RESTORE ACT CENTER OF EXCELLENCE FOR LOUISIANA ALL-HANDS MEETING AUGUST 20, 2019

Background

The Water Institute of the Gulf was selected by the Louisiana Coastal Protection and Restoration Authority (CPRA) to serve as the State's RESTORE Act Center of Excellence (LA-COE), and on Nov. 1, 2015, the U.S. Department of the Treasury awarded CPRA a grant to begin its research program. Funding for the research program comes from fines and penalties in the wake of the 2010 Deepwater Horizon oil spill.

Announced on June 22, 2017, 13 projects were awarded with a total near $3 million that included research and collaborative awards as well as graduate studentships. On Aug. 17, 2018, the LA-COE, in cooperation with CPRA, held its first All-Hands meeting in Baton Rouge to receive updates from the 2017 grant awardees funded under the first request for proposals.

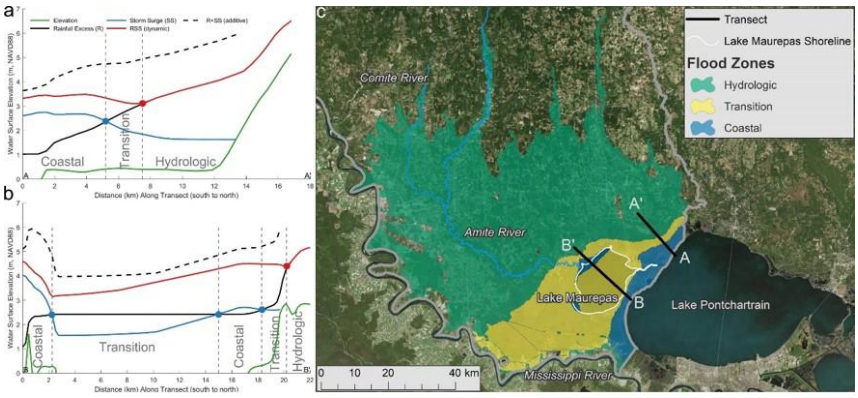
A second All-Hands meeting in Baton Rouge was held on Aug. 20, 2019. Since the previous meeting, one researcher, Dr. Sanjay Tewari, moved out of state and left the program. As their projects approach completion, the 12 grant awardees presented research updates as well as highlights on how their research can be used to inform CPRA's Louisiana Coastal Master Plan. Summaries of each awardees' research are presented below.

Projects

Coupling hydrologic, tide and surge processes to enhance flood risk assessments for the Louisiana Coastal Master Plan ($499,882)

PI: Scott Hagen, Professor & Director, Louisiana State University Center for Coastal Resiliency (LSU CCR)

Co-Investigators: Matthew Bilskie, LSU CCR; John Atkinson, ARCADIS; Donald Resio, University of North Florida



In the wake of the August 2016 floods in southeastern Louisiana, officials were concerned about the the potential consequences of a tropical storm making landfall on already saturated soils and a flooded landscape.

This project seeks to understand the compound effect of rainfall with storm surge on flooding in low-lying coastal areas as defined by flood transition zones (see graphic from Bilskie & Hagen, "Defining Flood Zone Transitions in Low-Gradient

Coastal Regions." *Geophysical Research Letters*, Vol. 45(6), pp. 2761-2770, 2018. https://doi.org/10.1002/2018GL077524). By coupling hydrologic (e.g., rainfall and runoff) and tide and surge flooding processes at the coastal land margin, the ability to model the overall process was enhanced. This compound flood modeling application could provide further information on the combined effects of storms (winter and tropical) with antecedent rainfall, lead to a more complete return period analyses, and ultimately result in the capability to assess flood risk in the transition zone – all of which will benefit restoration projects. Research outputs include numerical models on the Lake Maurepas and Barataria watersheds that can capture surge and wind with modeled and/or gridded rain. This modeling tool can be especially important for the assessment of Coastal Master Plan projects in low gradient coastal regions and is the basis for all work that will be done within flood transition zones under the Louisiana Watershed Initiative.

