphology. I established this study in an estuarine (Nicoya Gulf) and in a deltaic (Térraba-Sierpe Delta) coastal environmental setting along the Pacific coast of Costa Rica to test differences in coastal environmental settings in a mesotidal conditions. Root mass was sampled using the trench method, and accretion was assessed via the feldspar marker horizon method and plastic mesh plates for comparison. I found no significant differences in biomass allocation and necromass contribution between estuary and delta coastal environmental settings. Similarly, accretion rates exhibited no significant differences across these coastal settings. I estimated the first field-based belowground biomass/necromass allocation and accretion estimates for Costa Rican mangroves. Improved confidence in these estimates reduces uncertainty in accretion rate simulations. Our findings contribute to Costa Rica's National Blue Carbon Inventory and enhance estimates crucial for soil cohort models predicting sediment accretion and carbon sequestration rates in Costa Rican estuaries, deltas, and similar ecosystems worldwide.

Utilizing Biogeochemical Approaches to Aid in Pilot-Scale Seagrass Plantings in a Shallow, Well-Mixed Estuary

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In Spring of 2023, the Brevard Zoo conducted seagrass plantings of *Halodule wrightii* at multiple locations in the Indian River Lagoon (IRL), located on the central east coast of Florida. These pilot-scale projects were intended to test planting methods including use of herbivory exclusion devices and to identify metrics driving site suitability. Monitoring of sediment and water quality identified metrics if interest including conductivity, dissolved oxygen, light and sediment composition. Additional data regarding microbial communities from the IRL and seagrass nurseries were evaluated to refine and improve outcomes with respect to increasing nursery output, survival of outplanted seagrass, and benefits to the ecosystem. These ecosystem services include expanded seagrass habitat and associated geochemical benefits including nutrient cycling and mitigation of sulfide toxicity. Results from these studies will be used to aid in site selection and nursery stock for future projects.

Factors Influencing Microplastic Abundance in Stormwater Basins

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Microplastics (MPs) and nutrients are both common anthropogenic pollutants that enter freshwater aquatic systems, particularly stormwater basins and partially excavated lakes. In addition to having common sources (i.e., adjacent human development) MPs may directly hinder nitrogen (N) uptake, alter microbe communities and pathways, and reduce N and phosphorus (P) removal in freshwater systems, possibly leading to an increase in N and P concentrations in the water column. However, it is unknown if there is a correlation between MP abundance and concentrations of N and P in stormwater basins and lakes. Moreover, this study seeks to understand if the concentrations of these pollutants vary spatially within a basin (based on proximity to development) and between basins. Microplastic type and abundance, along with nitrate and soluble reactive phosphorus (SRP) concentration, will be quantified in the water column of at least five stormwater basins and two lakes. To limit plastic contamination of the samples, glass bottles will be used to obtain water samples. Once returned to the lab, samples will be poured through a gridded filter using vacuum filtration and using foil to cover all open areas containing samples to avoid contaminants in the air. The microplastics on the gridded filters will be placed under the macroscope, counted, and separated into fragments, fibers, or beads. Nutrient concentrations will be quantified colorometrically with a discrete water analyzer. A positive correlation between MP abundance and nutrient concentration is predicated, as well as a direct relationship between MP abundance and proximity to anthropogenic development. This research will help land managers recognize the relationship between MPs and nutrients to determine if one can be used to predict the other and will improve knowledge for overall pollution management.

Inundation Regimes Impact on Leaf Litter Decay Rate in Forested, Freshwater Wetlands

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Wetlands play a crucial role in breaking down allochthonous leaf litter, influencing the biogeochemical cycling and export of carbon (C) across a variety of spatiotemporal scales. In forested watersheds leaf litter is the primary source of detrital C and decays through two simultaneous pathways: (i) leaching of soluble compounds and (ii) microbial-mediated mineralization and humification of structural compounds. In freshwater wetlands, the activation of these biogeochemical pathways is influenced by inundation regime (i.e. the duration, magnitude, timing, and rate of change of inundation). However, there is no clear consensus on how inundation regimes impact leaf litter decay rate in freshwater wetlands, and it is uncertain how stressors affecting inundation regimes (i.e., climate and land use change) will impact leaf litter decay rates. The goal of this study is to investigate the relationship between leaf litter decay rates, heterotrophic soil respiration, and inundation regime in forested, freshwater wetlands along a gradient of hydrologic connectivity. We conducted the study at the J. Nicolene Tanglewood Biological Station located in western Alabama's Coastal Plain physiographic region. We selected nine wetlands with varying modes of hydrologic connectivity, ranging from hillslope-connected to floodplain-connected wetlands. At each wetland, we conducted serial leaf litter incubations, laboratory soil microcosm experiments, and continuous wetland water level monitoring to quantify both leaf litter decay and heterotrophic soil respiration as a function of changes in inundation. We focused on Tulip poplar (Liriodendron *tulipifera*) and Florida anis (Illicium *floridanum*) leaf litter. We hypothesize that leaf little decay rates will be highest in intermediate-connected wetlands due to increased frequency and decreased duration of inundation events. Our results will provide important insight into leaf litter decay and subsequent carbon and energy movement in forested, freshwater wetlands.

Pocosins: North America's Forgotten Peatlands for Climate Mitigation and Sea Level Protection

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Pocosins are coastal evergreen shrub bogs in the SE USA which cover over one million ha, an area similar in size to the Everglades National Park. They are ignored as important C sinks on the landscape mainly because these peatlands have been drained, burned, fertilized and are now under intensive agricultural or forestry practices, exacerbating C loss due to increased greenhouse gas (GHG) losses, (mainly as CO_2), increased nutrient and C export in runoff to coastal estuaries, reduced C sequestration and occasional uncontrolled deep peat fires. In addition, in their natural state they provide coastal protection against sea level rise. A 10-year study on the effects of water levels on CO_2 fluxes has shown low levels of CO_2 and CH_4 loss compared to other wetland ecosystems even under drainage and extended droughts due to the recalcitrant nature of the peat C chemistry in these peatlands. Our long-term restoration research provides key scientific data which quantifies the amount of increased C sequestration that occurs annually when restoration to natural hydrologic conditions takes place on these former drained peatlands. Eddy-covariance analyses revealed that restoring peatlands by raising water tables by 30 cm, i.e., by decreasing water table depth (WTD) from -60 to -30 cm, significantly reduces CO_2 losses to the atmosphere. When mean annual WTDs are deeper than a threshold of -30 cm, the drier peatlands generate an annual C loss and if WTDs are shallower than the threshold (wetter), the peatlands show annual C gains. Results show a net positive C storage balance that could be profitable on the open C market. Our Eddy-Covariance measurements of CO_2 fluxes under different seasons and water levels allowed us to develop a model that can be used to predict changing GHG losses in response to alterations of WTD and solar radiation across the SE USA. The restoration of 45,000 to 76,000 ha of similar drained peatlands along the Atlantic seaboard could prevent an additional 1– 1.6 Tg of CO_2 from entering the atmosphere each year. Thus, rewetting drained and fallow shrub peatlands along the southeastern coastal plain, which cover less than 0.01% of the US land area, would substantially reduce GHG emissions and could potentially contribute up to 2.4% of the annual reduction increment required to reduce the current 5 Pg of annual US CO_2 emissions to net- zero emissions by 2050. Thus, restoring (i.e., rewetting) not only rejuvenates pocosin peatlands as major C sinks on the coastal landscape, but also restores hydrologic conditions that prevent catastrophic ground- fire losses, excessive runoff of freshwater and nutrients into adjacent estuaries and restores degraded habitat for many endemic plant and animal species.

Pre-restoration GHG Dynamics of a Freshwater Coastal Wetland in Southeast Australia

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Coastal wetland restoration is emerging as a promising climate change mitigation solution in Australia, with recent policy and management focus on the importance of "blue carbon" ecosystems. However, little is known about the impact of tidal reinstatement on the greenhouse gas (GHG) dynamics of these ecosystems. This knowledge gap is particularly significant given the scarcity of pre-restoration data available, which limits our understanding of the restoration process and its effect on the radiative balance of coastal wetlands. Coastal wetlands can act as a sources or sinks, defined by a positive or negative overall GHG flux, which is critical to estimating the radiative balance of the ecosystem. Everlasting Swamp, located in northern New South Wales is a large (1700 ha) coastal wetland, which was tidally disconnected 100 years ago for agricultural use, and has been identified as a site with future restoration potential. In the winter of 2024 and summer of 2025, soil-atmosphere GHG fluxes (carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)) and physicochemical characteristics were measured via the opaque static chamber method across 3 transects spanning elevation and vegetation gradients to provide pre-restoration baseline. Across both seasons, Everlasting Swamp was a net source of all target gases, and highly variable (mean CO_2 = 134.1 ± 129.7 μg m^{-2} s^{-1}, mean CH_4 = 1.0 ± 2.9 μg m^{-2} s^{-1}, mean N_2O = 0.009 ± 0.01 μg m^{-2} s^{-1}), which are similar to those measured at Burdekin catchment in Queensland, Australia. Mann-Whitney U tests indicated no seasonal difference in the CO_2 flux (winter mean = 130.7 μg m^{-2} s^{-1}, summer mean = 112.6 μg m^{-2} s^{-1}, p=0.3), or N_2O flux (winter mean = 0.02 μg m^{-2} s^{-1}, summer mean = 0.005 μg m^{-2} s^{-1}, p = 0.15), but CH_4 fluxes were significantly higher in summer than winter (winter mean = 0.02 μg m^{-2} s^{-1}, summer mean = 0.1 μg m^{-2} s^{-1}, p = 0.01). Preliminary analysis of the regressions with the physicochemical variables identified the key statistically significant drivers shaping gas flux dynamics. The most significant driver of CO_2 flux was moisture content, with a strong inverse correlation (r = -0.70 p < 0.001). CH_4 was positively associated with soil moisture content (r = 0.51, p = 0.01) and porewater nitrite concentration (0.69, p = 0.010), and negatively associated with soil bulk density (r = -0.63, p = 0.001) and porewater ammonia concentration (r = -0.56, p = 0.047). None of the measured parameters showed statistically significant correlations with N_2O flux. Further analysis into the drivers controlling GHG fluxes will provide critical insights into how tidal reinstatement may alter the radiative balance of coastal wetlands in southeast Australia, informing future restoration efforts and climate change mitigation strategies.

