Abstract Compilation

April 6th, 2016

A partnership between:

State of the Coast Conference
June 1 – 3, 2016
Ernest N. Morial Convention Center
New Orleans, LA

SOC16: Conference Summary

10 Session Blocks

- 1 Opening Plenary: Governor John Bel Edwards
- 3 Lunch Plenaries
    - Wednesday, June 1st: Kim Reyher, Coalition to Restore Coastal Louisiana
    - Thursday, June 2nd: Michael Ellis, Coastal Protection and Restoration Authority
    - Friday, June 3rd:
        - The Water Institute of the Gulf
        - Mayor Mitch Landrieu, City of New Orleans
- 100 Sessions (10 Session Blocks, 9 meeting rooms)
- 76 Conventional Sessions, 228 Presenters, 37 Student Presenters, 76 Moderators
- 10 Panel Discussions
    - 2016 High Water Event Implications
    - Regional Sediment Management Approaches to Restoration in Louisiana, with Other Gulf Perspectives
    - Operating Sediment Diversions for the Real World: Recommendations from an Expert Working Group
    - Oh the Humanities!: Culture and Values in Coastal Restoration
    - Water Entrepreneurship in New Orleans
    - The Hiring Process: Do's and Don'ts from Resume Writing to Salary Negotiation
    - Funders Circle: Strategically Financing Non-profit Efforts *(In Development)*
    - Federal Perspective on Louisiana Coastal Restoration and Protection *(In Development)*
    - Coastal Parish Perspectives on Restoration and Protection *(In Development)*
- 6 Movies (*shown more than once)
    - *Barge**
    - *New Orleans, Here and Now*
    - *Paratus 14:50*
    - *An Enduring Legacy: Louisiana's Croatian Americans**
    - *Delta Justice: The Islenos Trappers War*
    - *Vanishing Pearls: The oystermen of Pointe a la Hache**
- 72 Posters, 34 Student Posters
- Committees
    - Steering Committee
    - Program Committee
    - Sponsorship Committee
    - Student Engagement Committee

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Abstracts are grouped by type and ordered as they occurred in the Draft Program as of April 6th, 2016. This document may not be an accurate reflection of changes made to the Program since then.

More information and Program updates can be viewed at:

www.stateofthecoast.org

Contents

Friday, June 3rd

Panel Discussions

Wednesday, June 1st

Session Block I, 10:30 – 12:00 noon

2016 High Water Event Implications

Invited Speakers:

- Commander of NOD or Mark Wingate
- Mead Allison
- Alex Kolker
- Barb Kleiss
- Sean Duffy
- Virginia Burkett

Panelists will address the following questions:

- Was this high water event a missed opportunity? What are the current constraints of how the river is currently managed?
- How do the timing of high river flows impact the way they're managed and what it the potential role that climate change plays in the timing and magnitude of these events?
- What are the impacts of the changes in timing and seasonality of high water events?
- Looking forward – how do we address some of the issues that are present with the management of the river?

Session Block II, 1:30 – 3:00 p.m.

The Hiring Process: Do's and Don't's from Resume Writing to Salary Negotiation

Invited Panelists:

Louisiana State University Olinde Career Center
Bren Haase, CPRA
Alyssa Dausman, RESTORE Council
Non-Profit Representative
Consulting/Engineering Representative
Academic Representative

1:30 – 1:35 Moderator Introduction (5 min.)
1:35 – 1:50 Resume Writing (15 min)
1:50 – 2:05 Interviewing (15 min)
2:05 – 2:20 Interview Follow-up (15 min)
2:20 – 2:35 Salary Negotiation (15 min)
2:35 – 3:00 Round Robin: Hiring from Different Perspectives (25 min, ~5 min each)

a. State / Federal Government
b. Nonprofit
c. Consulting / Engineering Firm
d. Academia

This session seeks to provide support to students nearing graduation and facing an impending job search. It will cover the basic do's and don't's of resume writing, interviewing, etc. from a variety of perspectives in the private sector, government, and academia. The goal is to help career-seeking students launch their resumes through H.R. to the desks of hiring managers, ace the interview, and successfully negotiate their salary. This session is one of a series of events aligned to aid students in their professional and network development.

Thursday, June 2nd

Session Block IV, 8:30 – 10:00 a.m.

Advancing a Regional Sediment Management Approach to Restoration in Louisiana, with Other Gulf Perspectives

Panelists:

- Linda Lillycrop, USACE, Coastal & Hydraulics Laboratory OR Jacqueline Keiser, USACE, Jacksonville District
- Carl Ferraro, Biologist, Alabama DCNR-State Lands Division, Coastal Stewardship Office
- Sean Duffy, Executive Director, Big River Coalition
- Maury Chatellier, Engineering Division Administrator, CPRA

Moderator: Derek Brockbank, Executive Director, American Shore and Beach Preservation Association (ASBPA)

The intent of this session is to a) provide the audience with a short overview of the concept of Regional Sediment Management (RSM) and a couple case studies of how RSM combined with beneficial use of dredge material is restoring beaches and marshes along the Gulf Coast, then b) engage the audience and panelists in a dialogue on how RSM and beneficial use can be better applied to restore coastal Louisiana. Because successful RSM projects almost always take collaboration from the Army Corps, local or state partners, and stakeholders from the dredging area, this panel will has representatives from each.

Panel Introduction (3-5 min):

Derek Brockbank with American Shore and Beach Preservation Association (ASBPA) will introduce the concept of RSM and then explain that the panelists will provide comments on Regional Sediment Management (RSM) from their different perspectives, followed by an audience discussion.

Panelists Remarks (40 min total):

Each presenter will take 10 minutes to focus on the following, and all presenters will discuss hurdles overcome/lessons learned in facilitating RSM.

1. Linda Lillycrop or Jackie Keiser will provide an overview of the national RSM program's past achievements and future direction.
2. Carl Ferraro will tell about how the Mobile district of the Corps is working with Alabama Department of Conservation and Natural Resources and other coastal stakeholders to make use of sediment being dredged from Mobile Bay and other areas in Alabama.
3. Sean Duffy will discuss the sediment recycling program in the Lower Mississippi River that last year restored 2,000 acres with 20.7 million cubic yards of material removed from the channel. He will also discuss the role of river pilots and navigation in advancing beneficial use of dredge material.

4. Maury Chatellier (or someone from CPRA) will explain how RSM and beneficial use of dredge material currently appears in the Louisiana Coastal Master Plan, and the status of existing beneficial use projects.

Panel and Audience Dialogue (45 minutes):

Derek Brockbank will then facilitate a dialogue with panelists and audience. We will explore obstacles and successes of RSM and beneficial use in Louisiana that have been witnessed or experienced by other folks in the room. The goal of the dialogue is to identify the 2-3 top obstacles to fully successful RSM in Louisiana, and begin identifying possible solutions to them.

Depending on who joins the dialogue and if there is a local person willing to be a coordinator of an on-going effort, ASBPA may be able lend support to follow up conversations (either in person, or by phone) that will more specifically look at addressing policy, scientific/engineering, or political hindrances to having a more robust RSM program in coastal Louisiana.

Friday June 3rd

Session Block X, 2:00 – 3:30 p.m.

Water Entrepreneurship in New Orleans

Session Moderator: Andrea Chen

As climate change and catastrophic human-caused environmental destruction continue to wreak havoc on urban areas and the Louisiana coast, our urban water management systems and wetlands have become increasingly vital to our economy, ecosystem and coastal protection. Propeller: A Force for Social Innovation incubates and supports small and mid-size companies involved in the water management sector of Louisiana and will host a panel of program alumni that are directly involved in improving our region's resilience. This hour long panel will feature entrepreneurs working in coastal restoration and green infrastructure. Entrepreneurs will share opportunities they see and challenges they have faced.

Featured Entrepreneurs:

- Magnolia Land Partners (Propeller '15) secured 1,330 acres of Louisiana wetlands for restoration and permanent protection, with 2,000 acres projected in 2015.
- Greenman Dan Inc. (Propeller '15) launched an underground rain harvesting system. With current contracts in place, these systems will keep 900,000 projected gallons of water annually on-site and out of storm drains.
- Riverbottom Tech (Water Cohort '15) developed a working sediment harvesting prototype installed in South Plaquemines Parish to divert river sediment and restore wetlands.
- Wetland Resources (Water Cohort '15) is an environmental consulting firm that has planted over 100,000 cypress trees as a means of storm protection, developing a proprietary growth shelter device that would increase the amount of seedling planted per day from 400 to 4,000.
- The Riffle (Propeller '15), a project by Public Lab, raised $50,000 for evaluating water quality using low-cost, DIY tools that collect, interpret and share valuable data such as oil contamination and water conductivity.

Questions include:

- What is your business?
- What has your experience been as an entrepreneur in the emerging water sector of the region?
- How did you come up with your idea? How do you see your company growing?
- What's been most difficult about being a water entrepreneur?

Facilitated by Mike Eckert who is Chairman of the NO/LA Angel Network, the largest early stage investing group in Louisiana, and a Lead Mentor in Propeller's Accelerator Program. He has extensive start up experiences as a member of the launch team of The Weather Channel/Weather.com where he served as CEO for 14 years, and as CEO of Pathfire, an early stage digital media technology infrastructure business.