An evaluation of faulting in Holocene Mississippi River Delta strata through the merger of deep 3D and 2D seismic data with near surface imaging and measurements of vertical motion at three study areas ($349,174)

PI: Mark Kulp, Associate Professor of Earth and Environmental Sciences and Director of Coastal Research Laboratory, University of New Orleans
Co-Investigators: Nancye Dawers, Tulane; Rui Zhang, University of Louisiana at Lafayette; David Culpepper, The Culpepper Group; John Lopez, Lake Pontchartrain Basin Foundation; Kevin Yeager, University of Kentucky

South Louisiana contains a number of faults, some of which could extend to the surface which would be essential to be aware of in planning coastal restoration projects since these surface-impacting faults could impact how land subsides locally. While there is a good amount of information from deep seismic data collected through oil and gas exploration, this project is meant to bridge the gap between this data set and the surface. Looking at deep faults in three study areas using seismic industry data, this team is working to determine things like slip rates where possible, determine whether these faults have had impacts near the surface, and assess impacts to infrastructure by mapping elevation changes along roads that cross the faults. Three study areas are planned in northern Terrebonne-Timbalier Bay, Bayou Lafourche near Golden Meadow, and the Lake Pontchartrain/Lake Borgne areas of the Deltaic Plain to better understand the vertical motion of land surfaces. While the work continues, early results show that shallow movement of faults in the Lake Pontchartrain study area coincide with visible offsets and elevation changes along the Causeway and Highway 11 bridges. Similar surveys are being done in the Terrebonne Parish study area. Overall, this research will help develop a template for determining whether the presence of a fault should be considered during a project to improve a project's long-term success or viability.

Assessment of coastal island restoration practices for the creation of brown pelican nesting habitat ($299,733)

PI: Paul Leberg, Professor in Department of Biology, University of Louisiana at Lafayette
Co-Investigator: Jordan Karubian, Tulane University

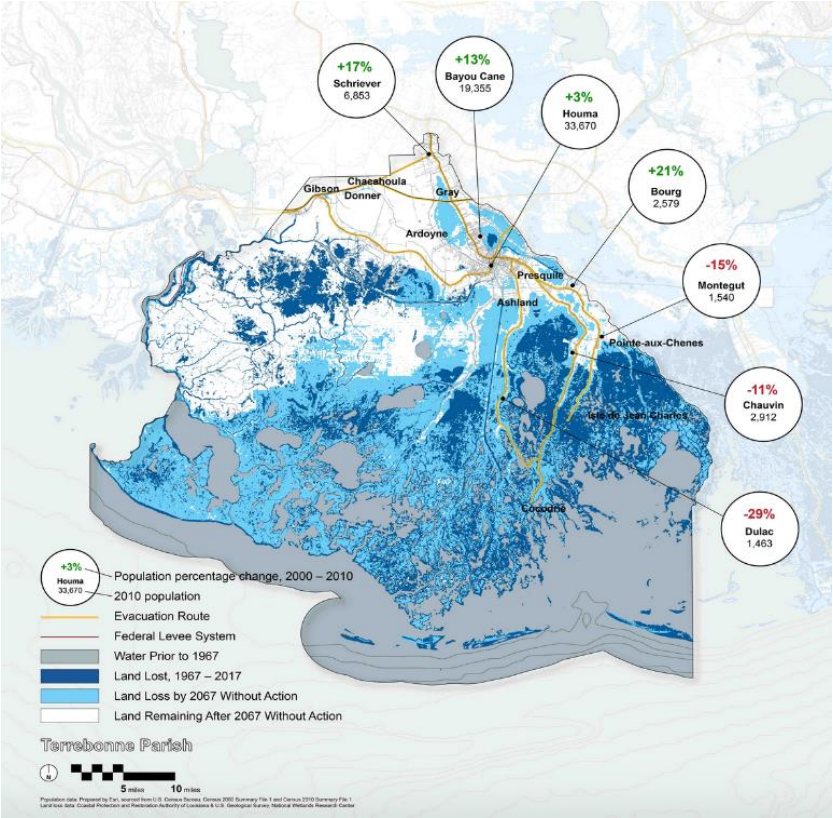
Restoration efforts on coastal islands, such as barrier islands, can significantly impact the habitats and the livelihoods of the seabirds that rely on them. This work seeks to understand the effects of restoration efforts on the suitability of coastal islands as seabird sites for breeding, nesting, and foraging, and how changes in vegetation and predator communities affect seabird colony success.
Two field seasons are completed, and one more season of transmitter and nest success data remains to be collected. At this time, some of the preliminary results indicate that birds tend to use smaller islands and ones that are further away from