Pollution Control in Wetland Soil and Water Around the Globe

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Soil and water around the globe are contaminated with various pollutions including PFAS, PHAHs, plastics, toxic elements such as arsenic, cadmium, mercury, antimony and others. In particular, wetland soils are very vulnerable since they serve as producer of food, including rice. Wetland soils are regularly flooded and thus, they underlie large fluctuations of redox conditions. Those changes of redox conditions have considerable impacts on the biogeochemical behavior of toxic compounds as well as on pH, carbonate, and carbon solubility, chemistry of iron, manganese, and sulfur as well as on microbial community, which control the mobilization of toxic compounds.

Doubtless, the redox potential and pH are master variables in governing those mobilization processes. We conducted experiments in the laboratory to study mechanistically the release dynamics of toxic elements. Also, we identified suitable amendments to stabilize those toxic compounds in wetland soil which should be stabile even under dynamic redox conditions. Biochar is considered as one option to fulfill this purpose. Results gained at various scales (laboratory and field scale) will be presented.

Assessing Landscape Cumulative Impacts of Natural and Human Disturbances on Mangrove Carbon Storage in Puerto Rico (Jobos Bay)

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Mangrove wetlands are considered one of the most efficient global carbon sinks due to their carbon storage capacity (i.e., Blue Carbon, BC). Yet, they are negatively impacted by the increasing interaction of human and natural disturbances, triggering a significant global reduction. If BC markets are broadly implemented as a climate change mitigation measure, potential funding from these markets might be available to advance mangrove rehabilitation and restoration (R/R) projects. Yet, accurate carbon inventories are needed to monetize these inventories with reduced uncertainty at different spatial scales—especially to identify potential BC recovery and loss trajectories as financial systems develop in the following decades. Here, we analyze the spatial distribution of mangrove BC stocks in different sites across the Jobos Bay National Estuarine Research Reserve (JBNERR) in Puerto Rico's south coastal plain. Local and watershed-level hydrological alterations due to agriculture expansion, road construction, and urban development have historically impacted these areas (A, B, C, D). In addition, these areas were affected by hurricanes Maria and Irma in 2017. Two types of surveys were performed in each region to determine the spatial variability of total organic carbon (TOC) along transects ranging from 5-25 (stratified survey) to up to 900 (systematic survey) meters; the sampling occurred in the period 2022-2023. The TOC stock includes values for the soil, aboveground biomass, dead wood, pneumatophores, and litterfall compartments. All areas showed soil hypersalinity (pore-water) conditions (>60 ppt), particularly in inland areas (range 70- 140 ppt) at lower elevations and where extensive mangrove dieback was evident. TOC ranged from 217 to 455 MgC/ha, where the soil compartment contributed >90% of the total TOC; the higher values were measured in area B, followed by D, A, and C. These TOC values are less than half the mangrove global mean, underscoring the current and cumulative negative impact affecting mangrove spatial distribution and productivity in the JBNERR. The net difference in TOC densities among sites and within transects at each site helped delineate a timeline of sequential and cumulative adverse impacts in the JBNERR (site D), the Bosque Estatal de Aguirre (site B), and sites A and C. Despite the low value of aboveground TOC in site D, the mean soil TOC is higher (398 ± 40 MgC/ha) than in sites A (304 ± 29 MgC/ha) and C (153 ± 15 MgC/ha), where human impacts) are extensive (road construction). A regional TOC loss was estimated at ~419 MgC/ha, equivalent to an emission (CO_2 equivalent units) of 1537 Mg/ha CO_2*eq*. This is the first landscape-level blue carbon storage capacity study in heavily impacted forests in southern Puerto Rico. This study also underscores the need for holistic conservation approaches to ensure mangrove wetland resilience under significant human impacts interacting with climate change in the Caribbean region.

How to Increase Mineral-Associated Organic Matter Formation in Organic-Rich Soils?

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Mineral-associated organic matter (MAOM) serves as a critical reservoir for long-term soil carbon (C) stabilization due to its strong physicochemical binding to minerals, which resists decomposition from microbial and enzymatic activity. This research explores the mechanisms underlying MAOM formation broadly, focusing on interactions between soil organic matter (SOM) and mineral surfaces influenced by factors like SOM source, minerals properties, and pathways (derived from microbial or plant derived processes). To analyze these mechanisms, we reviewed literature on different types of soils, identifying key features of minerals or other relevant soil amendments that promote MAOM stabilization. Results indicate that while existing studies focus on MAOM formation in mineral-rich soils from upland systems, there are significant knowledge gaps in how these processes translate to organic-rich soils, such as histosols, where unique factors—such as high organic content, redox dynamics, and specific microbial communities—impact MAOM stabilization. In response, we emphasize the distinguishing features of organic-rich soils and subsequently propose potential amendments for enhancing MAOM in cultivated histosols and similar soils that exist in less aerobic environments. We highlight short- and long-term impacts of these amendments on MAOM stabilization, underscoring the importance of addressing confounding factors like mineralization, CO_2 release, and environmental conditions, including temperature, precipitation, and soil moisture. In conclusion, this review provides insights for future research to stimulate MAOM formation in organic-rich soils, offering implications into effective strategies for enhancing soil C storage and contributing to climate mitigation efforts.

Influence of Redox Processes on Phosphorus Storage, Transformation, and Mobilization

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Coastal wetlands are dynamic sites that act as biogeochemical hotspots for nutrient and mineral transformations. Globally, and particularly in the southeastern U.S., coastal areas are experiencing saltwater intrusion and shifts in redox conditions associated with sea level rise and human activities, which affect carbon and nutrient storage, transformation, and export. Prolonged flooding shifts soils from transiently oxidizing to persistently reducing conditions, while salinity varies according to relative contributions of fresh- and saltwater during inundation, with implications for phosphorus (P) fate and transport. Phosphorus is often a limiting nutrient in fresh- and saltwater environments but can also affect water quality and cause eutrophication at high concentrations. However, P speciation and solubility are understudied compared to C and N in coastal soils, representing a key knowledge gap. The aim of this research is to develop a new understanding of P biogeochemistry in coastal systems by evaluating controls on P mobility across redox and salinity gradients. We hypothesize that highly abundant redox interfaces in freshwater wetlands will favor P sorption to metal oxides, and that changes in redox conditions driven by soil flooding will regulate P mobility via formation and dissolution of Fe oxides. Soils were collected along an inundation gradient on the emerging Wax Lake Delta in the Atchafalaya basin in Louisiana to investigate how soil organic matter and metals influence phosphorus cycling in freshwater deltas. Soils were collected in bulk (surface soils; 0-5 cm) and cores (0-30 cm) from five plots along the transect. We used a suite of analytical tools to investigate P speciation, incorporating analyses targeted towards both the organic and mineral phases in the system. Chemical separations and other complimentary techniques were used to quantify total soil P and determine P associations (e.g., iron-bound, aluminum-bound, etc.). Soil extractions revealed differences in total phosphorus and the proportion of phosphorus associated with soil minerals associated with inundation pattern. Sites that were more frequently inundated stored less phosphorus in iron mineral associations, accompanied by an increase in reduced iron-sulfur associations at the same sites. The results of this research will improve our understanding of how nutrients are stored and processed across flooding and salinity gradients that represent current and future coastal ecosystems.

Belowground Bio- and Necromass Allocation and Soil Shear Strength Across Northern Gulf of Mexico Mangroves

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Mangroves dominate most of the world's tropical and subtropical sedimentary coastlines. Outside the tropics, however, mangroves' extent expands and contracts in response to changes in climate and relative sea level rise. At range limits such as the northwest Atlantic coastline, the environmental setting nears physiological tolerance thresholds, and mangrove's ability to cope with acute (hurricanes, frosts) and chronic (sea level rise) impacts is reflected in biomass allocation strategies (i.e., above- vs belowground growth). Mangrove mortality events can lead to rapid soil organic matter collapse resetting ground elevations below the point at which even more flooding tolerant saltmarsh species establish, resulting in coastal wetland land loss. Here, we assessed mangrove belowground bio- and necromass (BGB and BGN) across the northern Gulf of Mexico. To capture the diversity of coastal typologies along GoM, we sampled a tide-dominated lagoon in Texas and a river-dominated estuary in Louisiana. Mangrove BGB and BGN were approximately 2 and 5 times higher in the river-dominated estuary relative to the wave-dominated lagoon. These patterns in root mass allocation should reflect differences between coastal typologies and may be partly attributable to successional trajectories following distinct disturbance legacies (e.g., hurricanes, frosts). Our findings strengthen our understanding on biotic feedbacks (e.g., root productivity) that control soil elevation capital in critically endangered mangrove ecosystems with implications for coastal management practices aimed at improving resilience along land-ocean boundaries (e.g., targeted species composition in wetlands creation and restoration projects).

Phosphorus Retention in Riparian Wetlands Restored on Formerly Farmed Land: Key Drivers and Lessons for Future Restoration

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Poor and declining water quality in Lake Champlain and increasing frequency of extreme flood events in the Lake Champlain Basin pose threats to both residents and aquatic ecosystems. Riparian wetlands and floodplains can help address these threats by slowing floodwater, trapping sediment, and serving as nutrient sinks. The Wetlands Reserve and Agricultural Conservation Easement Programs have invested millions of dollars to protect and restore wetlands in the basin. This presentation will focus on the Vermont CEAP Wetlands research project, the primary objective of which is to quantify the water quality benefits that accrue from restoration of riparian wetlands in terms of phosphorus (P) load reductions. While wetlands are generally known to be P sinks, data are relatively scarce for restored riparian wetlands on formerly farmed land, where legacy P can potentially be released in dissolved form during inundation. We have monitored water quality during numerous flood events on five such wetlands in Vermont since 2022, including a historic flood in July 2023. Using a combination of field monitoring, soils analysis, laboratory incubations, and modeling, we estimate net P retention for various scenarios at each site that represent a range of plausible hydrologic and biogeochemical conditions. Results to date suggest positive net P retention at all monitoring sites, with site hydrology, soil P storage capacity, and influent river water quality being key factors in determining the balance between P capture and release. Our findings will inform ongoing efforts to reduce watershed P loads, estimate the water quality benefits of wetland and floodplain restoration, and refine the design of restoration plans to achieve intended water quality benefits.