He is a seasoned business executive with particular expertise in the early stage investment eco-system. Mike is also Vice Chairman of the Angel Capital Association(ACA) , which is comprised of over 200 angel investing groups and over 10,000 individual investors. Mike chairs the ACA's Public Policy Committee and leads its strategic planning activities. Mike is recent past Chairman of the Atlanta Technology Angels, one of the largest angel investment groups in the Southeast. Mike also serves as a Fellow in Georgia Tech's VentureLab program, is a judge of many start-up business plan competitions, has served and serves on the boards of directors of a number of early stage companies, is an active angel investor and is a limited partner in a number of Venture Capital funds. Mike currently resides in New Orleans and is active in the early stage business community there.

Organization:

Propeller: A Force for Social Innovation accelerates social entrepreneurs by giving them the tools they need to bring market-based solutions to improve urban water quality, water retention, and restoration of our coastal, wetland, and marshland environments. Propeller has incubated 21 water ventures since 2012. With $18.7 billion estimated in the settlement for the BP oil spill and $50 billion slated to be spent in the next 50 years to restore Louisiana's coast, there exist numerous potential revenue streams for Propeller water entrepreneurs to finance innovative solutions. In addition to individual business acceleration, Propeller convenes entrepreneurs, policymakers, potential funders, and other players within the sector to build a critical mass of water entrepreneurs collaborating for collective impact as they solve our region's greatest water challenges.

New Orleans is a city remarkable for its spirit of grassroots activism and civic engagement. High-level policymakers and community members alike face deep systemic problems, such as blighted land, coastal erosion, failing schools, and food shortage. These problems require creative solutions. Propeller seeks to facilitate collaboration between top-down problem solvers and ground-up innovators, combining the creativity of entrepreneurs, the influence of policymakers, and the talents and strategy acumen of Propeller's own networks to accelerate change.

Supportive Programming:

- The Water Challenge: an initiative presented by Propeller focused on solving Louisiana's most pressing regional water challenges through entrepreneurship. The Water Challenge culminates each year at New Orleans Entrepreneur Week featuring a $10,000 business pitch competition. Originally seeded by the Greater New Orleans Foundation and The IdeaVillage, the WaterChallenge is funded by the Greater New Orleans Foundation, sponsored by Entergy Corporation and the U.S. Economic Development Administration, and supported by JPMorgan Chase & Co.
- Year-round public programming: workshops featuring water management policymakers and opportunities for entrepreneurs in areas such as the Comprehensive Zoning Ordinance, Regional Approaches to Water Management, Water Data Monitoring, and Equity in the Water Sector.
- Policy Initiatives supported by Propeller help to build market opportunity for entrepreneurs tackling critical water challenges.

Operating Sediment Diversions for the Real World: Recommendations from an Expert Working Group

The path to construction for a sediment diversion still has many obstacles to overcome. At this time, the Coastal Protection and Restoration Authority (CPRA) is tackling engineering and design challenges concerning the size, location and type of structure, as well as modeling questions such as anticipated ecological, social and natural resource outcomes. However, in many ways, these decisions about the construction of a diversion structure are not nearly as significant to the ecosystem and stakeholders as decisions about how the structure will be operated initially and over time. To facilitate the modeling and design process, CPRA has adopted a simplified operation based on the flow of the river. For instance, the diversion would be opened anytime the river is above 600,000 cubic feet per second (cfs). Although this basic operation facilitates an easy comparison of different alternatives, it is not an operation that will work in the real world.

In order to acquire a permit for construction, CPRA will have to provide an Operation and Adaptive Management Plan that defines how, when and why the diversion structure will be opened and closed; what factors will be considered; what monitoring is required; what governance and decision-making structures will be used to oversee these decisions; and what role stakeholders will play in the decision-making process. Since September 2015, a group of interdisciplinary experts have been meeting to explore, discuss, debate and document the state of the knowledge, data gaps, trigger points, monitoring and recommended operation strategies surrounding the complex physical, ecological, and social issues related to operating a sediment diversion. Core members of the expert working group include:

Invited Panelist	*Expertise*	*Affiliation*
Rex Caffey	Natural Resource Economics	Louisiana State University
Jim Cowan	Fisheries	Louisiana State University
Dubravko Justic	Oceanography / Hydrology	Louisiana State University
Alex Kolker	Sedimentology	LUMCON / Tulane
Shirley Laska	Social Sciences	University of New Orleans
Alex McCorquodale	Hydrodynamics	University of New Orleans
Earl Melancon	Oysters	Nicholls State University
Robert Twilley	Estuarine Ecology	Louisiana State University
Jenneke Visser	Vegetation	University of Louisiana at Lafayette
John White	Biogeochemistry	Louisiana State University
Jim Wilkins	Law / Policy	Louisiana State University

In addition to the core members, each meeting included guest experts with specific expertise in the topic being discussed. Topics that are being covered by the working group includes, but are not limited to:

- River Hydrology and Sediment Loads
- Receiving Basin Geology, Sediment Retention and Land-Building
- Water Quality (including salinity, nutrients, hypoxia, algal blooms, etc.)
- Wetland Health (including water levels, vegetation, flooding and retention times)
- Fish and Wildlife
- Communities, User Groups and Socio-Economic Effects (flooding, fisheries, drinking water, navigation, industry, etc)
- Operation Strategies (timing, discharge, offshore forcing, climatic conditions, multi-year, systems operations, etc.)
- Governance and Stakeholder Role
- Systems and Multi-Year Operations

This proposed session will feature an overview presentation of the recommendations of the Operations Expert Working Group followed by an open discussion format to discuss specific recommendations. A panel of working group members will answer questions and participate in open discussion with the audience.

Oh the Humanities!: Culture and Values in Coastal Restoration

In 1859, Louis Hebert, the State Engineer of Louisiana, addressed a body of government officials about flood protection. Frustrated with the lack of a comprehensive plan to control the Mississippi River, he announced that "We are still quarrelling between ourselves, to describe by words and arguments founded on conjecture, what the Mississippi was, is, and will be." This was in 1859! And yet none of us would be surprised to hear similar words spoken during a legislative session or a scientific conference today. The sentiments of Hebert remind us of the need to bear in mind the historical and cultural impact of past, present, and future efforts at coastal protection and restoration. Moreover, aside from the plethora of personal anecdotes and the occasional reference to John Barry's book *Rising Tide*, they also highlight the general indifference to or ignorance of a growing body of historical and anthropological scholarship on matters related to the dynamic conditions of Louisiana's coastal communities, environment, and economy.

A roundtable on the role of the humanities in coastal protection and restoration will serve as an interdisciplinary forum for historians and anthropologists to stimulate conversations among scientists, engineers, policymakers, and planners on the need for more serious consideration of how we design for the future with the past and present in mind. Dr. Craig Colten, Professor of Geography at LSU, will moderate the roundtable and provide his own insight into the history and geography of the Mississippi valley and coastal Louisiana. The roundtable also brings together four of the leading scholars on the history and culture of coastal living in Louisiana, all of whom will provide short yet incisive case studies that address how their research applies to the more traditional coastal protection and restoration disciplines of science, engineering, and planning. Ultimately, the overall purpose of the roundtable is to invite audience members to think out loud about strategies for integrating the humanities into the work of local, state, and federal constituencies committed to the coast.

Session Structure:

Introduction: 5 minutes (Craig Colten)
Case Study #1: 7 minutes (Carolyn Ware)
Case Study #2: 7 minutes (Christopher Morris)
Case Study #3: 7 minutes (Andy Horowitz)
Case Study #4: 7 minutes (Michael Pasquier)
Synthesizing Remarks: 7 minutes (Craig Colten)
Roundtable Discussion and Audience Participation: 50 minutes

Total: 90 minutes

Parish Perspectives on Coastal Restoration and Protection Programs, Projects, and Funding

Moderator: Chip Kline, CPRA

Confirmed Panelists:

- Lafourche Parish President Jimmy Cantrelle
- Terrebonne Parish President Gordon Dove
- St. Bernard Parish President Guy McInnis
- City of New Orleans Chief Resilience Officer Jeff Hebert
- Cameron Parish Administrator Ryan Bourriaque

- Jefferson Parish Assistant Director of Environmental Affairs Marnie Winter
- St. Tammany Parish President Pat Brister

Movies

New Orleans, Here and Now: Ten Years, Six Stories, One City

Synopsis: A collection of six provocative short films from directors whose work has been recognized by the Sundance Film Festival and other major venues, *New Orleans, Here and Now* offers an inspiring reflection on the city's resurgence through gripping personal stories spanning multiple generations. The short film series was sponsored and released by *Time, Inc.*, to coincide with the tenth anniversary of Hurricane Katrina, however few people have seen the films because of a pay wall on the time.com website. The films were also organized by Court 13, the filmmaking cooperative that produced the acclaimed *Beasts of the Southern Wild*. The anthology features "The Boatman," which shares an oyster farmer's love for a boat that he's been building for decades; "Everything is To Be Continued," which examines how music is at the heart of the people of New Orleans; "The Older Fish," which follows four high school seniors who were 8 years old when Katrina hit; "Two Cities," which recounts what it means to be part of the displaced New Orleans population in Houston; "Labor of Love," which explores the multi-cultural family bonds of the Vietnamese population of New Orleans; and "The Best Eva 1.5," which chronicles the triumphs of Tiffany Junot to become the World Boxing Council Welterweight Champion of the World." Though not directly related to actual coastal restoration and protection projects, these films highlight what's at stake as we develop ways to ensure the security of New Orleans and other coastal cities. The combined time for all of these films is approximately 90 minutes, so they could be screened sequentially as if it were a single film.