the mainland, that they are much more likely to nest on restored islands, and that the number of islands used by seabirds is rapidly declining. This research has many potential implications for the Louisiana Coastal Master Plan, for example, these results can be used to improve habitat suitability models for the Brown Pelican in the upcoming and future Coastal Master Plan.

From adapting in place to adaptive migration: designing and facilitating an equitable relocation strategy ($295,338)

PI: Marla Nelson, Associate Professor Planning and Urban Studies, University of New Orleans
Co-Investigators: Traci Birch, LSU Coastal Sustainability Studio; Anna Brand, University of California-Berkley; Renia Ehrenfeucht, University of New Mexico

As sea levels encroach upon our coasts and threaten coastal communities, difficult decisions about adaption and, in some extreme cases, relocation, must be considered. This project is working to understand how households adapt and respond to increasing environmental vulnerability, as well as the role of public officials in facilitating and supporting equitable relocation.



Several communities in Terrebonne Parish are identified in the Louisiana Coastal Master Plan as particularly vulnerable to flooding in the next 25 and 50 years. In order to better understand the challenges and identify innovative practices, interviews were conducted with Terrebonne Parish residents and officials, and past policies and programs were reviewed.

This research can inform policy in the Louisiana Coastal Master Plan to assist in implementing relocation as nonstructural mitigation.

Specifically, the following outputs from this research can be utilized: (1) identification of resident and public official priorities and concerns, (2) explanation of how residents make adaptation decisions, (3) identification of innovative practices and barriers from other buy-out and relocation efforts, (4) development of a strategy to collaborate with communities to design, evaluate, and implement relocation strategies, and (5) development of criteria for identifying suitable relocation and resettlement sites.

Enhancing sediment retention rates of receiving basins of Louisiana sediment diversions ($292,495)
PI: Kehui (Kevin) Xu, Associate Professor, Department of Oceanography and Coastal Sciences, Louisiana State University (LSU)
Co-Investigators: Samuel Bentley, LSU; Yanxia Ma, LSU; Zuo George Xue, LSU

One of the major coastal restoration and protection efforts undertaken by CPRA is to build river sediment diversions to reconnect the river to its floodplain and mitigate land loss. This project is investigating the sediment transport and retention rate in Barataria Bay, one of the proposed sites for a sediment diversion.

Specifically, the study explores the sediment characteristics, the settling and compaction of dredged sediment, and the impact of Sediment Retention Enhancement Devices (SREDs) on how well sediment can be retained (in order to build land) in the receiving area of a river diversion site. Two tripods were deployed in Barataria Bay in late 2018 to early 2019 to capture the effects of winter cold fronts.

A conceptual model was developed, wherein the SREDs effectively divide the receiving area into smaller sub-basins. This model showed that the sediment retention rates generally increased landward (or upstream), but that this can be complicated by impacts of storm surge. There are several potential uses of this research for implementation in the Louisiana Coastal Master Plan. These include focusing on enhancing river sediment delivery, increasing sediment retention, minimizing erosion, testing the design of SREDs, terraces, and living shorelines, and considering the potential benefit of higher retention rates in more landward receiving basins.