Carbon Sequestration in the Oldest Tidal Wetland Restoration Projects Along the West Coast, USA

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Tidal wetland restoration, often implemented by re-introduction of tidal flow, is a critical tool to increase coastal wetland area and enhance ecosystem services and resiliency to sea level rise in tidal wetlands. Although billions of dollars have been spent on restoration over decades, we still have limited information on some of the oldest projects and how their condition can inform future restoration efforts. Restoration practitioners, managers, scientists, and coastal policy makers need data on restoration outcomes and trajectories to plan future projects and quantify restoration benefits. Working with four west coast NERRS reserves, regional blue carbon working groups, and other partners, we compiled data on wetland elevation, vegetation communities, and carbon sequestration in eleven older restoration sites (10 to 60 years, post-restoration) and adjacent reference wetlands in California, Oregon, and Washington. We also used existing data sets and conducted targeted new sampling to examine restored site condition and relationships between vegetation, elevation, estuary landscape features, and carbon sequestration and storage. The rate of carbon sequestration is the product of sediment carbon density and the rate of sediment accretion. We found that over all sites, restored and reference, sediment accretion, rather than carbon density, was the best predictor of carbon sequestration. Additionally, rates of sediment accretion equaled rates of sea level rise in nine of the eleven restored sites and all eleven reference sites. While rates of sediment accretion and carbon restoration were similar in the reference and their paired restored sites, carbon densities were still lower in the restored sites, even decades after restoration. Finally, we describe a “blue carbon restoration trajectory” wherein rates of accretion and carbon sequestration are initially high in the restoration sites (often higher than in the paired reference sites) and then decrease and stabilize over time. Conversely, carbon densities start low in the restoration sites and gradually increase over time.

Floating Treatment Wetlands with Biochar to Treat Nutrients in a Stormwater Pond

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Stormwater ponds are intended to mimic natural aquatic waterbodies and to treat urban runoff, prevent flooding by slowing stormwater surges, and filter nutrients that come from these landscapes. Floating treatment wetlands are a type of phytoremediation technique used to remove nutrients in stormwater ponds through biogeochemical processes. These systems allow plants to grow hydroponically in stormwater ponds. The plants take up nutrients from the water column through their roots and promote healthy rhizospheres, which transform nutrients. The purpose of this investigation was to see if the performance of Floating Treatment Wetlands in an urban stormwater pond were enhanced by mixing a perennial wetland plant called *Canna flaccida* (*Golden canna*) and a perennial grass called Fakahatchee grass (*Tripsacum dactyloides*). The study also investigated whether a mixture of the species removed more nutrients compared to monocultures. Additionally, a subset of floating wetlands had a planting media mixture of biochar and coir with plants to see if biochar increased nutrient uptake from the water column and promoted root growth compared to treatments without biochar. Nutrient monitoring of the surrounding pond water over time assessed water quality changes in the pond, and the plants were harvested after 4 months of installation. Total fresh mass and dry mass were measured to look at nutrient uptake by the plants. The coconut fiber was dried until constant weight and ground for combustion and colorimetric methods, and the 2M KCl extraction method was used to extract nutrients from biochar. Total nitrogen (TN), total phosphorous (TP), ammonia (NH_3), and ammonium (NH_4) were assessed in planting media after the single harvest event. We hypothesized that mixed species would perform better on removing nitrogen from the water column than monocultures and that mats with biochar incorporated into planting media would uptake more nutrients from the water column due to their efficient absorption capacity. We further hypothesized that biochar with coir would promote healthy root rhizospheres, enhancing nutrient uptake by plants and microorganisms at the stormwater pond. Results showed that the treatment with *Canna flaccida* and coir only performed best removing TN species down to 0.44 mg/L after a highest value of 0.75mg/L for a 42% removal difference, NH_4-N (10%), NO_3 (10%), DON (47%). The treatment with coir and biochar only with not plants was the second-best treatment for a removal of TN (66%), NH_4-N (20%), NO_3 (63%), DON (36%), indicating that biochar enhanced nutrient removal from the water column. Additionally, the treatment with Fakahatchee grass, coir, and biochar together performed best on removing P species from the water column with OP (7%), TP (8%). The research will help inform stakeholders, urban community members, and farmers about the role of floating treatment wetlands and their benefits in removing excess nutrients from surface water at stormwater ponds, the type of Florida Nativa plants they can use in the system, and the use of biochar to improve the absorption capacity of the system promoting sustainable ecosystems and more cleaned urban water systems.

Algal Bloom Events and Environmental Drivers in Big Cypress and Brighton Seminole Reservations in Florida

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In recent years South Florida has been increasingly impacted by harmful algal blooms (HABs). In July and August 2023, thick algal mats, characterized by intense green to blueish coloration and strong odor, were reported in the Big Cypress and Brighton Seminole reservations as well. The likelihood that these were HABs raised concerns. In response, we conducted surface water field sampling and analysis to identify and quantify algal species and to assess water quality conditions. Surface water was tested for chloride, magnesium, potassium, silica, sodium, alkalinity, nitrogen (organic and inorganic), phosphorus, pH, conductivity, temperature, dissolved oxygen, and solids content.

Using non-metric multidimensional scaling (nmds) and k-means clustering, we categorized algal communities into four distinct clusters (ALGAE1–4). Clusters ALGAE3 and ALGAE4 contained the highest relative abundance of potentially toxic (ptox) cyanobacteria species, notably belonging to the *Sphaerospermopsis* and *Dolichospermum* genera, which dominated samples during peak bloom events. Dissimilarities in species composition among clusters were driven by elevated water temperature (r^2 = 0.52) and by elevated levels of total Kjeldahl nitrogen (r^2 = 0.77) and total phosphorus (r^2 = 0.49). In contrast, ALGAE1 represented communities characterized by much lower potential toxicity and accounted for 81% of the samples.

Flowing water proved to be an effective strategy for reducing blooms' severity. For example, both bloom density and toxicity decreased after increasing water flow in the internal ditch network, resulting in a shift from ptox- to non-ptox-dominated communities. Regression analyses revealed significant correlations between algal bloom severity and additional surface water parameters that can be monitored as indicators of algal blooms formation and proliferation, such as dissolved oxygen (r = 0.77), pH (r = 0.70), and turbidity (r = 0.71). Our findings highlight the importance of nutrient management and hydrologic interventions in preventing HABs. Elevated nutrients enter the Seminole reservations from upstream sources. Strategies such as reducing external nutrient inputs and maintaining water flow seem effective in mitigating bloom risks. Clear correlations between algal bloom severity and several other surface water characteristics were observed. Surface water features such as color, turbidity, mat thickness, and odor proved to be useful field indicators for an initial qualitative assessment of the potential toxicity of the blooms.

Formation and Fate of Iron Sulfide Compounds Following Simulated Dredged Sediment Placement in Coastal Wetlands

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Restoration projects are being implemented to address natural and anthropogenic threats to coastal wetlands, including sea level rise and historic landuse alterations. Dredged sediments can be used in restoration projects to increase elevation and stabilize marsh platforms. However, some dredged sediments contain iron sulfide minerals (FeS_x) or they form after sediment placement. Under aerobic conditions, such as drought, FeS_x oxidizes generating acidity that can dramatically lower soil pH, impacting plant establishment and threatening the success of wetland restoration projects. This talk communicates the results of two simulated dredged sediment placement experiments involving the formation and fate of FeS_x compounds under three hydrological scenarios including continuous inundation, tidal flushing, and drought. The dredged sediment used in the first experiment did not contain FeS_x but resulted in FeS_x horizon development initiated within 16 days, expanding to encompass > 30% of the soil profile after 120 days under continuously inundated and simulated tidal conditions. The second experiment introduced FeS_x rich dredged sediments which rapidly oxidized (< 21 days) after wetland placement across all treatments followed by declining oxidation reduction potentials, increasing dissolved Fe concentrations, and subsequent FeS_x re-precipitation in continuously flooded and simulated tidal treatments. Results suggest that FeS_x compound, whether deposited with dredged sediments or formed after wetland placement, pose minimal risk of acidification under prolonged saturated conditions.

Does Benthic Biogeochemistry Drive Algal Blooms in Shallow, Subtropical Florida Lakes?

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Algal blooms have become increasingly common occurrences in shallow lakes, including in Lake Washington and Blue Cypress Lake, located in east-central Florida (USA). These blooms have raised concerns about cultural eutrophication and questions about whether the nutrients that fuel them come from allochthonous (external) or autochthonous (internal) sources. To determine if the nutrients that cause these blooms come from within the lakes, specifically from phosphorus in bottom deposits, a sediment characterization and flux study was conducted. Characterization of the lake deposits involved collecting sediment cores from sites throughout the two shallow waterbodies and measuring porewater nitrogen, phosphorus, and metal species at depths in the profiles. In a related study, we collected a second group of sediment cores that were continuously incubated over a period of 24 hours, with overlying samples of water collected every 4-6 hours. Water samples were analyzed for soluble reactive phosphorus (SRP), as well as N_2, O_2, ammonium, and nitrate. Statistical analysis of bulk sediment and porewater indicated spatial variability in benthic substrate lithology and element concentrations, especially in Lake Washington. Regardless of porewater and substrate element concentrations, nutrient fluxes into the overlying waters were extremely low or below the detection limit in both lakes. The only noticeable flux from the sediments to the water column was from N_2 gas, suggesting there was denitrification in Blue Cypress Lake and nitrogen fixation in Lake Washington at the time of sampling. It is possible that SRP is bound by oxidized iron, aluminum, and calcium at the sediment/water interface, particularly under oxic conditions, thereby preventing nutrient release into the overlying water. Internal recycling of nutrients does not appear to be fueling algal blooms in these lakes, suggesting that allochthonous nutrient sources are the major driver of primary productivity.

Comparison of Soil Total Nitrogen Stocks in Natural and Restored Mangrove Forests of Southwest Florida

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Human activities have more than doubled the amount of N applied to terrestrial soils in the past century, and 20-60% of this N is exported to the aquatic environment. These rates are expected to double or triple by 2050. Excess N can lead to eutrophication of coastal systems, causing algal blooms, fish kills, coastal acidification and decreases in biological diversity. Coastal wetlands are globally important for N cycling and storage, with temperate mangrove soil total N (TN) stocks estimated between 2.73 – 20.73 Mg Ha-1. However, much remains unknown about local drivers of soil TN accumulation. The objective of this study is to quantify and compare TN stocks in natural and restored mangrove sites in Southwest Florida. Soil cores have been collected from 24 plots at 4 sites in our study regions. In each plot a single core was collected for Pb-210 dating so that stocks of natural and restored sites can be compared for equivalent timeframes. Measurement of dry bulk density and loss-on-ignition were made from four cores within each plot for quantifying spatial uncertainty. For preliminary results, TN will be estimated using LOI data because measurement of TN concentrations from an elemental analyzer are ongoing. Understanding the TN stocks in natural and restored mangrove forests will help inform better understanding of how factors like surface elevation, vegetation biomass, and time since restoration influence the amount of TN mangrove soils can store.