Paratus 14:50

Director: Kaitlin Smith

Synopsis: *Paratus 14:50* is a feature-length documentary on the United States Coast Guard's response to Hurricane Katrina in 2005. The story focuses on Coast Guard air rescues carried out by Coast Guard Air Station New Orleans and Coast Guard Aviation Training Center Mobile across southern Alabama, Louisiana, and Mississippi in the first two weeks of the response. These men and women helped contribute to pulling more than 500 people from the impacted areas, the greatest single rescue in our nation's history.

Awards won by film: Alabama Public Television Official Release

Delta Justice: The Islenos Trappers War

Director: David DuBos

A documentary about the friction between South Louisiana's Islenos community and St. Bernard powerbroker Leander Perez in the early 20th century.

Awards won by film: Audience Award for Louisiana features at the 2015 New Orleans Film Festival.

Vanishing Pearls: The Oystermen of Pointe a la Hache

Director: Nailah Jefferson

For over a century, the people of Pointe a la Hache, Louisiana have survived by fishing off of the plentiful waters surrounding their community. Over time, the powerful oil and gas industry has threatened this small, tight knit community's way of life, culminating with the 2010 Gulf of Mexico Deepwater Horizon oil spill disaster. Told from the point of view of the film's "David", local oyster fishing businessman Byron Encalade, we learn how a once prolific fishing community has nearly vanished.

An Enduring Legacy: Louisiana's Croatian Americans

Directors: Jim Catano, Carolyn Ware

Synopsis: The Croatians of Lower Plaquemines Parish have used grit and determination to build an oystering industry that has made Louisiana famous. Little-known even in their home state, the history of the tight-knit Croatian-American community is portrayed in this documentary through the lives of four figures who embody the 150-year Croatian experience in Louisiana: George Barisich, Domenica Cibilich, John Tesvich, and Pete Vujnovich. Seen at work on the water, in home movies, at social gatherings and in interviews in their homes, these figures put an immediate and compelling face on a people who have endured economic privation, hurricanes, loss of their homes, oil spills, and the never-ending toil of watery farming existence. As their stories unfold, it becomes clear that these individuals offer a premier example of the American dream – and of the drama that lies behind this quintessentially American saga.

Awards won by film: Louisiana Public Broadcasting Official Release

Barge

Director: Ben Powell

Synopsis: A towboat drifts down the Mississippi River, due for the port of New Orleans. The water, the banks, the bright lights of a port ahead; the lure of a coming paycheck and a home-cooked meal. This is the world of *Barge*. On board, dry land's misfits find purpose and direction twenty-eight days at a time as the steady hands of an industrial ecosystem teeming with line boats, fleet boats, and a few million tons of cargo moved each year. A green deckhand following his father and grandmother into the family business. A former convict working his way upward job by job, in the hope of being First Mate. A thirty-eight year veteran engineer in no hurry to retire. An ancient waterway pulling a double shift as the backbone of a national economy; a tangle of thick steel cables, tied together just right. As long as the boat's moving, they're making money. *Barge* is an intimate portrait of the machinery of American ambitions.

Awards won by film: Official Selection, South by Southwest Film Festival; Best Feature Documentary, Crossroads Film Festival; Official Selection, Full Frame Film Festival; Official Selection, Montclair Film Festival; Grand Jury Prize, Dallas International Film Festival; Honorable Mention, Ashland Independent Film Festival

Conventional Sessions

Wednesday, June 1st

Session Block I, 10:30 – 12:00 noon

Oil Spill Effects

Spartina Alterniflora Growth Responses to Weathered Macondo Well Oil Applied to Soil and Aboveground Tissue: a Mesocosm Assessments

Jonathan M. Willis [1], Mark W. Hester [1]

[1]Institute for Coastal and Water Research
University of Louisiana at Lafayette, Lafayette, LA, USA

Many coastal ecosystems, including the salt marshes of Louisiana, are at risk for exposure to petroleum hydrocarbon contamination due to the colocation of oil and gas industry infrastructure in these areas. Although substantial research has been conducted on the responses of *Spartina alterniflora*-dominated salt marshes to oil contamination, considerable data gaps remain to be addressed to enhance our understanding of, and response to, such environmental incidents. In particular, interactive assessments of how the oiling of soils and aboveground plant tissues can differentially affect *Spartina alterniflora* salt marsh responses would be greatly beneficial. We employed a mesocosm study to determine how the application of weathered Macondo well oil to *Spartina alterniflora* aboveground tissues and associated soils affect vegetation survival, growth responses, and relevant biogeochemistry. Specifically, we assessed both instantaneous (photosynthetic processes) and integrated (biomass partitioning) indicators of *Spartina alterniflora* growth responses, as well as a range of biogeochemical characteristics. Complete coating of aboveground tissues with oil significantly reduced light-adapted chlorophyll fluorescence shortly after the inception of the study. By the conclusion of the study, net CO_2 assimilation and light-adapted chlorophyll fluorescence were significantly reduced by soil oiling, but not by coating of aboveground tissues. Live aboveground biomass was significantly lower in treatments experiencing complete coating of plant tissues at harvest. Soil oiling significantly impacted *Spartina alterniflora* health, with the percentage of live stems significantly reduced midway through the study and virtually complete mortality of aboveground tissues occurring by harvest. Interestingly, by the conclusion of the study interstitial sulfides were significantly elevated with soil oiling, suggesting that soil gas exchange was hampered by the application of oil. These findings indicate that the oiling of either aboveground plant tissues or soils adversely impacts *Spartina alterniflora* short- and long-term growth responses, as well as key aspects of salt marsh biogeochemistry.

PAHs and Gulf Menhaden: The Legacy of The DWH Spill in the Northern Gulf of Mexico

Gregory M. Olson [1], Buffy M. Meyer [1], Ralph J. Portier [1]

[1.] Department of Environmental Sciences, Louisiana State University, Baton Rouge, LA

Approximately 4.9 million barrels of crude oil and gas were released into the Gulf of Mexico (GoM) from April to July 2010 during the Deepwater Horizon (DWH) spill. This resulted in the possible contamination of marine organisms with polycyclic aromatic hydrocarbons (PAHs), USEPA identified constituents of concern. To determine the impact of the DWH oil spill, Gulf menhaden (*Brevoortia patronus*), a commercially harvested and significant trophic grazing species, was sampled from two Louisiana coastal regions from 2011 to 2013. Tissue extraction and GC/MS analysis demonstrated measurable concentrations of PAH within Gulf menhaden. Analysis yielded total PAHs, carcinogenic equivalents (BaP-TEQ), and mutagenic equivalents (BaP-MEQ) which provided an initial toxic potential assessment of this GoM Fishery. Gulf menhaden contained significantly less total PAH concentrations in 2013 as compared to 2011($p<0.05$). Total BaP-TEQs from 2011 to 2013 were significantly reduced as were total BaP-MEQs ($p<0.05$). Data indicated an overall decrease of total mutagenic equivalents in years following the spill, however 2013 was significantly greater than 2012 (despite a significant reduction form 2011) for BaP-MEQs indicating additional contamination of heavy PAHs. The reduction of total PAH concentrations and the increase in BaP-MEQs between 2012 and 2013 indicates a diminished input of new source PAHs, and bioaccumulation of persistent residual aromatic hydrocarbons.

Understanding the Fated and Effects of the Oil Spilled During the Deepwater Horizon Disaster

Edward B. Overton,[1] M. Scott Miles, Buffy Meyer, Greg Olson and Puspa Adhikari

[1]LSU School of the Coast and Environment

The Deepwater Horizon disaster occurred in the spring and summer of 2010 and resulted in something over 170 million gallons of oil spilled into the northern Gulf of Mexico. A significant portion of this oil was naturally and chemically dispersed in the deep water and never made it to the surface. Of the oil that did surface, some was burned and chemically dispersed in an effort to try and keep oil from impacting the vast coastal wetlands and sandy beaches of Louisiana and the northern Gulf panhandle. However, a significant amount of oil made its way onto the beaches and into tidally affected coastal marshes. This presentation will describe the chemical composition of the oil as it made it way into and onto the coastline, and discuss the weathering transformations that change the oils composition as well as physical properties after coastal impacts and in the subsequent years since the spill. It will also review mechanisms for environmental impacts from the chemicals that constitute oil residues and their modes for causing damage.

Mid-Basin Sediment Diversions: A Look Forward

Adaptive Management Strategy for the Management of Mid-Basin Sediment Diversions

Richard C. Raynie [1]

[1]Coastal Protection and Restoration Authority, Baton Rouge, LA

Future conditions of coastal Louisiana are highly uncertain due to the dynamics of riverine and marine processes, storm events, climate change, population growth, economic activity, and ongoing human reliance on the natural resources the coast provides. Managing such a complex system in which the natural and socio-economic systems are highly integrated is inherently difficult. Therefore, the Coastal Protection and Restoration Authority has developed an adaptive management strategy to promote flexible and agile decision-making utilizing the best available technical, economic and social information as it continues to evolve.

Critical to the success of adaptive management are the actions that ensure feedback of information among the various phases of project selection, engineering and design, construction, monitoring, and operations and maintenance. Adaptive Management is embodied by building institutional knowledge to continually improve understanding of the system and how management actions can best achieve program goals.

CPRA's Adaptive Management Strategy integrates project design and construction with system level monitoring by creating a comprehensive strategy to identify lessons learned and link activities within CPRA and across different state agencies. The scale and complexity of Louisiana's Coastal Master Plan requires a robust adaptive management strategy to cultivate a growing body of knowledge related to restoration and protection science.