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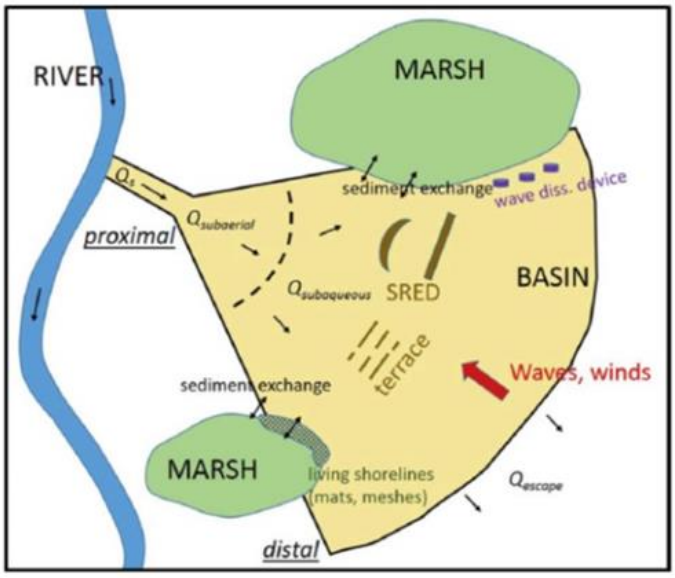


Fig. 7. Processes and sediment budget in a receiving basin of sediment diversion. Q_s is diverted sediment into the basin, $Q_{subaerial}$ is the deposited fluvial sediment as land and $Q_{subaqueous}$ is the deposited fluvial sediment under water. Q_{escape} is the sediment leaving the defined basin area. SRED is Sediment Retention Enhancement Device. See Fig. 10 for some examples of SRED and terrace.

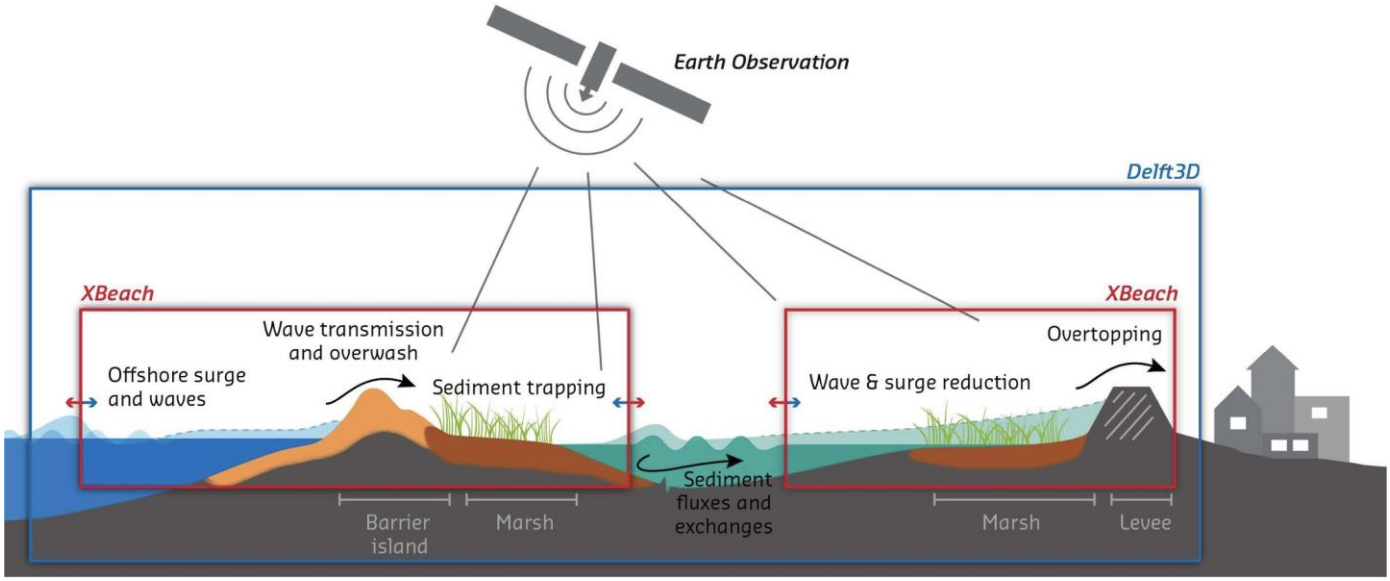
Plant and soil response to the interactive effects of nutrient and sediment availability: Enhancing predictive capabilities for the use of sediment diversions and dredging ($292,914)
PI: Tracy Quirk, Assistant Professor, Department of Oceanography and Coastal Sciences, Louisiana State University
Co-Investigator: Sean Graham, Nicholls State University