Assessing the Influence of Breakwaters on Salt Marsh Denitrification Ecosystem Services

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In coastal environments, nature-based solutions like breakwaters are increasingly used to protect shorelines from erosion and promote marsh resilience to sea-level rise. While breakwaters are designed to decrease wave height and energy, they may also alter patterns of sediment deposition, marsh plant distribution, and carbon storage, with potential consequences for other ecosystem services. Here, we investigate how breakwaters impact nitrogen removal and retention. To assess the impact of breakwaters on nitrogen dynamics, we measured potential rates of denitrification (DNF) and dissimilatory nitrate reduction to ammonium (DNRA) using sediment incubations that employ the isotope pairing technique in three marshes along the Swift Tract shoreline in Bon Secour Bay, AL. One marsh had no breakwaters (control), one marsh had breakwaters established in 2012 (TNC), and one had breakwaters established in 2017 (NRDA). Within each marsh, we measured potential DNF and DNRA rates in both unvegetated and vegetated sites to identify potential plant-mediated effects on nitrate reduction. Preliminary results indicate there were no differences in DNF or DNRA in the unvegetated control marshes relative to unvegetated breakwater marshes, suggesting physical changes behind breakwaters may not affect nitrate reduction, although variation was high. We also found no differences in DNF in vegetated control marshes relative to vegetated breakwater marshes. Across all marshes, DNF was higher in unvegetated sites relative to vegetated sites. Overall, these results suggest that marshes behind breakwaters function similarly to marshes without breakwaters, as breakwaters did not enhance nitrogen removal ecosystem services.

Seagrass Sediment Carbon in the Indian River Lagoon, Florida

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Seagrass meadows are vital to estuarine ecosystems, serving as efficient natural carbon sinks by sequestering CO_2 through photosynthesis and storing organic carbon in their sediments. Despite the important benefits and services provided, seagrass ecosystems are declining globally due to a myriad of climatic and anthropogenic factors. Historically, extensive seagrass meadows were common throughout the Indian River Lagoon (IRL), Florida, however, eutrophication and subsequent declines in water quality and light attenuation has led to significant losses over the last decade. The loss of habitat structure reduces carbon storage capacity, which can weaken both ecosystem stability and resilience. Seagrass carbon stock data are currently lacking in the IRL and baseline information on spatial variability is required to forecast changes in stocks over time and to derive regional and global estimates. In 2023, we quantified seagrass biomass and sediment carbon stocks at 27 sites spanning the IRL's latitudinal gradient. We found significant differences in carbon storage across IRL basins, which are related to seagrass diversity and persistence. This study offers the first comprehensive carbon stock assessment of seagrass habitats across the IRL, establishing crucial baseline data for these vital ecosystems. By strengthening the science, supporting the storage potential of coastal ecosystems, carbon sinks, and our understanding of associated biogeochemical processes, the ability to identify and manage priority areas for conservation and restoration will greatly improve.

The Effect of Manganese Oxides and Ferric Hydroxides on the Treatment of Greywater in Unsaturated Constructed Wetlands

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Onsite reuse of greywater for various purposes is increasingly common but requires treatment to meet legal and safety standards for both users and the environment. Constructed wetlands (CWs) are effective for greywater treatment, providing both efficient contaminant removal and ecosystem services. While greywater usually has low concentrations of bulk organic contaminants, it may contain high levels of organic micropollutants, which pose risks when reused for irrigation. CWs can remove some biodegradable or non-mobile micropollutants, though many are poorly removed. Enhancing removal efficiency is possible using reactive filtration bed additives like iron hydroxides and manganese oxides. The study aimed to determine the impact of these amendments on organic micropollutants removal and the abundance of functional genes. A vertical-flow CW with an intermittent feeding regime and unsaturated bed was used, promoting aerobic processes. The system was fed with artificial greywater containing 26 organic micropollutants at concentration 10 or 50 µg/L. Ferric hydroxides improved organic micropollutants removal by 28%, and manganese oxides by 7%, compared with the efficiency in treatment filled with sand. Vegetation did not affect organic micropollutant removal in control sand-filled CWs but increased it by 7% in manganese oxide columns. In the systems with iron hydroxides, vegetation reduced organic micropollutant removal by 9%. The removal processes mediated by the (hydr)oxides could be assumed to be oxidation and also sorption. The highest overall removal of organic micropollutants, 84%, was achieved in the planted systems with ferric hydroxide. However, some compounds, such as artificial sweeteners, fluconazole, and hydrochlorothiazide, remained resistant to both biotic and abiotic degradation and require further attention. This study found that media type significantly affected the absolute abundance of 15 genes ($p<0.05$). Ferric hydroxide supported higher prokaryotic and fungal community growth than sand and manganese oxide ($p<0.05$), showing the highest abundance of bacterial 16S rRNA, archaeal 16S rRNA, and fungal ITS genes. Manganese oxide had the lowest prokaryotic and fungal community abundance among all media tested. The abundance of the gene involved in the Fe-oxidizing process (encoding MtoA c-type cytochrome) was only detected in the presence of ferric hydroxide, while the proportion of genes associated with the Mn-oxidizing process (*mnxG* and *mcoA*, belonging to multicopper oxidases group) was the highest in the manganese oxide-filled CWs. The proportion of key genes related to the indirect electron transport chain for both Fe and Mn-reducing processes (*mtrA*, *mtrB*, *cymA*) tended to be lower in the presence of ferric hydroxide($p<0.05$) compared to manganese oxides and sand ($p<0.05$). In the CWs filled with ferric hydroxide or manganese oxides, *mnxG* genes dominated over *mcoA* and mtrA, mtrB, and cymA genes.

Linking Phosphorus Storage Mechanisms with Removal Performance in Everglades Stormwater Treatment Wetlands

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Constructed wetlands (CWs) have been applied all over the world to reduce excess phosphorus (P) from nonpoint source nutrient pollution. However, the relationship between the function of CWs and the biotic and abiotic mechanisms that drive P storage has not been widely studied. This study seeks to better understand the biotic and abiotic mechanisms that contribute to P storage in a study of six Everglades Stormwater Treatment Area (STA) CWs representing a range of performance designations (i.e., well- vs under-performing). A principal component analysis (PCA) was conducted on accreted soil (i.e., floc and recently accreted soil layers) P fractionation data from STA-1E EFW, STA-1E CFW, STA-2 FW3, STA-2 FW4, STA-3/4 CFW, and STA-5/6 FW1. The results of this study found that there are four P storage mechanisms present in the STAs: (1) microbially driven biotic, (2) abiotic driven by carbonate formation, (3) abiotic driven by iron (Fe), and (4) abiotic driven by aluminum (Al) and potassium (K). Well-performing FWs stored the majority of P via the abiotic mechanisms driven by carbonate formation as well as Al and K. Under-performing FWs stored the majority of P via the microbially driven biotic mechanism and abiotic mechanism driven by Fe. The results of this study point to various management strategies to improve P storage and P removal performance, such as submerged aquatic vegetation management and better understanding of the exact mechanisms behind the abiotic mechanisms driven by Al, Fe, and K.

Modeling Climate and Land Use Change Impacts on Net Ecosystem Carbon Balance in Coastal Wetlands

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Ecosystem- and landscape-level assessments of wetland carbon sequestration are increasingly required to inform greenhouse gas inventories, land management planning, and climate mitigation policies. However, the impact of climate and land use change on wetland net ecosystem carbon balance, and contributions to local-, regional- and national-scale carbon accounting, remains unclear. Over the past decade we have developed the **L**and **U**se **CA**rbon **S**imulator (LUCAS), a modeling framework comprised of integrated sub-models of landscape change and carbon cycling, which allows us to assess multi-scale effects of changes in land cover and climate on carbon stocks and fluxes, including estimates of uncertainty, for a wide range of terrestrial ecosystems.

The focus of this presentation is to highlight recent advances in the LUCAS model, which incorporate wetland-specific vertical and lateral carbon fluxes (e.g., methane emission, lateral flux of dissolved carbon, soil carbon accumulation) in ecosystem carbon estimates for both emergent and forested wetlands. We present a case study from the Mississippi River Alluvial Plain, illustrating historic climate and land use change impacts on net ecosystem carbon balance in emergent and forested wetlands of coastal Louisiana. Using alternative scenario analyses, we highlight the importance of wetland carbon fluxes to regional net ecosystem carbon balance through comparisons of terrestrial versus wetland forest scenarios. This work provides a method for improving carbon accounting at the local-, state-, and national-scale by incorporating wetland carbon fluxes into net ecosystem carbon balance estimates and highlights future research and data needs for broad-scale application.

Understanding the Great Lakes: It Is More Than Just Phosphorus

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The Laurentian Great Lakes (GL) contain 20% of the world's surface fresh water, spanning more than 1,200 kilometers from west to east. Composed of Lakes Superior, Michigan, Huron, Erie, and Ontario, the GL basin is home to over 38 million residents of two countries, eight states, and two provinces. These inland seas contain 22,573 km^3 of fresh water and are being subjected to numerous stressors, including excess runoff stimulating harmful algal blooms, over 180 aquatic invasive species, toxic sediments from prior industrial activities, and loss of critical habitat, among others.

Although the five Great Lakes are often thought of as a single unit by people living outside the Basin, in reality there are significant differences in their ecology, hydrology, and anthropogenically-induced stressors. In this talk, I will describe the general features among the Great Lakes, review their differences and commonalities, and briefly describe a few restoration efforts and habitats with an emphasis on biogeochemical processes. Specifically, these examples will address 1) phosphorus (P), which caused massive benthic algal blooms in the 1970s but was thought to be controlled through the Clean Water Act and has returned in a different form; 2) a wetland restoration project that has successfully reduced water column P concentrations from 1500 µg/L to 30 µg/L; 3) the biogeochemistry and productivity in Great Lakes freshwater estuaries; and 4) unique sinkhole ecosystems, whose microbial communities depend on ancient venting groundwater for their metabolic existence.

The talk will conclude with science-related recommendations for the future, which are designed to generate the necessary knowledge to better understand this critical aquatic system.

"Going Local": Addressing Heterogeneity in Biogeochemical Cycling in Mangrove Systems Through Sedimentary Setting and Geomorphology

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Highly productive mangrove forests are valued as 'blue carbon' systems for their ability to sequester organic carbon within their soils. Due to this utility, multiple global assessments have been carried out to identify global central tendencies of mangrove organic carbons stocks and flux rates. Mangrove forests, however, exhibit high ecological heterogeneity that is obscured in accounting of global central tendencies. In these studies, a macroscale mangrove typology based on hierarchical classification of sedimentary and geomorphic setting was used to identify global variability in mangrove soil organic carbon burial rates and elemental stoichiometry of mangrove soil stocks. Mangroves occupying terrigenous sedimentary settings bury organic carbon at a faster rate than carbonate settings, though terrigenous setting mangrove soils exhibited lower ratios of OC:SOM. Differences in sedimentary setting and geomorphology provide insights concerning ecosystem properties, can be used for prioritizing mangrove restoration, and underscore the importance of 'going local' to improve fundamental understanding of carbon cycling in mangrove ecosystems.