As an important component of CPRA's adaptive management strategy, the System-Wide Assessment and Monitoring Program (SWAMP) has been developed and designed in a nested fashion to facilitate the integration of project-specific data needs into a larger, system-level design framework. Monitoring and operation of diversion projects will be nested within the larger basin-wide and coast-wide SWAMP framework and will allow informed decisions to be made with an understanding of system conditions and dynamics at multiple scales.

Past Challenges and Current Considerations for Developing Operations Plans of Two Mississippi River Sediment Diversions

Kent Bollfrass [1] and Brian Lezina [1]

[1] Coastal Protection and Restoration Authority

The Louisiana Coastal Protection and Restoration Authority (CPRA) recommended that two Mississippi River Sediment Diversions enter the Engineering and Design (E&D) phase in October of 2015. Since the recommendation a major focus has been placed on the operational challenges and strategies needed to maximize the land building potential and habitat protection of sediment diversions while minimizing impacts to specific stakeholders. Several efforts to date have focused on diversion evaluation with

specific goals of either determining preferred individual diversion locations or, in a separate effort, determining which diversions to prioritize for E&D funding. Each effort selected a single operations strategy in order to compare all alternatives or each diversion with equal parameters.

Although using single operations strategies was useful in location selection and project prioritization, there many questions to address in E&D to develop a robust operations plan for each diversion. Developing operations plans presents a unique challenge that must consider, over large spatial and temporal scales, project goals, socioeconomics, protected resources, thresholds, resource limitations, variable seasonal and annual weather patterns, climate change including sea level rise and subsidence, and interaction with other projects and landscape features. To address these challenges CPRA will develop operations plans which may be informed by basin-wide monitoring, adaptive management strategies, informed interagency panels, use of expanded real- and near-real time data collection networks, and enhanced forecasting tools to adapt operations as needed. Additionally, monitoring efforts will allow for diversion operations to be compared to a measureable set of identified goals. Experience with interagency panels for the current Davis Pond and Caernarvon Freshwater Diversions provides insight to procedures and challenges associated with selecting operations plans across a diverse group of stakeholders. It has never been more important to develop consistent operational guidelines yet maintain the operational flexibility to respond to numerous highly dynamic variables.

Coastal Eco-Morphological Real-Time Forecasting (CERF) System

Ehab Meselhe [1], Daniel Twight [2], Francesca Messina [1], Ashok Khadka [1], and Katelyn Costanza [1]

[1]The Water Institute of the Gulf, [2]Deltares

The 2012 Coastal Master Plan developed by the State of Louisiana Coastal Protection and Restoration Authority proposes implementing sediment diversions and dedicated dredging as a large scale restoration tools to create new wetlands and replenish existing coastal marsh areas. The Water Institute of the Gulf jointly with Deltares developed a real time forecast system that bridges an information and forecast gap between forecasting tools focusing on inland watersheds and riverine system and the offshore Gulf. As such, the Coastal Eco-morphological Real-time Forecasting (CERF) System focuses on the coastal zone. The real time forecasting system presented here is based on the Flood Early Warning System (FEWS) developed by Deltares and the Community Hydrologic Prediction System (CHPS) developed by the National Weather Service. In this initial phase of the development, the CERF system is setup for Barataria and Breton Sound Basins. The system is designed to provide seven-day forecast on water level, salinity, and temperature conditions.

The CERF system includes the following components: freshwater riverine inflow, rainfall, evaporation/evapotranspiration, wind, tide, and salinity of the Gulf of Mexico. Data required to generate this information is obtained through an automated data ingests, processing and storage. This is a challenging and novel component of the overall system as the various data pieces vary spatially and temporally, in format, frequency of availability and are hosted by multiple parties. The system provides an interface to display observed data and forecasted model output jointly. This interface provides valuable information regarding the overall conditions of the basins and offers an opportunity to adaptively manage existing and planned diversions to meet certain salinity and water level targets or thresholds while maximizing land-building goals. Future phases of the development of the CERF system include forecasting of sediment and nutrient concentrations.

Implementation of the Caminada Headland Beach and Dune Restoration Project, from Planning through Construction

Planning of the Caminada Headland Beach and Dune Restoration Project

Honora Buras [1]

[1] Coastal Protection and Restoration Authority of Louisiana

The importance of Louisiana's barrier islands and headlands as unique coastal habitats and for their role in providing the framework of an estuary has been long been recognized. The Caminada Headland forms the western-most portion of the Barataria Basin barrier shoreline system and extends from Belle Pass to Caminada Pass. It provides storm surge protection for Louisiana Highway 1, the only evacuation route for Grand Isle, and also protects Port Fourchon and other infrastructure such as the LOOP pipeline which comes ashore on the headland. The headland consists of a sand dune, beach berm, back- barrier marshes, and chenier ridges interspersed with mangrove thickets, coastal dune shrub thickets, lagoons, and small bayous. This headland has experienced some of the highest rates of shoreline movement on the Louisiana coastline, with long-term erosion rates as high as 12.6 meters/year.

The 1998 Coast 2050 Plan identified the Barataria Basin barrier shoreline as seriously threatened, with many of the islands anticipated to be lost by 2050 if nothing was done. This plan was the basis for a 1999 USACE Reconnaissance Report that demonstrated a Federal interest in restoration of coastal Louisiana wetlands. As a result, in February 2000, the USACE and the State of Louisiana initiated the Barataria Basin Barrier Shoreline (BBBS) Feasibility Study to develop a comprehensive restoration plan for 52 miles of barrier islands and shorelines from Sandy Point to Belle Pass. This study was suspended in 2002 during the development of the LCA Comprehensive Coastwide Ecosystem Restoration Feasibility Study that resulted in a 2004 Near-Term Plan that recommended incorporating the work from the BBBS Study into a new study focused solely on the restoration of the Caminada Headland and Shell Island.

This presentation will provide an overview of the planning process leading to the restoration of the Caminada Headland shoreline.

Engineering and Design of the Caminada Headland Beach and Dune Restoration Project

Brad Miller [1], Michael Poff [2]

[1] Louisiana Coastal Protection and Restoration Authority, [2] Coastal Engineering Consultants, Inc.

Design for the Caminada Headland Beach and Dune Restoration Project was initiated in 2011. Due to funding limitations the project was broken into two increments, Increment I restoring the western half of the Headland and Increment II restoring the eastern half. Both increments followed the design template of the BBBS LCA Feasibility Report. The typical beach elevation was designed to +4.5 ft. NAVD 88 with a width of 65 ft, while the typical dune elevation was designed to +7.0 ft. NAVD 88 with a width ranging from 210-290 ft.

Preliminary activities to design the project included bathymetric and topographic surveying, geotechnical investigations, analyses of coastal processes, and Phase I and Phase II cultural resources investigations. All of the above data were processed and evaluated to assist in the development of fill template design alternatives, borrow area designs, and pump-out and conveyance corridor options.

Permitting for the project involved Biological Opinions for both migratory and nesting birds on the Headland and sea turtles in the Ship Shoal borrow area. In addition a non-competitive negotiated agreement from BOEM was needed for the use of Offshore Continental Sand resources.

Due to favorable bids an additional 7,000 linear ft. were added to the design of the Increment I project for a total design of 31,000 linear ft. The design template for Increment II was 39,000 liner ft.

Construction of the Caminada Headland Beach and Dune Restoration Projects

Jacques Boudreaux [1] and Steve Dartez [2]

[1] Louisiana Coastal Protection and Restoration Authority, [2] Coastal Engineering Consultants, Inc.

The Caminada-Moreau Headland is a flanking barrier headland that spans from Belle Pass to Caminada Pass for a length of approximately 13 miles. To address land loss and to protect and preserve barrier shoreline structural integrity, restoration of the beach and dune is currently under construction. The following describes overall construction methodology: cutterhead suction and hopper dredges are mobilized to the South Pelto borrow area; sand resources are collected and transported approximately 30 miles from the borrow area to the headland; pipeline hookups are accessed at permitted pumpout areas; dredge material is discharged via pipeline to the fill area; and land-based equipment is used to shape fill material according to design drawings.

Restoration of the headland is comprised of two increments. The first increment of headland construction was initiated March 2013 and was deemed substantially complete January 2015. The second and final increment was initiated February 2015 and is on schedule for completion October 2016. Construction challenges included encountering migratory birds during nesting season and relocating sea turtles during hopper dredging operations.

In May 2014, migratory birds had begun arriving in the fill area and began to show signs of nesting potential. Bird abatement measures were initiated; however, these measures proved to be ineffective and the first signs of nesting were identified. Hopper dredges were also utilized around this time, and the requirement for sea turtle relocation trawling was initiated. Within a span of five days, approximately one half of the total allowable relocations were exceeded for a bi-annual basis. As a result of coordination meetings and consultations with regulatory entities, protocols were established that allowed construction to continue.