This project seeks to understand the interactive effects of nutrient and sediment availability on marsh nutrient cycling, plant productivity, biomass allocation, decomposition, and soil organic matter accumulation and accretion. This work can enhance the predictive modeling capabilities of sediment retention at diversion sites. The hypothesis is that the availability of mineral sediment deposition and elevation influences plant and soil response to nutrient-enrichment. One field-based study in Barataria Bay and two greenhouse studies were conducted. Results indicate that mineral sedimentation deposition and nutrient enrichment treatments generally resulted in stimulated plant growth (above and below ground) or at least reduced the negative effects of low intertidal elevations. These results can be incorporated in predictive models of marsh morphology and accretion response to sediment diversions (e.g., the basin wide Delft3D model and the Master Plan model), this can also inform adaptive management (e.g., thin-layer deposition, marsh creation).

Integrating high-fidelity models with new remote sensing techniques to predict storm impacts on Louisiana coastal and deltaic systems ($501,270)

PI: Kehui (Kevin) Xu, Associate Professor, Department of Oceanography and Coastal Science, Louisiana State University (acting PI).

Co-Investigators: Qin Jim Chen, Professor, Civil and Environmental Engineering, Northeastern University; Claire Jeuken, Deltares USA; Ap van Dongeren, Robert McCall, and Mindert De Vries, Deltares; Brady Couvillion, U.S. Geological Survey.



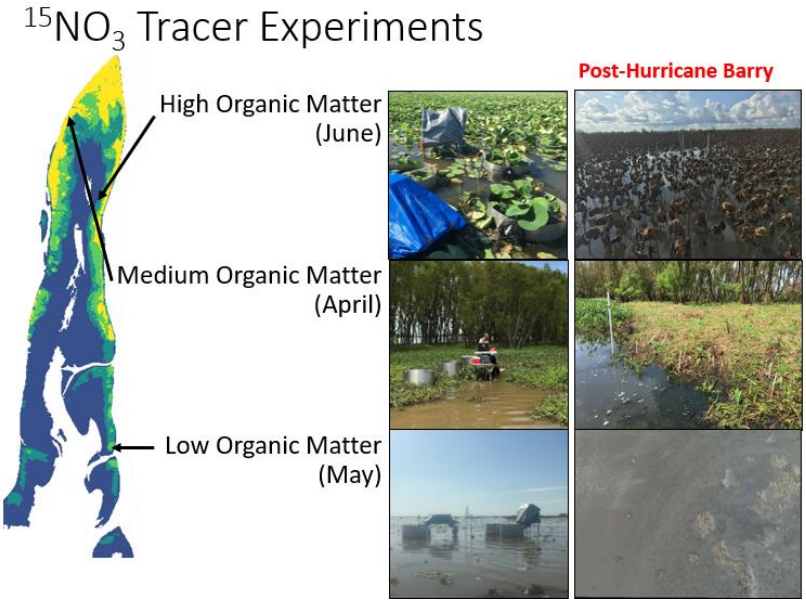
The role and dynamics of barrier islands and back-barrier marshes is important to understand as they represent the "first line of defense" against sea level rise and erosion by wave impacts and storms. The research goal of this project is to develop and apply an innovative model system that integrates Delft3D and XBeach models with field and remotely-sensed observations of hydrodynamic and biophysical data. This integration will enable the prediction of barrier-marsh dynamics, and assess the effectiveness of marshes as a nature-based defense.