Modeling Wetland Redox Biogeochemistry and Vegetation Function at Site to Continental Scales

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Redox cycles, geochemistry, and pH are recognized as key drivers of subsurface biogeochemical cycling in wetland ecosystems but are typically not included in land surface models. Vegetation responses to inundation and salinity are also key factors in coastal wetland function and are not included in large-scale land models. These omissions may introduce errors when simulating carbon cycling and greenhouse gas emissions in systems where tidal influences, redox interactions, and pH fluctuations are important, such as coastal regions where sulfate concentrations associated with saltwater influence can drive biogeochemical contrasts across salinity gradients. Here, we coupled the Energy Exascale Earth System Model (E3SM) Land Model (ELM) with geochemical reaction network simulator PFLOTRAN, allowing geochemical processes and redox interactions to be integrated with land surface model simulations. We implemented a reaction network including aerobic decomposition, fermentation, iron oxide reductive dissolution and dissolved iron oxidation, sulfate reduction, sulfide oxidation, methanogenesis, methane oxidation, and pH dynamics. We used the model framework to simulate biogeochemical cycling and methane production across redox gradients in coastal wetlands across gradients of salinity. In addition, we incorporated plant functional responses to water level and salinity and parameterized salt marsh and mangrove plant functional types in the model. Model simulations were parameterized using laboratory incubations and literature values and evaluated using measured porewater concentrations and surface gas emissions from wetland field sites across coastal regions of the United States. These results demonstrate how directly simulating biogeochemical reaction networks and coastal vegetation function can improve land surface model simulations of subsurface biogeochemistry and carbon cycling in wetland ecosystems and highlight the value of porewater biogeochemical data for evaluating process-based wetland biogeochemical models.

Does Mangrove Encroachment Enhance Biogeochemical Resilience to Sea Level Rise?

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Tidal marshes are biogeochemical control points in the landscape, intercepting and removing reactive nitrogen (N) at the terrestrial-marine interface. This function is tightly coupled to marsh vegetation, as plants can regulate soil redox conditions and provide organic carbon to heterotrophic microbes. However, climate change has resulted in multiple, often concomitant impacts on vegetation composition, productivity, and persistence, with subsequent impacts on associated belowground biogeochemical processes. We investigated how two climate disturbances, saltwater intrusion and mangrove expansion, impact soil nitrogen removal potential (i.e., denitrification). Individually, both disturbances can alter marsh nitrogen removal capacity. Salinization can lower plant productivity and increase sulfide accumulation in soil, inhibiting the denitrification pathway. In contrast, the change in root structure associated with mangrove encroachment can increase oxygen delivery to the soil, alleviating sulfide inhibition and promoting coupled nitrification-denitrification. To test how these concomitant disturbances can affect marsh nitrogen processing, we conducted a full factorial greenhouse experiment where *A. germinans* seedlings were grown in conjunction with *J. roemerianus* at increasing levels of salinity (0, 5, 10, 15 psu). We predicted that *A. germinans* would buffer salinity effects on denitrification potential rates, measured using the isotope pairing method on soil slurries. We found that salinity, rather than plant assemblage, impacted denitrification potential. Rates in the 0-salinity treatment were more than twice as high as all other salinity treatments. While there was a trend of higher removal potential in *A. germinans* compared to mixed and *J. roemerianus* treatments, there was no significant effect of assemblage on N-removal potential. Our results indicate that at least at early stages of mangrove growth, saltwater intrusion may have a greater impact on N-removal rates than mangrove expansion. However, it is possible that the greater salt tolerance of mangroves may help maintain ecosystem N-removal capacity.

Assessment of Soil Greenhouse Gas Fluxes Along a Salinity Gradient in Coastal Deltaic Floodplain of Louisiana

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Estuarine marshes are important ecosystems because they provide ecological services to human beings, such as carbon storage and sequestration, and water filtration. Despite this, salt marshes are potentially a major source of methane (CH_4) and nitrous oxide (N_2O). Climate change and human activities are threatening these ecosystems with unclear implications for greenhouse gas (GHG) emissions, specifically on the Louisiana coast. Estuarine marshes in the delta have been negatively affected mainly by the relative rise in sea level and alterations in river discharge, with significant seasonal shifts in salinity. We are assessing the fluxes of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) along a salinity gradient (brackish, saline, and freshwater) and including different types of vegetation in three sites during a year. The sites were selected to represent freshwater and saline endmembers, with a mid-salinity site that varies above and below 4 ppt salinity. The freshwater site is Wax Lake Delta, the saline site at Old Oyster Bayou (> 20 ppt), and the brackish site in mid-Folleague Bay (~4 ppt). Soil gas fluxes are measured with a chamber and trace gas analyzer (LI-COR). In addition to the fluxes of the three gases, sediment temperature and redox, water level, pore water, organic matter, and nutrients are monitored. The experimental design of this study is a Repeated Measured Design (RMD). We hypothesize that fluxes on the sites and vegetation will vary over the seasons based on river discharge. To test these hypotheses, an ANOVA will be applied with repeated measurement over time. Fluxes of CH_4 will be higher with greater river discharge as salinities decrease. The implications will be that climate change impacts on precipitation patterns in the upper Mississippi River Basin may have a significant impact on the CH_4 fluxes and GHG production in coastal deltaic floodplains of the active Mississippi River Delta.

Using Long-Term Monitoring Datasets to Demine Wetland Resilience

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The Coastal Reference Monitoring System (CRMS) stations in Louisiana serve as a critical framework for monitoring and evaluating the coastal environment. These stations are designed to systematically collect data on various environmental parameters, including water quality, salinity, and sediment dynamics. The data obtained from these stations is essential for understanding coastal processes, guiding conservation initiatives, and managing natural resources within Louisiana's unique ecosystems. Salinity intrusion poses a significant threat to Louisiana's coastal wetlands, impacting their ecological balance and resilience. Predicting its impact involves identifying early warning signs, as indicators that can help conservationists and restoration planners take proactive measures to mitigate damage. The salinity intrusion can lead to the loss of freshwater vegetation and the conversion of marshes into open water. Monitoring spatiotemporal salinity patterns, as well as the health of key vegetation species, is crucial for understanding and managing these transitions. Additionally, incorporating predictive models that account for factors like sea-level rise, storm surges, and human interventions can provide valuable insights for restoration efforts. Understanding and enhancing the resilience of ecosystems facing salinity intrusion in delta regions is a critical and multifaceted challenge. Focusing on components like sensitivity to increased salinity, recovery ability from disturbances, and adaptability through system diversions provides a comprehensive framework for assessing resilience. It's intriguing that none of the estuarine systems consistently outperformed the others across all resilience components. This highlights the complex trade-offs inherent in ecosystem management. Enhancing resilience in one aspect might inadvertently compromise another, emphasizing the need for a balanced and nuanced approach. The way ecosystems respond to salinity intrusion will undoubtedly shape their long-term adaptability, not just to salinity changes but also to broader social-ecological phenomena. For wetland systems under stress, bolstering resilience is vital. Implementing policies and interventions, reallocating resources, and adjusting farming practices can sustain agricultural production or facilitate a smoother transition to alternative systems when necessary. In order to contribute to this ongoing effort, we have implemented three key components of resilience: (1) the sensitivity of the CRMS stations to increased salinity intrusion; (2) the capacity to recover from salinity-induced damage or perturbations; and (3) the ability to transition to alternative systems or diversions should salinity levels increase in the future. The nomenclature and identification of CRMS station IDs were derived and developed from the Coastal Information Management System (CRMS) database (http://cims.coastal.louisiana.gov).

Soil and Groundwater Dynamics Within Varying Land Classes of a Proposed Forested Wetland Mitigation Bank

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Wetland mitigation programs aim to reduce impacts from the permitted destruction of wetlands by preemptively creating, restoring, enhancing, and preserving wetland structure and function within "banks" located in similar ecological boundaries. Research has revealed numerous positive benefits of mitigation efforts, but gaps remain in our understanding of comparable biogeochemical functionality between natural and restored wetlands, particularly within forested riverine wetlands. Several active mitigation projects within the Army Corps of Engineers New Orleans District claim improved biogeochemical functionality from created, restored, or enhanced wetlands without adequate assessment of pre and post functionality. Here, we demonstrate soil and groundwater functional analyses prior to vegetative and hydrologic restoration in a proposed mitigation bank located within 3 km of the Mississippi River near St. Gabriel, Louisiana. Local precipitation currently drives hydrologic dynamics in the bank whereas seasonal river flooding was the former driver prior to construction of protection levees. In and around the bank, we assessed bulk density, organic matter, pH, and nutrient distribution (P, K, Na, S, Zn, Ca, Cu, Mg, total N, total C) in soil profiles of varying land classes at 15 systematically placed sites with 5 randomly spaced sampling subsites. At each site, we monitored groundwater to 2 m depth weekly. Land classes included bottomland hardwood forest, cattle pasture, row crop, and revegetated pasture. Soil deposits included rarely flooded Sharkey clays with some frequently flooded Sharkey clays and Commerce silt clay loams. Soils were sampled at 0 – 10 cm, 10 – 20 cm, and 20 – 30 cm profiles. We hypothesized that bulk density of the upper profile would be lowest in the forested land class due to increased organic inputs and highest in the cattle pasture due to trampling and compaction. This hypothesis was correct and only the top profile of the revegetated pasture had similar bulk density to the forested sites. We also anticipated C/N ratios to be highest in the forested and revegetated areas with greater inputs of dead plant material and lowest in the cattle pastures and row crop land classes. This hypothesis was correct with the lowest C:N ratios in the row crop land class. We expected nutrient content to have a negative relationship with elevation. This hypothesis was correct as nutrients filter downslope. The highest concentrations of Ca, Cu, Mg, K, Na, and S were found in the forested land class. Finally, we expected more seasonally responsive groundwater dynamics in the forested areas than pasture lands, though we did not observe this relationship. These baseline estimates reveal potential benefits of restoring pastureland or row crops to bottomland hardwood forest, such as increased soil nutrients and quality. We propose incorporation of these pre-restoration functional assessments into wetland credit valuation, and we advocate for more comprehensive long-term monitoring of biogeochemical functions within wetland mitigation banks to ensure 1:1 replacement of wetland value.