Submerged Aquatic Vegetation

Drawing the Map of Submerged Aquatic Vegetation in the Northern Gulf of Mexico: Distribution and Patterns of Abundance Across Salinity Zones

Kristin DeMarco [1], Michael Osland [2], Stuart Brown [3], Brady Couvillion [4] and Megan La Peyre [5]

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[3] Louisiana Coastal Protection and Restoration Authority
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Submerged aquatic vegetation (SAV) is a critical habitat in the northern Gulf of Mexico (nGOM) coastal landscape. Many species of wildlife, including highly desirable waterfowl populations, depend on SAV for food and will adjust population numbers and location according to SAV presence and cover. However, the distribution, abundance and patterns of growth of SAV across salinity zones remains poorly understood. To better understand these patterns, we sampled 384 sites across the nGOM extending from San Antonio Bay, Texas to Mobile Bay, Alabama during 3 separate growing seasons (2013-2015). We define predictors for SAV presence across salinity zones and present a map of observed SAV presence, abundance and distribution. Hydrodynamic drivers (water level and salinity) are combined with habitat features (marsh type, pond size, and fetch) to estimate percent cover under present day conditions. These maps and data are the first step in the application of hydrodynamic modeling to describe SAV resource response to changes in salinities and water levels as a result of sea-level rise and landscape change. Additionally, these estimates and predictions of SAV resources assist researchers attempting to predict wildlife response to a changing climate.

Environmental Drivers of Seasonal Variability in Coastal Marsh Pond SAV Communities Along a Salinity Gradient in Barataria Basin, Louisiana, U.S.A.

Eva Hillmann [1], Kristin DeMarco [1], Megan La Peyre [2] and Andrew J. Nyman [3]

1 School of Renewable Natural Resources, Louisiana State University, Agricultural Center, Baton Rouge, LA
2 U.S. Geological Survey, Louisiana Cooperative Fish and Wildlife Research Unit, School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA
3 School of Renewable natural Resources, Louisiana State University, Baton Rouge, LA

Predicted effects of climate change are expected to alter the distribution and composition of habitat types and vegetation communities within coastal estuaries. Submerged aquatic vegetation (SAV) is ecologically and economically significant and grows along the estuarine salinity gradient from fresh to saline. While several studies indicate that water depth, water clarity and salinity are key predictors of SAV biomass and community composition, their accuracy in highly variable estuarine environments, such as coastal Louisiana, is limited. We documented bi-monthly changes in SAV biomass and water quality (salinity, water depth, PAR, nutrients, sediment characteristics) at sixteen sites, stratified by salinity in Barataria Bay, LA over a 12 month period. All sites were located in proximity to continuous

water data recorders providing hourly salinity, water level and temperature data. All sites differed in community composition and SAV biomass throughout the year- indicating a highly dynamic habitat. While temperature variation was similar between all sites, salinity and water levels varied significantly temporally *within* each site, and spatially *between* sites, with intermediate and brackish sites being exposed to the greatest ranges of values. Lowest salinity sites, on average, maintained higher species richness and biomass throughout the year as compared to other sites, while saline sites had lowest species richness and biomass. Discrete annual sampling or predictive models based only on annual sampling likely only represent a small fraction of the diversity and variability in SAV biomass across a dynamic salinity gradient in the northern Gulf of Mexico. Improved understanding of relationships between environmental variation and SAV response throughout the year is critical to accurately quantify these resources. More precise models will enable resource managers to more precisely predict effects of climate change and restoration on SAV and their associated fish and wildlife.

The Nutrient Status of Abundant Submerged Aquatic Vegetation Species Along a Salinity Gradient in Louisiana

Kelly Darnell [1], Tim Carruthers [1], Patrick Biber [2], Megan La Peyre [3], Kristin DeMarco [4], Eva Hillmann [4]

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2 Gulf Coast Research Laboratory, The University of Southern Mississippi
3 U.S. Geological Survey, Louisiana Cooperative Fish and Wildlife Research Unit, School of Renewable Natural Resources, Louisiana State University Agricultural Center
4 School of Renewable Natural Resources, Louisiana State University, Agricultural Center

Submerged aquatic vegetation (SAV) communities are critical ecosystems that support many ecosystem functions including carbon sequestration, nutrient cycling and export of organic matter. The Louisiana coast supports high diversity of submerged aquatic vegetation that span both salinity (freshwater to saltwater) and nutrient (low to high) gradients. Freshwater and brackish water-tolerant SAV grow across most of the Louisiana coast, whereas saline-adapted species (seagrasses) are restricted to growing offshore along the Chandeleur Islands. Essential baseline data on plant dynamics, including species-specific nutrient content, are lacking for SAV species in Louisiana, despite the necessity of this information for predicting change under future scenarios. We used SAV collected from an extensive northern Gulf of Mexico-wide survey in 2014 and seagrass collected from the Chandeleur Islands between 1998 and 2015 to assess species-specific spatial and temporal variation in plant nutrient status across the coast. Nutrient content of seagrasses was similar across sites at the Chandeleur Islands, and leaf nutrient levels of the dominant seagrass species, turtle grass, have remained consistently high over time. Nutrient content of freshwater and brackish water SAV varied across species and locations, and is likely related to the surrounding nutrient conditions. Data from this study can be used to better predict change under future scenarios, and understand potential implications of historical and potential future changes in SAV for ecosystem functions, specifically nutrient and carbon storage.

Modeling Basin Response to Diversions

The Louisiana Water Resources Sustainability Assessment Framework

Scott Hemmerling [1] and F. Ryan Clark [1]

[1] The Water Institute of the Gulf

To effectively manage Louisiana's water resources, it is necessary to develop an assessment framework that can conjunctively appraise supply and demand in both ground and surface water units across the state. The Water Institute of the Gulf is working with the Louisiana Department of Natural Resources Office of Conservation (DNR) and the Coastal Protection and Restoration Authority (CPRA) to develop an organizational framework to assess water sustainability in Louisiana. The framework aims to appraise current and expected future water supply and demand and to develop a planning instrument that can 1) inform management decisions, and 2) minimize the potential impact of future growth on overall water supply. Past efforts at management of groundwater and surface water in Louisiana have treated the two as largely separate issues. One key feature of this framework is a conceptual water budget that quantifies the inputs and outputs of the hydrologic cycle and incorporates water withdrawals and usage in both ground and surface water units across the state. The basins, watersheds, and aquifers provided the organizational framework (hydro units) for the assessment and three hydro units were selected as case studies to test the framework; one in southwest Louisiana, one in southeast Louisiana, and one in north Louisiana. The selection of the case study units was determined based upon the presence of critical water supply and demand issues as well as the availability of data required to conduct the assessment. The framework has been constructed to provide uniformity of analysis across hydrologic units using existing data sources. Future water demand projections are being made based on projected urbanization and population change estimates.

Delft3D Modeling of Water Quality in Breton Sound Estuary, LA

Kelin Hu [1], Q. Jim Chen [1], and Hongqing Wang [2]

[1] Louisiana State University, [2] USGS Wetland and Aquatic Research Center

How will freshwater diversion projects and sea level rise affect ecosystems in Louisiana? The ability to accurately predict and model these influences is important as coastal restoration efforts need to better understand the hydrodynamics, sediment transport and water quality (e.g. salinity, temperature, suspended sediment concentration and chlorophyll-α concentration) in Breton Sound estuary.
The Delft3D model suite, including the hydrodynamic and water quality modules (i.e., Delft3D-FLOW and Delft3D-WAQ), was applied to the Louisiana coast for simulations of water quality. Parameters in water quality were carefully chosen, calibrated and validated via field observations at multiple stations across the Breton Sound estuary. Distributions of salinity, temperature, suspended sediment and chlorophyll-α concentration in the estuary were examined. Model results were in good agreement with field measurements. In addition, a series of numerical experiments were carried out to investigate the effects of freshwater diversion project and sea level rise on wetland environments in Breton Sound.

Model Development for Deltaic and Coastal Ecosystem Restoration: Nutrients, Pelagic Primary Production and Sedimentary Processes

Melissa M. Baustian [1], Hoon Jung [1], Ehab Meselhe[1], Johannes Smits [3],

[1]The Water Institute of the Gulf, [2]University of Louisiana-Lafayette, [3]Deltares

Deltaic and coastal ecosystems are undergoing change, such as sea level rise, subsidence, and eutrophication due to natural and anthropogenic forces that are requiring ecosystem-level restoration. Developing models that link ecosystem components of hydrology, morphology and ecology help to represent the essential processes and feedbacks in which managers and planners can use to inform decisions on an array of restoration projects. We developed a model that includes the Mississippi River and its estuarine receiving basins (Barataria and Breton) of the Deltaic plain to simulate the influence of diverting riverine water, sediment and nutrients for building new wetlands and to understand how the estuarine nutrient dynamics, phytoplankton responses and sedimentary processes are also affected. Delft3D, an open source code was utilized and the water quality model (D-WAQ, including nitrogen, phosphorus, silica, and carbon species) with the sediment layers as well as the phytoplankton module (BLOOM, including fresh and marine taxa) and light climate module (LIGHT, including suspended sediment) were applied and adjusted for coastal Louisiana conditions. Model calibration and validation was conducted using field data from year 2009 and 2014, respectively. Overall, the ecological model captured the general temporal and spatial ecological dynamics and the model compared well to most of the observations. Developing a coupled model that represents essential ecological processes in rapidly changing deltaic and coastal ecosystems is needed to better understand future environmental conditions but also to assist managers and planners in deciding on future restoration strategies.

Estuary Dynamics

Observations of Lower Mississippi River Estuarine Dynamics

Michael Ramirez [1], Mead Allison [12]

[1]Tulane University, [2]The Water Institute of the Gulf

At river discharges below 350,000 cfs, a saline bottom water layer ("salt wedge") moves upstream from Head of Passes into the main channel thalweg where the river depth is below sea level. At higher river discharges, the salt wedge is eroded from the mainstem channel and confined to the river outlets downstream of Head of Passes. The pycnocline interface between downstream-flowing water above the salt wedge and the low velocity saline water is a location where high shear between the two water masses can hinder fine-grained river sediment settling into the low velocity salt layer. The thickness and the upstream boundary of the salt wedge vary with river discharge, but can also be sensitive to astronomical and meteorological tidal effects.