New XBeach model results indicate that including back-barrier marshes and a realistic thickness of the sand layer is important. This was found by the successful coupling of Delft3D, SWAN, and XBeach, processing remotely sensed data, and validating XBeach for wave reduction in wetlands with two field datasets. Ultimately, this research shows that the coupling of Delft3D-XBeach enables realistic modeling of storm impacts on barrier islands and wetlands, which can be a powerful and useful implementation tool for the Louisiana Coastal Master Plan, in which a major focus is on barrier island restoration.

GRADUATE STUDENTSHIP AWARDS (ADVISING FACULTY ARE LISTED)

Multiple tools for determining the fate of nitrate in coastal deltaic floodplains ($63,100)
Robert Twilley, Louisiana Sea Grant College Program Executive Director

Graduate student Alex Christensen presented the updates at the All-Hands meeting on the research looking at how nitrates travel through the water column. Fieldwork in the spring of 2019 was interrupted when Hurricane Barry came to shore in July which killed all the plants at the Wax Lake study area. Sampling continued in August with plans to continue in October.



Research is ongoing, but one of the interesting things the researchers think might be going on is that some of the nitrate is turning into ammonium. Fieldwork and modeling results will help refine water quality models currently in use which could be applied to more specific planning of marsh creation projects for nitrogen uptake and potential impacts from upcoming sediment diversions.

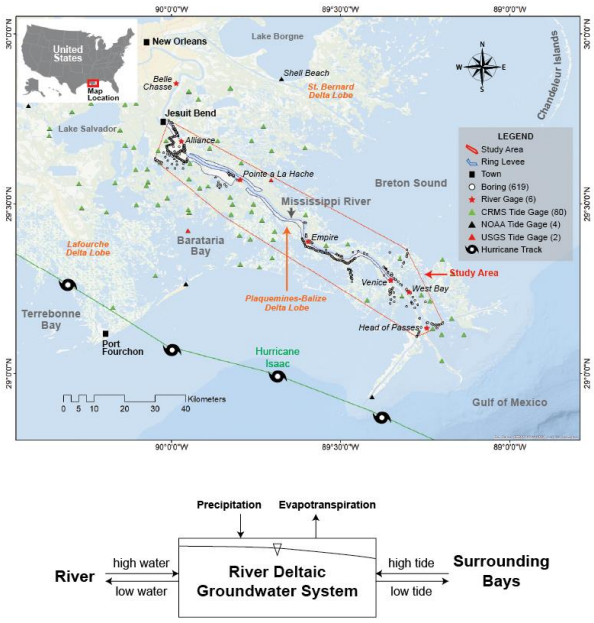
Project Louisiana rivers' sediment flux to the coastal ocean using a coupled atmospheric-hydrological model ($77,015)
Zuo (George) Xue, Assistant Professor, Department of Oceanography and Coastal Sciences, Louisiana State University