Mangrove Wetlands Leaf Productivity and Expansion are Controlled by Air Temperature, Phosphorus Availability, and Salinity in Port Fourchon, Louisiana, USA

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temperate coastal regions, driven by rising air temperatures associated with climate change in the Gulf of Mexico (GOM). While the presence of the mangrove species *Avicennia germinans* has been historically documented in this area, its expansion has accelerated over the last 20 years. Given the complex factors at play in competition among wetland plants for space and resources, it is expected that temperature alone does not drive and sustain this expansion, which is regulated by bio-geomorphic feedback at local spatial scales. This study evaluates how scrub mangroves (<1.5 m height)—the currently dominant mangrove ecotype—differ from taller trees (>3 m) (fringe and intermediate ecotypes) to understand how fertility and relative elevation influence net primary productivity (NPP). This information is essential for predicting expansion rates that will change habitat structure, function, and the quality and quantity of ecosystem services in coastal wetlands. Port Fourchon, located in an abandoned delta lobe of Louisiana, contains the largest mangrove area (~811-1000 ha); thus, it serves as an ideal site to assess the relative influence of temperature (freeze events/warming) and nutrient availability on foliar productivity (NPP_L)— a major contributor to soil formation. We addressed the following questions: 1) What is the difference in litterfall NPP (foliar and total) between fringe and scrub mangrove ecotypes? 2) What is the litter residence time on the forest floor? 3) What are the leaf stoichiometric (C:N:P) differences among the ecotypes? 4) Does phosphorus (P) availability restrict mangrove growth and productivity? Litterfall samples were collected monthly in litter baskets deployed across different ecotypes from 2019 to 2024. Porewater salinity in mangrove soils (>35) exceeded that of salt marshes NPP_L rates varied from 0.2 to 2-4 gdw m^{-2} yr^{-1}, with lower values found in the fringe forest. Both inorganic nitrogen (N) and P availability are high, supporting increased productivity rates. Carbon content in senescent leaves was similar in summer and spring, with variations in the C:N ratio reflecting growth patterns and changes in nutrient demand. N:P ratios were not significantly different among ecotypes, although a difference in the C:N ratio was observed. Experimental litter baskets, adjusted for area and canopy height, yielded comparable results. The concentrations of [PO_4^-] in soil pore water (PW) were 188±23 μM, and total organic P in senescent leaves was 522±21 μg/g, indicating substantial P availability; these PW concentrations represent the highest observed in *A. germinans* monospecific mangrove forests in the GOM. Despite their low stature, the reproductive output of mangroves is high, supporting and accelerating expansion rates even in the face of natural disturbances (e.g., defoliation from hurricanes and freezes).

Investigating the Cycling of Nutrients from Seafood Processors' Waste in Organic Fertilizer

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The seafood industry in Louisiana generates an economic impact of $2.4 billion annually. The chemical profile of waste from urban processors presents a unique input of naturally derived phosphorus and protein that become readily available nutrients for microbial communities. With processing operations being focused on commodities such as shrimp and crab, the generation of processing waste often exceeds 40-70% by weight of the raw materials used in the industry. Current trends of disposal of this waste in landfills are not only causing environmental pollution owing to the contamination of sensitive coastal ecosystems but also costing a significant amount of money to processors. The objective of this study is to test the potential of the Black soldier fly larva (BSFL)-based bioconversion system, which allows the valorization of seafood processing waste into protein-rich animal feed ingredients and fertilizer to be used in agricultural operations. The adoption of this system may enable the processors to run a sustainable processing operation that emphasizes on circular economy. Nutrient analysis of Louisiana seafood shells confirmed their suitability for BSFL rearing. Findings from larval growth trials indicated commercial BSFL diet could be replaced with up to 40% seafood waste without affecting larval development, while bioconversion efficiency improved at inclusion rates up to 60%. The nutritional content of harvested BSFL and fertilizer, referred to as frass, remained comparable to controls across all treatments, indicating seafood waste can effectively substitute commercial formulations in industrial-scale BSFL production. Comprehensive economic analysis and further research on the efficacy and safety of the resulting byproducts are recommended before commercial implementation of this strategy.

Does Agricultural Runoff Influence Anaerobic Methanotrophy in a Southern Californian Wetland?

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Wetlands are a rapidly growing source of atmospheric methane – a potent greenhouse gas – and are major natural contributors to the annual methane burden. Anthropogenic activity, including agriculture, may feed high concentrations of nitrate into wetlands. The impact of agricultural nitrate on anaerobic oxidation of methane – a significant sink for methane produced in wetland sediment – is not well understood. Likewise, the significance of the anaerobic oxidation of methane to alleviating the wetland nitrate burden is not yet well-studied. Nitrate is a thermodynamically favorable electron acceptor for anaerobic oxidation of methane. Consequently, high concentrations of nitrate may inhibit or minimize the use of other electron acceptors, such as iron and sulfate. The role of agricultural runoff for wetland anaerobic oxidation of methane may thus be pertinent to projecting future wetland methane emissions. We performed anoxic sediment slurry incubations to simulate agricultural runoff into a coastal wetland utilizing surface, runoff-exposed brackish sediment collected from a Southern Californian wetland — the Carpinteria Salt Marsh Reserve. We utilized ^{15}N-nitrate, ^{35}S-sulfate, and ^{14}C-methane labeling techniques to assess rates of nitrate reduction, sulfate reduction, and anaerobic oxidation of methane, respectively. We incubated slurry with and without methane, differentiating nitrate and sulfate reduction dependent on anaerobic oxidation of methane from all present nitrate and sulfate reduction. Preliminary ^{15}N-nitrate incubation results indicate that, in the presence of methane, denitrification and anammox rates significantly increase. DNRA rates were not significantly affected by the presence of methane. This may indicate that anaerobic methanotrophy is significant to removing nitrate from the brackish wetland sediment via denitrification and (potentially indirectly) anammox. Anaerobic methanotrophy did not significantly affect DNRA rates – a process that retains biological nitrogen within the system. Preliminary ^{35}S-sulfate incubation results indicate that high nitrate input may suppress sulfate reduction. Future analysis of ^{14}C-methane incubations will illuminate the significance of high nitrate input on anaerobic methane oxidation, particularly whether this partial sulfate reduction suppression is correlated with partial anaerobic methane oxidation suppression. Furthermore, analysis of ^{14}C-methane incubations will shed light on the individual significance of nitrate- and sulfate- dependent anaerobic oxidation of methane to total anaerobic oxidation of methane. This work will provide a deeper look into the dominant processes driving anaerobic methane removal in coastal wetland sediment and the potential role of agricultural runoff in shaping which processes dominate.

Distribution of Heavy Metals in Plants Growing in Constructed Treatment Wetlands

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Heavy metals do not represent a significant threat in domestic sewage from small municipalities and therefore, they are not a target for treatment. However, they do occur in measurable concentrations. The major aim of this study is to evaluate the distribution of heavy metals and metalloids in both aboveground and belowground biomass of plants growing in constructed wetlands treating domestic sewage. The results presented in this study were obtained during the period 2002-2016 at five constructed wetlands. The study includes sixteen samplings for *Phragmites australis* (common reed) and ten samplings for *Phalaris arundinacea* (reed canarygrass). In addition, for *P. australis* also five natural unpolluted stands were sampled for aboveground biomass. The samples were taken from a 0.25 m^2 quadrant (0.5 x 0.5 m). The aboveground biomass was clipped at the ground level and divided into stems, leaves and flowers. The belowground biomass was dug out from the same quadrant to the depth of 0,5 meters. In the laboratory, the belowground biomass was gently washed and divided into roots and rhizomes in big jars to prevent the loss of fine roots. The biomass was dried at 60°C to a constant weight and weighed. The biomass was then homogenized using a cutting mill and mineralized in nitric acid in a microwave under high temperature and pressure. The concentrations of heavy metals (Cd, Cr, Cu, Ni, Pb and Zn) were determined using the atomic absorption spectroscopy and concentrations of other heavy metals and metalloids (Al, As, Co, Fe, Mn, Mo, Se, Sn) were analyzed using ICP MS analyzer. The results were expressed as standing stock in mg/m^2. The results revealed that distribution of studied heavy metals and metalloids among aboveground parts is similar in *P. australis* and *P. arundinacea*. In *P. australis*, the average amounts in leaves, stems and flowers amounted to 53, 43 and 4%, respectively, while for *P. arundinacea* the respective values were 49, 47 and 4%. However, the substantial difference was observed for belowground parts. In *P. australis*, 44% and 56% of the metals and metalloids were sequestered in roots and rhizomes, respectively, in *P. arundinace* the respective values were 69% and 31%. This difference is apparently caused by different structure of the belowground biomass of both plants. While *P. australis* has more biomass located in the rhizomes, rhizomes of *P. arundinacea* are small but root network is very dense. The distribution of heavy metals and metalloids between aboveground and belowground biomass varies among elements but not too much among plants species monitored in this study. The highest amounts in the aboveground biomass were found for molybdenum (72 and 77% for *P. australis* and *P. arundinacea*, respectively) followed by selenium and zinc. On the other hand, the highest amount in the belowground biomass was found for cobalt (89 and 88% for *P. australis* and *P. arundinacea*, respectively) followed by iron and chromium.

Spatial Evaluation of Water Quality Parameters to Optimize Nutrients and Dissolved Oxygen for Crawfish Ponds

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Crawfish production in Louisiana is present in 29 parishes and contributes more than 214 million dollars to its economy. It is estimated that roughly 110,000 acres of land is used to farm crawfish with approximately 1,300 commercial farmers. These aquaculture farmers use surface and well water inputs to stimulate crawfish growth, nutrient dispersion, and dissolved oxygen generation. The objective of this study is to optimize water input and aeration areas to balance nutrient loads and dissolved oxygen for the ecosystem. A novel approach using uncrewed surface vessels and precision water quality analytical sensors was used to map the pond for nitrate, ammonium, temperature, conductivity, turbidity, pH, and dissolved oxygen. The autonomous systems are deployed in closed systems to run missions during different parts of the day and collect continuous data sets for spatial analysis of water quality parameters. The data sets will be linked to GPS coordinates around the pond to show nutrient and dissolved oxygen profiles correlated to surface water temperature and distance from the input water (or aeration) source. Methodologies and spatial contour mapping will be highlighted for future research missions and provide innovative analysis for a variety of aqueous systems. This project will ultimately provide data on the nutrient dynamics in crawfish ponds and account for the dispersion of dissolved oxygen across pond acreage.