During the low-flow seasons of 2012, 2013, and 2015, a series of observational studies were conducted as part of the Mississippi River Hydrodynamic Study in the lowermost 19 river miles to study the sedimentary dynamics of the estuarine salt wedge. Study methods included multibeam sonar, acoustic Doppler current profiling (both boat-based and bottom-stationary), physical sampling of river materials (suspended and bed material), and CTD and LISST (aggregate grain size) profiles of the river water column. Our results suggest a highly dynamic salt wedge, with substantial feedback on suspended particle dynamics. Variable shear in the pycnocline is driven by the diurnal tide controls particle settling, with the majority of flux to the bed occurring during the ebbing tide.

Understanding the estuarine processes in the lowermost Mississippi River is important for predicting navigation channel dredging frequencies and locations, and for envisioning the impact of any actions (e.g., climate-driven water supply from the catchment, dredging of upstream passes that divert water, sediment diversions for land building) that impact the length and minima of water discharge of the Mississippi River.

Mechanics of Salt-wedge Propagation in the Lower Mississippi River as a function of Residual Fluvial Discharge: Theory, Observations and Modeling

Ioannis Georgiou [1], Steve Ayres [2], Ahmed Gaweesh [1]

[1] University of New Orleans, [2] US Army Corps of Engineers, New Orleans District

The Lower Mississippi River (LMR) is a classical example of a well stratified channel, where during seasonal low flow conditions an arrested saline wedge intrudes upriver and often threatens freshwater intakes for lower parishes. The mechanics of saline intrusion and propagation are well known and frequently studied for many natural systems around the world. For most systems, propagation is proportional to the density gradient between and freshwater and the saline water, the river slope, and the ratio of fluvial discharge to tidal induced flow. In the LMR historic field based efforts and analytical modeling previously provided valuable insights into the like hood that an arrested saline wedge will near freshwater intakes. But, simplified analytical approaching although reliable often fall short on capturing

the local-to-regional dynamics associated with this complex system. Some of the system complexities include a low slope, an adverse slope for the last ~40-50 miles, irregular thalweg depth and width, and fluvial discharge that vary one order of magnitude. Here we present a historical perspective of field observations from previous low flow events documenting the arrested wedge as well as more recent (last 20 years) observations of wedge movement. We show these observations within a theoretical framework that used analytical solutions to predict the wedge position. Finally, we examine a range of future diversions proposed under the Mississippi River Hydrodynamics and Delta Management Study, where multidimensional models were used to investigate the response of the saline wedge to the future lower flows coupled with the effects of relative sea level rise.

Change in the Dynamics of Flow and Transport of the Lower Mississippi River and Delta in Response to Upstream Sediment Diversions

Ahmed Gaweesh [1], Ioannis Georgiou[1], Kevin Hanegan [1]

[1] University of New Orleans

The State of Louisiana in the Coastal Master Plan proposed a series of sediment diversions aimed to reconnect the River with the delta plain wetlands and estuaries in attempt to nourish and enhance present rates of land building and to combat current rates of wetland loss. Diverting flow and sediment from the Lower Mississippi River (LMR) can potentially affect the River itself, the delta and proximal basins, affecting ecosystem function. The objective of this study is to evaluate the corresponding change in: 1) flow distribution within the LMR distributary network, 2) salinity level within the modern delta and proximal basins, and 3) the upstream position of the salt wedge. The Finite Volume Coastal Ocean Model (FVCOM) was used to simulate flow and transport resulting from various scenarios using a domain that resolves the LMR and delta and most of the upper-continental shelf of the Gulf of Mexico. The model was calibrated to reproduce tidal signals, flow distribution and salt-wedge position using a comprehensive dataset collected during a field campaign in August 2012.
Scenarios were designed to examine the impact of moderate to high flow extractions (20% to 60% of a flood flow of 1,000,000 cfs) coupled with the impact of Relative Sea-Level Rise (RSLR). Results show that salinity concentrations show minimal changes in the vicinity of the modern delta and proximal basins with no observed change in future tidal dominance. Further, diversions have an appreciable impact on the flow distribution amongst distributary channels within the modern delta, a result that is affected further by subtidal water level variations. This impact increases as a function of increasing RSLR, and is amplified further with large flow extractions. Finally, the location of the arrested saline wedge from the head of passes was found to negatively correlate with fluvial discharge non-linearly.

Together at Last: Marrying Louisiana Water Law and Science

The Louisiana Water Resources Sustainability Assessment Framework

Scott Hemmerling [1] and F. Ryan Clark [1]

[1] The Water Institute of the Gulf

To effectively manage Louisiana's water resources, it is necessary to develop an assessment framework that can conjunctively appraise supply and demand in both ground and surface water units across the state. The Water Institute of the Gulf is working with the Louisiana Department of Natural Resources Office of Conservation (DNR) and the Coastal Protection and Restoration Authority (CPRA) to develop an organizational framework to assess water sustainability in Louisiana. The framework aims to appraise current and expected future water supply and demand and to develop a planning instrument that can 1) inform management decisions, and 2) minimize the potential impact of future growth on overall water supply. Past efforts at management of groundwater and surface water in Louisiana have treated the two as largely separate issues. One key feature of this framework is a conceptual water budget that quantifies the inputs and outputs of the hydrologic cycle and incorporates water withdrawals and usage in both ground and surface water units across the state. The basins, watersheds, and aquifers provided the organizational framework (hydro units) for the assessment and three hydro units were selected as case studies to test the framework; one in southwest Louisiana, one in southeast Louisiana, and one in north Louisiana. The selection of the case study units was determined based upon the presence of critical water supply and demand issues as well as the availability of data required to conduct the assessment. The framework has been constructed to provide uniformity of analysis across hydrologic units using existing data sources. Future water demand projections are being made based on projected urbanization and population change estimates.

Application of Freshwater Modeling and Model-based Decision Tools to Louisiana's Water Budget and Implications for Policy

Bryan Piazza [1], David Harlan [1], Michele Cutrofello Eddy [2], James Bergan, and Seth Blitch [1]

[1]The Nature Conservancy, Louisiana Chapter, Baton Rouge, LA, USA, [2]Research Triangle Institute International, Inc., Durham, NC, USA

A primary goal of environmental policy is to protect the environment from damage, while allowing for the wise-use of natural resources. For Louisiana water policy, that means promoting practices that support the ecological, economic, cultural vitality of our state – all supported by vast water resources. However, achieving sound, comprehensive water policy is challenging due to the tremendous natural and socio-economic complexities inherent in water decisions. To make sense of these complexities, it is imperative that we create and consult the best-available data and scientific resources and design ways to use that information in a comprehensive way.

We highlight tools that allow decision-makers and restoration professionals to use comprehensive scientific information to investigate water flow dynamics, calculate water budgets, and illustrate how upstream decisions about fresh water affect coastal resources.

We report on statewide, comprehensive hydrological models developed for Louisiana and Mississippi by The Nature Conservancy and RTI International, Inc. We will also describe three web-based science tools (apps) that use modeling estimates to inform water use, water budgets and water policy in Louisiana. The first, *HydroFlows*, delivers flow and water-budget metrics for current conditions and three future scenarios (climate change, projected future water use, and the combination of climate change and water use). The second is *OysterFlows*, an eco-flows app that shows the tradeoffs to oysters associated with water management decisions made over 100 miles upstream from the coast in the Sabine River system. The third app, *Water Quality*, investigates nutrient dynamics in watersheds to help focus water quality improvement programs in Louisiana. We will show these apps inside the *Freshwater Network*, an online space for viewing, mapping and using comprehensive, scientific data about Louisiana's water resources, and discuss implications of these tools for water policy.

Progress Toward an Integrated Water Code

Christopher Dalbom [1]

[1]Tulane Institute on Water Resources Law & Policy

The water code project focuses on an attempt to balance the state's water-related property laws with its civilian tradition and with a clear, sensible system is a necessity. This project intends to develop a model water code for the state of Louisiana that is both grounded in traditional water rights and responsibilities (public and private) and that is responsive to the evolving dynamics of water supplies and uses and to advances in all related fields of science. It will also approach water comprehensively, recognizing that ground water, surface water, and diffuse water are interconnected. Only with such a comprehensive water code will the many plans for Louisiana's coast be possible. This presentation will present the progress being made by the Louisiana State Law Institute's Water Code Committee in their work towards an integrated comprehensive water code for Louisiana.

Session Block II, 1:30 – 3:00 pm

Monitoring Approaches I

Utilizing Unmanned Aerial Vehicles (UAVs) to Monitor Land Loss, Assess Hazard Mitigation, and Evaluate Economic Sustainability of Louisiana Coast

Alahna Moore,[1] Malay Ghose-Hajra [1]

[1]The University of New Orleans

The Louisiana gulf coast is exceptionally vulnerable due to many factors including global climate change, sea level rise, geologic subsidence, loss of barrier islands, urban development, and an increasing number and intensity of coastal storms. The coast is currently experiencing unprecedented wetlands loss, reduced storm and surge protection, ground settlement, and increased flooding, leaving both urban and rural communities at risk.