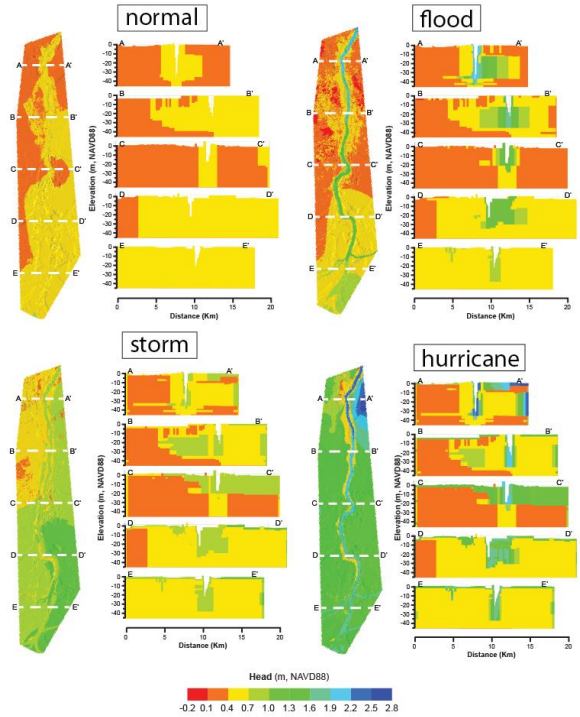
This research aims to better understand the contribution local rivers such as the Calcasieu, Mermentau, and Vermillion have on the stability of the Chenier Plain, especially as these local rivers are more vulnerable to long-term and short-term disturbances such as climate change, sea level rise, flooding, and restoration projects.

This project is coupling surface water and sediment modeling to better understand sediment movement through these local rivers and examine possible changes in water and sediment changes due to climate change or future restoration projects. Test runs of coupled models have been performed and the next step is to transfer this combination of models to the coastal landscape of Louisiana.

Constructing Mississippi River delta plain soil stratigraphy – implications for coastal land building and compactional subsidence ($70,070)
Frank Tsai, Professor Department of Civil and Environmental Engineering, Louisiana State University

This study investigates coastal land building and compactional subsidence through soil stratigraphy analysis and subsidence modeling of the Mississippi River Deltaic Plain. Essentially, this work hopes to show how groundwater impacts coastal projects. The project is developing a three-dimensional soil stratigraphy model, analyzing spatial patterns to identify seepage pathways for surface-groundwater interaction, and to develop a groundwater flow model which will imply where the ground rises, where it sinks, and where erosion could be implicated. Preliminary information shows interactions between the river, the gulf, and the groundwater system, can particularly be seen during high water events.





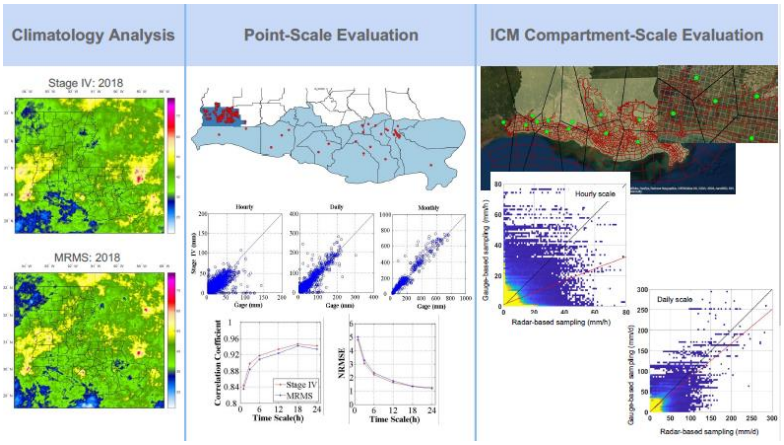
Determining the influence of surface water diversions on physical and nutrient characteristics of wetland soils ($83,328)
John White, Professor of Department of Oceanography and Coastal Sciences, Louisiana State University

In 2007, a series of 139 stations in the Davis Pond outflow area were sampled for plant type, bulk density, total carbon, nitrogen and phosphorus, pH, moisture content, and organic matter content. Results from this were published in 2012.