Unraveling the Drivers of Bubble Methane Emissions in Urban Rivers: The Roles of Organic Carbon, Temperature, and Water Depth

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Bubble methane (CH_4) emissions are recognized as a significant contributor to elevated CH_4 fluxes in urban rivers. However, due to the general lack of simultaneous monitoring of isotopes and bubble fluxes, our understanding of the driving factors and pathways of bubble CH_4 emissions in urban rivers remains limited. This study utilized in-situ surveys of the Huangpu River Basin in Shanghai, a typical megacity in China, to investigate the spatial and temporal variations of bubble CH_4 emissions and its potential controlling factors. In addition, we investigated the bubble CH_4 production processes through the combination of laboratory incubation and isotope techniques. In this study, bubble CH_4 fluxes ranged from 4.49 to 591.42 mmol m^{-2} d^{-1} (median: 39.36 mmol m^{-2} d^{-1}), contributed nearly 80% of CH_4 emissions and varied on spatial scales. High bubble CH_4 fluxes were attributed to elevated organic carbon content in sediments and the shallow water depths of urban rivers. Additionally, CH_4 emissions from bubbling exhibited a high temperature sensitivity, which was modulated by the ecosystem trophic status. Furthermore, our results demonstrated that the bubble emission rate was correlated with the variability of $\delta^{13}C$-CH_4, with the $\delta^{13}C$-CH_4 in bubbles ranged from -68.09‰ to -48.23‰. The relatively high bubble emissions were maintained by the acetoclastic methanogenesis process, which may be related to the input of fresh organic matter. Overall, further detailed isotopic and microbial investigations are necessary to constrain the contributions of different pathways to CH_4 production, consumption, and emissions.

Modeling Carbon Fluxes in Forested Wetlands in the Mississippi River Deltaic Plain Under Various Hydrologic Conditions

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Forested wetlands represent significant carbon (C) sinks. C dynamics in forested wetlands have been shown to be impacted by climate change. However, our understanding of the impact of climate change on the magnitude and variability of C storage and fluxes in forested wetlands in the Mississippi River Deltaic Plain (MRDP) remain limited. In this study, we applied a process-driven wetland biogeochemistry model, Wetland Carbon Assessment Tool DeNitrification-DeComposition model (WCAT-DNDC) to explore the responses of C dynamics in the swamp forests of Lake Maurepas, Louisiana, to climate change-induced hydrologic conditions. Eleven sites inside the Lake Maurepas swamp forests from the Coastwide Reference Monitoring System (CRMS) were selected for this modeling study. These sites represent three major swamp forest habitat types with different hydrological and salinity regimes: healthy, relict, and degraded. The climate change scenarios (dry, normal, and wet years) were determined by the Palmer Drought Severity Index (PDSI) for Southeast Louisiana during 2000-2023. The wet year with high water level from high flow during the spring season was simulated to represent the Mississippi River (MR) diversion condition. The WCAT-DNDC was calibrated and validated using field observed above- and below-ground net primary productivity in Lake Maurepas swamp forests with good agreements. Simulation results indicate that the responses of the C fluxes (productivity, sequestration, decomposition, export) in Lake Maurepas forested wetlands vary substantially to changes in hydrologic conditions especially during drought-induced saltwater intrusion conditions that could result in increased C loss and such loss could be reduced by MR diversion. The responses are complex and variable due to the non-linear relationships between C cycling processes and environmental drivers in the swamp forests impacted by both freshwater and saltwater under climate change and management of land and freshwater, such as the MR diversion/reintroduction into Lake Maurepas swamp forests. Data and information from this study may help ecosystem-based management of Lake Maurepas forested wetlands under the impacts of climate change and MR diversion.

Methane Escape from the Deteriorating Mississippi River Delta

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Large river deltas, as one of the most productive and economically important landscapes, develop diverse wetland ecosystems, including salt, brackish and freshwater marshes that sequester carbon dioxide from the atmosphere. However, as important carbon sinks, their contribution to the greenhouse gas (GHG) budget of the Earth system is poorly constrained, in part because of high spatiotemporal heterogeneity in GHG flux. The spatiotemporal heterogeneity of GHG flux (CH_4, CO_2, N_2O) is driven by both abiotic and biotic factors, and it adds great challenge to accurately estimate GHG emission from the heterogenous deltaic landscapes that are experiencing rapid deterioration. To tackle this challenge and improve the estimation of GHG emission from large river deltas, we set up a case study at the Mississippi River deltaic plain (MRDP), and configured a process-based subsurface reactive transport model for six selected hydrological regions (Atchafalaya, Mississippi Delta, Pontchartrain, Barataria, Terrebonne, and Breton Sound) in the MRDP to estimate the GHG emission from deltaic wetland during 2009 – 2019. Model simulation shows that, over the decade scale, CH_4 flux has different spatial distribution than the CO_2 and N_2O fluxes: (1) higher CH_4 fluxes are released from freshwater dominant areas than those from the saltwater environment across different hydrological regions, and (2) for greenhouse gas CO_2 and N_2O, higher fluxes are from regions where water temperature is warmer (i.e., seawater impact). It indicates that interior wetlands of the selected hydrological regions are probably large emitters for all three GHG, such as interior freshwater or intermediate marsh of Pontchartrain, Barataria and Breton Sound regions where both freshwater and seawater influences are limited.

Biochar Mitigated Zerovalent Iron-Induced Methane Emissions in an Arsenic-Contaminated Paddy Soil: The Mechanism

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Biochar (BC) and zerovalent iron (ZVI) can synergistically enhance immobilization of arsenic (As), but their synergistic effects on mediating methane emission in As-contaminated soils remain largely unknown. Here, the responses of soil organic carbon, methane emissions, and microbial community to combined use of ZVI and BC in an As-contaminated paddy soil were investigated in an incubation experiment. The results indicated that ZVI reduced As bioavailability by 65%, which was further enhanced by BC, however BC alone increased As availability by 36%. Regarding methanogenesis and oxidation, As discouraged methane emissions in soil partially due to decreased diversity and richness of bacterial and archaeal communities. Besides, ZVI remarkably stimulated methane emissions by decreasing soil redox potential, promoting organic substrate degradation, and enhancing hydrogenotrophic methanogen Methanobacterium. The ZVI-induced methane emission was alleviated by BC application. Firstly, BC inhibited methanogenesis because of promoted iron oxidation and decreased hydrogenotrophic methanogens abundance. Secondly, BC facilitated methane oxidation by enriching methane oxidizing bacterium Methylomonas and metabolic function. That is, BC can enhance As immobilization and mitigate ZVI-dominated methane emission. These findings highlighted the impact of BC and ZVI on carbon-iron-As nexus and its potential for simultaneous As mobilization and carbon sequestration in paddy soils.

Diel Fluctuation of Carbon Dioxide Emission Affected by Eutrophication and Dissolved Organic Matter in China's Largest Urban Lake

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The large variability of carbon dioxide (CO_2) emissions from urban lakes remains a challenge for partitioning these sources at meaningful spatial and temporal scales. Dissolved organic matter (DOM) governs spatial and temporal variations in CO_2. Yet, relationships of CO_2 concentration (cCO_2) and emission flux (FCO_2) with DOM in urban lakes have rarely been reported. In this study, we monitored cCO_2, FCO_2 and DOM composition over a 24-hour period at three sites in dry and wet seasons in China's largest urban lake, the Tangxun Lake. Our study found the ratio of day/night FCO_2 (mmol m^{-2} d^{-1}) decreased from the dry season (0.79; 7.68/9.68) to the wet season (0.25; 6.05/24.16), averaging 0.42 (6.77/15.97), implying that accounting for nighttime CO_2 emissions can elevate regional estimates by 70%. This study revealed that eutrophication affected diurnal CO_2 emissions with an increased algal growth enhancing daytime CO_2 uptake and subsequently increasing nighttime CO_2 emissions via DOM degradation (higher protein-like DOM fraction). We anticipate that the relative magnitude of FCO_2 between day and night from lakes is likely to increase due to urbanization and climate change, underscoring the importance of treating urban lakes as a distinct group, and integrating DOM dynamics into carbon cycling in future research.

Mercury Properties and Transformations in Wetland Sediments of the Changjiang Estuary

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Toxic trace metal mercury (Hg) is a recognized global pollutant. The health risk of methylmercury (MeHg) exposure to human primarily results from consumption of estuarine and marine fish and shellfish. The Changjiang Estuary is one of the most important fishing grounds in China. Studies have suggested that a large amount of Hg and MeHg from the Yangtze River basin are transported to the estuary every year. However, the properties and fate of Hg in sediments in this area is unclear. The objectives of our study were to (1) better understand the biogeochemical reactivity and mobility of Hg in the fine grains of the sediments by using thermodesorption techniques and chemical extraction methods; (2) examine the potential of Hg methylation under scenarios of external Hg input and periodically changing redox conditions by microcosm experiments. The concentrations of Hg fractions in sediments were analyzed by a DMA-80 direct Hg analyzer at different heating temperatures of 175, 225, 325 and 750 °C. Hg compounds in selected sediments were determined by sequential chemical extractions with 0.5 M HCl followed by 1 M KOH. The concentrations of MeHg in the sediments were extracted by the $CuSO_4$–HNO_3–CH_2Cl_2 extraction method and was detected by cold vapor atomic fluorescence spectrometry.

Total Hg in wetland sediments (0−40 cm) ranged from 12.3−129.8 ng/g, with average 75.3 ± 15.8 ng/g (n = 354). In addition, the proportions of labile Hg fractions released at 175 °C were less than 5% of the total Hg. Furthermore, more than 74% of Hg in the sediments was released at temperatures between 175 and 325 °C, which corresponded well to the amount of organic-chelated Hg in the sediments as determined by extraction with 1 M KOH. The mean concentrations of MeHg in surface and vegetated sediments is 0.38 ± 0.29 ng/g (n = 237), ranged from 0.02−2.3 ng/g. MeHg/THg(%) was 0.09−2.6% with the highest potential methylation rates occurred in the upper surface sediments(<12 cm). For 252-days microcosm incubation that stimulated the fluctuation of redox conditions in wetlands, the results showed that MeHg net formation in sediment increased by 43.3−205.9% under anoxic conditions following soluble Hg loading increased by 113.0–329.9%, and MeHg exhibited slight variations with the changes in redox conditions. After 140 days incubation, however, MeHg net formation greatly increased following plant residuals' addition under anoxic conditions. Yet MeHg decreased rapidly following sediment resuspension under oxic conditions.

Our results suggest Hg bound to humic substances or to organomineral complexes could play a key role in controlling Hg species in sediments in wetlands of the Changjiang Estuary. The MeHg net formation and its degradation after mercury loading was closely relative to the degradation of labile organic matter, and the risk of MeHg could be significantly reduced after a long-term aging of mercury under the scenario of low concentration input.