Unmanned aerial vehicles, or (UAVs), equipped with digital cameras have proven to be a viable alternative to traditional means of capturing aerial imagery, commonly using an airplane or satellite. Their low altitude flight allows for super high resolution imagery, and the precision of autonomous flight has greatly expanded the potential for generating highly accurate elevation and land survey data. When processed with ground positioning information, UAV photography can produce 2D and 3D geospatial models with an absolute accuracy of less than an inch. This tool can revolutionize the way that we monitor quickly changing environments such as the Louisiana coast by making high resolution data easily attainable and affordable, at a more frequent interval than airplane or satellite imagery. UAVs can accurately repeat flights over a specific area which allows users to monitor change over time, such as soil erosion/restoration, changes in vegetation or wildlife utilization, the success or failure of mitigation projects, and pre and post-storm conditions. Additionally, UAV imagery can be used to monitor construction progress or inspect infrastructure. This capability allows the project team to examine areas where traditional surveys would be very time consuming and expensive.

This presentation will summarize example methodology of unmanned aerial vehicles that can be used in Louisiana coastal restoration projects. Application and benefits of UAS systems for Louisiana coastal protection and restoration projects will be deliberated using data obtained and analyzed from diverse projects in coastal Louisiana.

Understanding Coastal Changes Using High Resolution Imagery from Unmanned Aircraft Systems

Christopher M. Zarzar [1], Padmanava Dash [1], Jamie L. Dyer [1], Sathish Samiappan [2], Robert Moorhead [2], Gray Turnage [2], Lee Hathcock [2]

[1]Department of Geosciences, Mississippi State University, Mississippi State, MS
[2]Geosystems Research Institute, Mississippi State University, Mississippi State, MS

This project utilizes Unmanned Aircraft System (UAS) imagery from a series of UAS missions flown over the Lower Pearl River Estuary (LPRE) in Southern Louisiana to develop a method for delineation of the

stream network and precise land cover classification. Oftentimes, accurate identification and classification of surface features in coastal watersheds is difficult due to the dynamic nature of the environment, especially after extreme hydrological or meteorological events (i.e., tropical storms, river flooding, storm surge, etc.). However, it is important to identify and quantify changes to surface water features and land cover in these coastal regions to maintain a precise and up-to-date representation of the watersheds and river networks. UAS platforms are an ideal tool for this task because they provide the flexible temporal, spectral, and spatial resolutions needed while maintaining a relative ease of implementation compared to commonly used data collection tools (e.g. satellite, ground survey, and manned aircraft).

The UASs in this project are being flown over the LPRE approximately every two months providing a seasonal record that is important for identifying both the temporal and spatial changes in surface water features and land cover. The UAS imagery is first corrected for atmospheric errors, after which surface features are classified to provide information about the hydrologic and land cover characteristics of the area. Change detection analyses are applied to the land cover classification data to quantify changes in the surface water features and land cover between missions. This information is vital for research on surface hydrologic processes and land surface/atmosphere interactions, with the specific advantages of using UAS evident through higher precision stream identification and land cover classifications.

New Techniques for Data Visualization and Analysis in Evaluating Marsh Erosion using Unmanned Aerial Vehicles(UAV) as a vehicle for high resolution aerial mapping

Ryan Fuselier P.E., P.L.S.[1]

[1]Operations Leader – Advanced Technologies, C.H. Fenstermaker and Associates

The measurement of the environmental impact of shoreline marsh erosion is regulated by the Louisiana Coastal Management Division requiring an impact analysis to be performed before and after Oil & Gas exploration activities. Drilling rig movement into shallow water requires prop washing to move localized sedimentary deposits to increase water depths for final placement of the drilling rig. This study evaluates the methodology of establishing a baseline for the shoreline marsh before and after movement of the drilling rig into shallow water using traditional surveying techniques and comparatively using UAV's for high resolution aerial mapping.

Before the drilling rig is moved onsite, traditional surveying methodologies utilize the technique of setting polyvinyl chloride (PVC) pipes at regular intervals into the ground along the shoreline marsh prior to prop washing in order to establish a baseline of environmental conditions. Photographs are then taken N/S, E/W as appropriate at the established PVC positions for visual validation of the marsh baseline. When drilling activities are completed the rig is removed and field work is again performed to measure linear distances at the baseline PVC positions to the marsh shoreline to establish if any erosion has occurred from the drilling activities.

This study examines the use of low altitude UAV's as an aerial data acquisition platform to establish the marsh baseline before and after drilling activities. Survey grade ground control combined with UAV photogrammetry is processed to generate orthomosaics, Digital Surface Models (DSM) and high density point clouds. With Pre and Post construction 3D data sets, quantitative measurements can be performed using transects at any location along the model shoreline for environmental impact analysis. In addition, these models provide an historical reference point for any future needs.

Implications:

This study offers a new solution to visualize and monitor shoreline marsh erosion using low altitude high resolution photography from UAV's to create a more accurate model for measurement of the environmental impact of activity in shallow water where prop washing is required, while also reducing the environmental impact of PVC pipe installation/retention.

Flooding Impacts of Diversions on Wetland Vegetation

Understanding Coastal Wetland Plant Responses to Flooding

Mark. W. Hester [1], T. M. Sloey [2], J. M. Willis [1], J. M. Visser [3]

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Hydrology is often referred to as the "master variable" in structuring wetland plant communities. Frequency, depth, duration, and percentage of time a marsh surface is flooded, exert strong influence in determining which species can establish, survive and successfully compete in a given environment. This is because although wetland plants have specialized adaptations to growing in flooded soils, not all wetland plants are equally adept at tolerating flooding stress. The primary effect of flooding is reduced availability of oxygen in the soil. As oxygen is depleted in a soil, the soil becomes reduced and compounds that are toxic to plants (phytotoxins) can accumulate, such as hydrogen sulfide. Differential tolerance among wetland plant species to flooding is largely driven by differences in morphological/anatomical and physiological/metabolic adaptations, in combination with other environmental factors.

A key anatomical adaptation to growing in flooded soils is aerenchyma, which essentially functions as a conduit to transport oxygen from the atmosphere to the leaves and stems, and then down to the roots to support aerobic respiration, which yields more metabolic energy than anaerobic respiration. Prolonged periods of elevated water levels, as is expected to occur with large-scale sediment diversions, may be especially stressful not only in terms of soil reduction, but also in terms of prolonged submergence of aboveground stems and leaves that are important both for photosynthesis and for oxygen transport from the atmosphere to belowground tissues.

Results from multiple flooding experiments, illustrate differences among plant species to hydrology, as well as highlight key data gaps in our understanding of how hydrology interacts with other environmental factors, such as salinity and nutrient supply. Achieving a greater understanding of species (and community-level) differences in flood tolerance and growth responses can greatly assist the planning and design of coastal restoration projects that influence hydrologic regime, especially large-scale sediment diversions.

Flooding Impacts of Diversions on Wetland Vegetation

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There are several concerns about diversions based on short term, growing season, experiments with potted plants or vegetation responses in areas in which river introduction is sporadic and designed to minimize sediment transport. In contrast, relative little effort has been expended at studying areas where river water is freely flowing into existing marshes. These areas exist along the Atchafalaya River and Wax Lake outlet in the coastal Atchafalaya Basin and in the Bohemia Spillway area of the lower

Mississippi River. I used data from the Coast-wide Reference Monitoring System to show that marshes in these areas receive significantly more flooding during the early growing season (March through May) and some sites in the Atchafalaya Basin are flooded 100% of the time. Yet all of these sites, have 100% vegetation cover and there is no land loss in these areas. In the Atchafalaya Basin these marshes are dominated by freshwater species. In the Bohemia spillway, river flooding is limited to flood stages of the river and saline conditions return in late summer and fall, therefore most of this area is dominated by brackish and saline species. More research efforts should be allocated to these important landscape analogs to understand how planned sediment diversions may impact existing marsh landscapes.

Flooding Impacts of Diversions on Wetland Vegetation

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We have constructed a model of Louisiana's wetland plant communities and we have used it assess the effects of flooding on plant biomass, above/below ground allocation and community structure. Our model integrates three distinct modeling frameworks that complement each other and represent different aspects of plant biology and ecology. The first model was derived from LAVegMod, a community dynamics model that was developed as part of a larger modeling effort to inform Louisiana's Master Plan for managing wetland resources. LAVegMod simulates changes in landscape scale community composition in response to changes in hydrology, morphology and salinity. The next model was derived from VEGMOD, a biomass dynamics model that is part of Delft3D, a physics based simulator for hydrology and sediment dynamics. VEGMOD simulates changes in plant biomass in response to changes in hydrology, salinity, temperature and nutrient availability. We used LAVegMod to project annual changes in plant community composition and VEGMOD to predict the daily changes in the biomass of individual species. The third model simulates changes in above/below ground biomass allocation of plants. This model, LAVegMod.rootshoot, interfaces with VEGMOD to project biomass allocation to above and below ground structures in response to changing nutrient conditions. This model simulates the balance that plants must strike when allocating finite resources to below ground structures, allowing them to obtain nutrients, and above ground structures required to sustain photosynthesis. These models are linked back to the Delft3D hydrology model allowing the overall system to reflect feedbacks between biological and physical systems. Comparison of our plant model to actual biomass samples reasonable approximation of the total biomass as well as above and belowground allocation. Further improvement can be made by testing different flooding heights and flood duration on the major species affected by diversions.

We have used our integrated model to assess the potential effects of flooding on the species composition of plant communities and the amount of biomass accumulated. In particular we have applied our model to understand the impact of different proposed strategies for diverting water and sediment from the Mississippi River into Barataria Bay and Breton Sound.