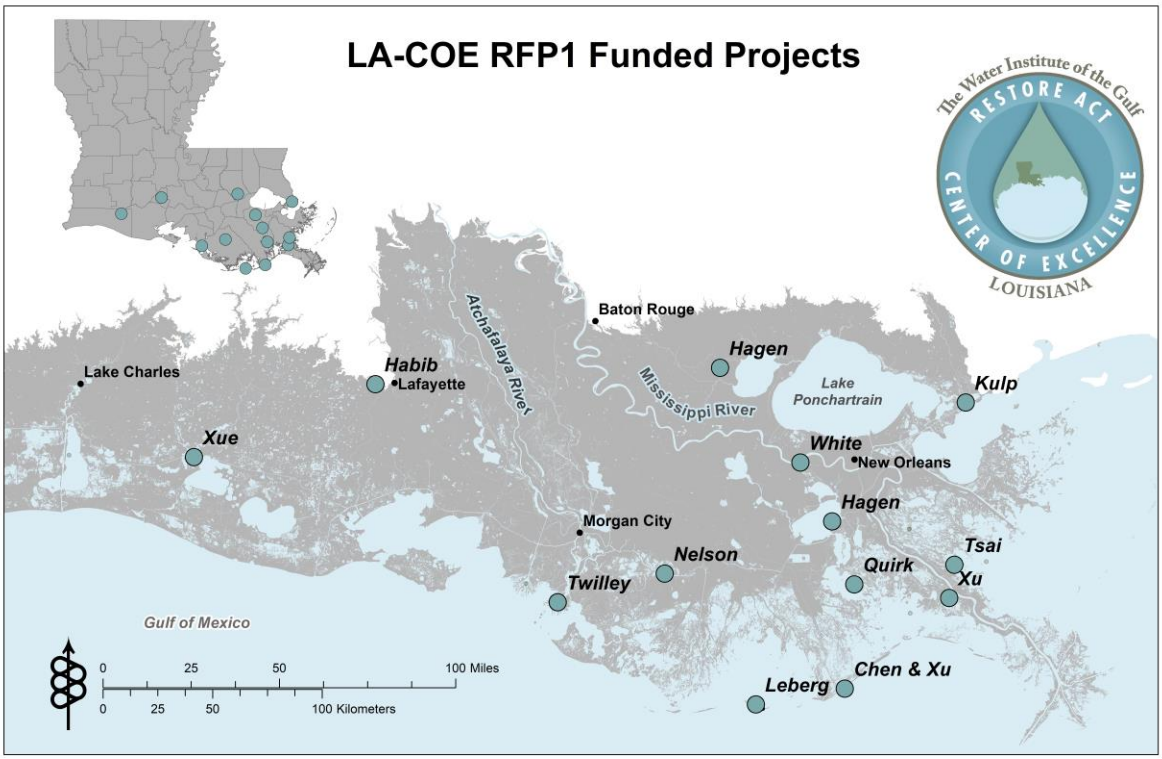
Now more than 11 years later and with years of operation at Davis Pond, this project team is taking samples in the same areas to help answer the questions on whether the operation of the diversion has altered soil properties such as bulk density, organic matter content, or nutrient content, all of which are important to coastal marsh growth and resilience in Barataria Basin. Field work on this project is underway. Data from this research could help inform CPRA about the continued use of freshwater diversions such as Davis Pond and Caernarvon.

Evaluation of radar-based precipitation datasets for applications in the Louisiana Coastal Master Plan ($71,148)

Emad Habib, Professor of Department of Civil Engineering, University of Louisiana at Lafayette



Precipitation varies over space and time and no dataset that currently exists is perfect, but it is an input into various models used by CPRA for coastal restoration and protection planning. In addition, there are currently only 10-15 rain gauges included within the 946 model compartments included in the model used in the 2017 Coastal Master Plan. This research looks into whether radar-based precipitation datasets could provide a vital improvement to these models for future plans. Radar-based precipitation products offer the advantage of identifying short- and long-term spatial rainfall patterns, ability to provide rainfall estimates at different time scales (hourly, daily, monthly), and could better support project-scale modeling studies that require high-resolution rainfall patterns.



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