Investigation of Salt Marsh Platform Vegetation Stress Indicators to Reveal Potential Marsh Loss Mechanisms

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In the Northeastern US, tidal salt marsh is being lost at rates 5-10% per decade, attributed to symptoms of sea-level rise, such as fragmentation, edge erosion, and tidal channel expansion. Unexpectedly, high-elevation plants are experiencing mortality, contributing to the development and expansion of ponds, pannes, and areas of bare peat on the marsh platform. These observations of high marsh mortality contrast strongly with conceptual models of salt marsh vulnerability to climate change, where generally low-elevation vegetation exposed to excessive inundation is considered more vulnerable to loss. However, observations of high marsh plant mortality are in strong accordance with the dominant paradigm of salt marsh ecohydrologic zonation, which identifies poorly drained conditions in the upper marsh, and sustained periods of continuous upward flow of saline water in these zones during neap tides. To help identify spatial patterns in plant stress, we conducted a study of soil redox, greenhouse gas exchange, and other plant stress indicators at three locations in Massachusetts, New York, and New Jersey, where excessive ponding is found on the marsh platform. We employed analysis of satellite imagery for band ratios, porewater sulfides, analysis of water levels and pressure gradients from nested piezometers, as well as greenhouse gas exchange. Our results reveal significant spatial patterns in plant stress, challenging the assumption that low marsh elevations are most vulnerable. These findings suggest a complex relationship between tidal flooding, soil redox, and plant health, emphasizing the need for nuanced models to accurately capture the dynamics of marsh disintegration.

Microbe Mischief: How Microbes Drive Cryptic Cycling in Mangrove Wetlands

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Coastal mangrove wetlands are notorious for vast carbon storage relative to the space they occupy. Within these vegetated sediments, carbon is transformed into greenhouse gasses (e.g., methane and carbon dioxide) via microbial respiration. Shifts in vegetation from mangrove to salt marsh could alter primary production and hence carbon storage, causing a lasting impact to their environment. This study collected sediment across spatial and diel scales to investigate how vegetation shifts affect associated sediment microbial communities and methane production. Methane and carbon dioxide gas was measured using flux chambers and calculated from discrete measurements. DNA and RNA were extracted simultaneously, resulting in 49 paired metagenomes and metatranscriptomes. These datasets were used to investigate microbial community structure and function with regards to cryptic cycling. We noticed a significant difference in daytime and nighttime methane flux at each vegetation type. There was a significant difference between total (DNA-based) and active (RNA-based) microbial communities. This pattern was also observed when it came to the expression of methane cycling genes and transcripts. There was a noticeable difference in the structure of our microbial communities when compared across sediment depth. There was more similarity in metabolic function between each vegetation types' top 2-4 and 12-14 cm depths, likely due to sediment mixing (e.g., waves, bioturbation); whereas, deeper depth of 20-22 cm grouped independently indicating an increase in stability with depth. We observed structural variability with functional redundancy in the active microbial community. This indicates that as changes occur within mangrove wetlands, the functionality may remain the same. The presence of active methanotrophs and active methanogens, consuming and producing methane, respectively, indicate a putative methane cycle within our wetland sediments.

Consequences of River Reconnection on Water Quality in Barataria Bay

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Coastal wetland loss in Louisiana is driven by a number of factors including sea level rise, subsidence, loss of river connection through levee construction as well as canal construction and geologic features. Louisiana has 40% of all coastal wetlands in the contiguous USA but experience 80% of the loss. Restoration efforts include reestablishing the connection of the coastal basins with the Mississippi River through diversion structures. The diversions will change the water temperature, salinity and nutrient concentrations in the receiving basins. Consequently, we will review recent research on diversion impacts on nitrogen and phosphorus cycling in both wetland soils and submerged sediments under changing conditions to better predict impacts of the under construction Barataria Sediment Diversion. The denitrification rates of the coastal marshes far exceeds that of the submerged sediments. However, the relative flooding time suggests that the marsh will only be flooded 35% of the time while the submerged sediments will be flooded 100% of the time. Hence, the lower rates of denitrification for submerged sediments may actually play a larger role in the nutrient removal of the incoming river water. Colder Spring water temperature has been shown to decrease denitrification rates and this is expected to occur during diversion operations since the maximum sediment is carried by the river on the rising limb of the first flooding event. The phosphorus loading from the Mississippi River will be dominated by the inorganic particulate fraction as the SRP levels are generally ~ < 0.1 mg/L. Additionally, the N:P ratio favors complete uptake of SRP with nitrate remaining by diatoms. The Equilibrium Phosphorus Concentration, the point at which P release equals P uptake by the sediment, is expected to change with the introduction of mineral, primarily Fe-Al bound Mississippi River sediment into the coastal basin containing organic phosphorus dominated wetland soils. Analogs such as Mardi Gras Pass can be used to better predict changes to the coastal basin.

Meta-Analysis Describing How Plant Species Composition Drives Salt Marsh Greenhouse Gas Fluxes

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Salt marshes are considered net carbon sinks, yet there is substantial uncertainty about the factors driving variability in greenhouse gas (GHG) fluxes, which may offset their net climate benefits. Salt marsh plants fix carbon dioxide (CO_2) into organic carbon that can be buried and stored long term. Salt marshes also emit CO_2, methane (CH_4), and nitrous oxide (N_2O). Because plants differ in their tolerance to stress and competitive ability, their presence or absence indicates salt marsh environmental conditions. Additionally, plants shape the environmental conditions in which they grow, which can, in turn, alter GHG fluxes. We hypothesize that plant species composition integrates long-term salt marsh conditions and thus will be a strong predictor of GHG fluxes. Although individual studies compare salt marsh GHG fluxes across different vegetation types, a global synthesis is needed to determine if the relationship between vegetation and GHG fluxes can be used as a predictor of fluxes in order to estimate the GHG sink capacity of salt marshes. Here we will present the results of a global meta-analysis of 118 peer reviewed studies that measure salt marsh GHG fluxes across different vegetation types. We extracted the study location, month of sampling, method of sampling, plant species composition, respiration (CO_2), net ecosystem exchange (NEE, CO_2), CH_4 flux, and N_2O flux. We also extracted environmental parameters (e.g., salinity, tidal range, photosynthetically active radiation, soil temperature, pH, etc.). We used Hedge's *g*, an approach used to calculate standardized mean differences in meta-analyses, to calculate pairwise comparisons of fluxes between *Spartina alterniflora* and different species within a marsh. Additionally, we ran mixed-effects meta regression models with study ID as a random effect to explore potential factors driving differences in fluxes. Plant species, season, salinity, tide, and sampling method were included as moderators in the model and explain heterogeneity in effect sizes. These results can be used by coastal managers to more accurately estimate the carbon sink capacity of salt marshes, enabling better-informed conservation and management strategies.

Assessing Water Quality of Wetland Reserve Easements in the Mississippi Alluvial Valley

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Wetland systems receive nutrient inputs from atmospheric, terrestrial, and aquatic sources, transforming them through various biogeochemical processes that enhance downstream water quality and ecosystem productivity. However, extensive agricultural conversion in the Mississippi Alluvial Valley has exacerbated wetland loss, diminishing an important function of net nutrient sinks amid bottomland hardwood forests. The Agricultural Conservation Easement Program-Wetland Reserve Easement program, administered by the United States Department of Agriculture-Natural Resources Conservation Service, aims to mitigate wetland losses and degradation and restore wetland function on private lands. A core objective of the Wetland Reserve Easement program is to improve water quality through restored hydrology and vegetation, thereby enhancing processes of nutrient retention and removal. To assess restoration success, we examined seasonal water quality patterns from 37 sites (5 cropland fields, 5 historic wetlands, and 27 Wetland Reserve Easements) quarterly from June 2023 to May 2024 in Mississippi and Louisiana. Water quality conditions in Wetland Reserve Easement sites differed ($p < 0.05$) from both cropland and reference sites. Across multiple parameters, restored sites maintained water quality values intermediate between cropland and reference conditions. Water temperature was a consistent driver of water quality across all modeled parameters. Nutrient concentrations were significantly elevated in cropland fields, particularly during summer and autumn, while reference wetlands consistently maintained the lowest levels across all seasons. Total nitrogen and dissolved reactive phosphorus were 40–50% and 30–75% lower, respectively in Wetland Reserve Easement sites across seasons compared to cropland sites. Total organic carbon was lower in cropland sites compared to Wetland Reserve Easements ($p < 0.05$), and total suspended solids were more variable in Wetland Reserve Easements, with values between cropland and reference conditions. Alkalinity was also of intermediate level in restored sites and declined across all site types in winter and spring. Specific conductance and total dissolved solids decreased significantly in cooler seasons, but there was no effect among site types. Our findings suggest that water quality of Wetland Reserve Easement sites is enhanced from cropland sites, reflecting transitional ecological conditions and seasonal patterns, and partial functional recovery following restoration

Effects of Chlorinated Disinfectants on Greenhouse Gases Emissions from Urban Inland Waters

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Chlorinated disinfectants are widely used in urban wastewater treatment systems. Excessive use of these disinfectants can lead to higher levels of residual chlorine and disinfection by-products (DBPs) being discharged into surface waters and even water sources through effluent discharge and surface runoff, potentially affecting the health of aquatic ecosystems, including microbial communities. However, the potential impacts of these emerging contaminants on key carbon and nitrogen cycling processes and greenhouse gases (GHGs) emissions in water remain largely unknown. In this study, we selected 15 wastewater treatment plants (WWTPs) in a megacity in China as our research subjects to investigate the effects of effluent discharge on GHGs emissions in upstream and downstream river. The results showed that in summer, the N_2O, CO_2, and CH_4 fluxes from WWTPs were 114.07 ± 10.81 mmol $m^{-2}\cdot h^{-1}$, 9.65 ± 7.59 mmol $m^{-2}\cdot h^{-1}$, and 0.16 ± 0.10 mmol $m^{-2}\cdot h^{-1}$, respectively. The average concentration of residual chlorine was 0.72 ± 0.34 mg L^{-1}. We detected DBPs in almost all water in the vicinity of the WWTP, with a total concentration range of 0-39.68 μg L^{-1}, with the highest concentrations of 14.31 ± 10.38 μg L^{-1} for HAAs, 7.78 ± 7.90 μg L^{-1} for THMs, and 0.99 ± 1.17 μg L^{-1} for HANs. Additionally, we found that water with higher concentrations of DBPs had lower concentrations and fluxes of GHGs, suggesting that DBPs may alter the activity of related microbial communities, thereby affecting the GHGs production process and reducing GHGs emissions. To further reveal the potential mechanisms by which residual chlorine and DBPs impact GHGs, we plan to conduct further laboratory culture experiments to explore the effects of DBPs on GHGs production and emission in urban rivers.