Barrier Island and Inlet Dynamics

Breach Management Program: Criteria, Process, and Results

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The Breach Management Plan concept includes the identification, classification, and prioritization methodologies for assessing barrier shoreline breaching, identifying breach and response measures, and establishing protocols for implementing these measures. It has been well documented that breaching leads to significant increases in the rate of land loss from the shorelines adjacent to the breach.

Based on a detailed literature review, knowledge and experience with Louisiana barrier shoreline restoration, and professional judgment, three breach criteria were developed including the minimum island width equal to or less than 200 feet, minimum island width to updrift length ratio equal to or less than 3%, and ratios of updrift length and downdrift length to total island length greater than or equal to 27%. These criteria are recommended for evaluating the potential for barrier shoreline breaching that will result in the interruption of longshore sediment transport, thereby forming a new inlet. A five-step protocol was developed to classify the potential for barrier shorelines to breach and estimate the year of breaching.

Areas identified as having the potential to breach prior to implementation of a planned restoration project were classified as severe. Applying the protocol, four islands along the barrier island chain were classified as severe and conceptual plans were developed to reinforce these barrier shorelines and prevent breaching at identified vulnerable areas. Further, allocating appropriate sediment resources for future breach prevention and closure response projects should be integrated into the breach management framework.

To facilitate rapid and efficient response to breaching events, a Breach Response Protocol has been developed. This Protocol was developed utilizing lessons learned from previous breach response projects in Louisiana as well as other states. The Protocol recommends establishment of a Breach Management Team who will oversee the implementation of the Protocol and take preparatory actions and establish strategies for breach response implementation.

Morphodynamics of a Transgressive Tidal Inlet-Flood Tidal Delta System: Raccoon Pass, LA

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Raccoon Pass is a wave-dominated tidal inlet and part of a transgressive shoreline encompassing East Timbalier Island and the Caminada-Moreau headland. During the past century, the inlet has undergone significant morphological changes and has migrated onshore due to reduced sand availability that has

caused the ongoing transgression of the barrier arc. Moreover, human modifications completely altered the updrift longshore sediment transport system, initially facilitating the transgression, widening of the tidal inlets, opening of new tidal inlets, and restricting inlet sediment bypassing. To determine sediment transport trends in the vicinity of Raccoon Pass we (1) conducted hydrodynamic observations during winter storms and fair weather conditions, (2) 37nalysed historic shorelines and bathymetric profiles, and (3) assessed hydrodynamic data in terms of regional and local bathymetric controls. Our analyses highlight multiple regimes and pathways of sediment transport at this inlet, which is dominated by high-energy events such as winter storms when backbarrier basins exchange larger volumes of water. During these events, water exchange results in subtidal water levels in the backbarrier basin imposing critical controls on local fluxes at the inlet, and at times diminish flood-tidal currents altogether. This response, coupled with large waves and strong currents along the upper shoreface and through the inlet, have significant influence on the sediment budget of this system. Finally, geometric analyses of bathymetric profiles and shoreline positions over long time scales, underscore the upper and lower shoreface response compared to the shoreline migrational trends, indicating different pathways of barrier migration and associated geomorphic environments (inlets, spit platforms, flood/ebb deltas, etc.). Regionally tropical cyclones are suggested as the primary mechanisms of coastal change, whereas this work highlights the cumulative effect of changes induced on a more seasonal and frequent basis.

Modeling Interactions Between Backbarrier Marshes, Tidal Inlets, Ebb-Deltas, and Adjacent Barriers Exposed to Rising Sea Levels

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Along barrier island chains, tidal exchange between the backbarrier and coastal ocean supports unique saltwater and brackish ecosystems and is responsible for exporting sediment and nutrients to the surrounding coast. The tidal prism volume, basement controls, and the wave and tidal regime of the coast dictate the size and number of tidal inlets and the volume of sand sequestered in ebb-tidal deltas. The inlet tidal prism is a function of bay area, tidal range, and secondary controls, including flow inertia, basinal hypsometry, and frictional factors. Sea- level rise (SLR) is threatening barrier islands by causing flooding, changes in sediment supply, and conversion of backbarrier wetlands and tidal flats to open water. These factors are impacting basinal hypsometry, resulting in enlarging tidal prisms, increased dimensions of tidal inlets and ebb-tidal deltas, and erosion along adjacent barrier beaches. Although the effects of SLR on coastal morphology are difficult to study by field observations alone, physics-based numerical models provide a sophisticated representation of coastal processes over decadal time-scales, offering opportunities to link process causation to long term development. Here, we use a numerical model that includes the relevant features in the barrier/tidal basin system, linking dynamic vegetation response, inlet expansion, and ebb-delta growth to barrier shoreline erosion through long-term hydrodynamic and morphology simulations. Sediment exchange and process interactions are investigated using an idealized domain resembling backbarrier basins of mixed-energy coasts so that the sensitivity to varying SLR rates, interior marsh loss, sediment supply, and hydrodynamic controls can be more easily analyzed. Model runs explore the processes over decadal time scales, demonstrating the vulnerability of backbarrier systems to projected SLR and marsh loss. Results demonstrate the links between changing basin morphology and beach erosion patterns that initiate barrier transgression.

Soils

Results from the Recent Geophysical Survey Conducted in Barataria Basin as a Part of the System Wide Assessment and Monitoring Program (SWAMP)

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Bathymetric data are needed to resolve long-term and storm-driven morphological evolution trends within Barataria basin and is important for setting up numerical model grids for hydrodynamic, sediment transport and land-building models. Bathymetry data are not systematically collected within estuarine open water bodies, although these data are sporadically collected in individual water bodies to meet specific project and modeling needs. Long-identified as a substantial data gap, systematic bathymetry has not been collected throughout Barataria Basin since the 1930s.

As a part of the implementation of the System Wide Assessment and Monitoring Program (SWAMP) Barataria Basin Pilot, CPRA has commissioned the collection of geophysical data from transects throughout the basin. The recent effort covered approximately 1,300 nautical miles of transect lines and collected a full suite of hydrographic and geophysical data including sub-bottom sonar, magnetometer, and single beam bathymetry. Data were collected within Barataria Bay, Little Lake, Lake Salvador, Lac des Allemands, Lake Cataouache, The Pen, Bayou Perot and Rigolettes, and other major hydrologic pathways. In addition to the above parameters, sidescan sonar data were also collected in Little Lake and Barataria Bay. These data are currently being used to expand oyster monitoring within the basin to improve our spatial coverage and our understanding of oyster productivity within the basin.

The dynamic and detailed geomorphology of waterbody features within Barataria basin and the potential expansion of tidal inlets and tidal prisms have profound effects on potential future storm impacts and implications for sea level rise. These data are important for understanding change to the system, and for establishing baseline conditions preceding the implementation of river diversions. This presentation will discuss the collection and findings from the recent geophysical survey data within Barataria basin.

Characterization of Coastal Sediments Used in Marsh Restoration Projects

Malay Ghose Hajra

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Coastal property development, sea level rise, geologic subsidence, loss of barrier islands, increasing number and intensity of coastal storms and other factors have resulted in water quality degradation, wetlands loss, reduced storm and surge protection, ground settlement, and other challenges in coastal areas throughout the world. These natural and human hazards are putting more people and property at risk exposing significant infrastructure to open water conditions and making the areas situated nearby less suitable for human as well as various wildlife and fish species. One of the goals towards

reestablishing a healthy coastal ecosystem is to rebuild wetlands with river diversion or sediment conveyance projects that optimally manage and allocate sediments, minimally impact native flora and fauna, and positively affect the water quality. Restoring the marshes through deposition of dredged material from adjoining ocean, navigation canals and river beds and subsequent reestablishment of emergent wetland vegetation will help to protect the coastal properties and infrastructure systems from accumulated damage due to elevated water levels and storm surge forces as well as create a sustainable coastal environment to booster vital economic, social, and recreational opportunities for thousands of coastal habitants. Engineering properties and material characteristics of the dredged material and foundation soils are input parameters in several mathematical models used to predict the long term behavior of the dredged material and foundation soil. Therefore, proper characterization of the dredged material and foundation soils is of utmost importance in the correct design of a coastal restoration and land reclamation project. The sedimentation characteristics of the dredged material as well as their effects on the time rate of settlement of the suspended solid particles and underlying foundation soil depend, among other factors, on the (a) grain size distribution of the dredged material, (b) salinity (fresh, brackish, or saltwater environment) of the composite slurry, and (c) concentration of the solid particles in the slurry. This paper will present current methodologies used and advancements made in properly characterizing the sediments dredged and used in coastal restoration projects. Results obtained from field testing and laboratory measurements of coastal deposits from actual restoration projects in Louisiana will be presented.

Quantifying Thin Mat Floating Marsh Strength and Interaction with Hydrodynamic Conditions

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The state possesses over 350,000 acres of unique floating vegetated systems known as floating marshes or flotants. Floating marshes make up 70% of the Terrebonne and Barataria basin wetlands and exist in several forms, mainly thick mat or thin mat. Salt-water intrusion, nutria grazing, and high-energy wave events are believed to be some contributing factors to the degradation of floating marshes; however, there has been little investigation into the hydrodynamic effects on their structural integrity. Due to their unique nature, floating marshes could be susceptible to changes in the hydrodynamic environment that may result from proposed river freshwater and sediment diversion projects introducing flow to areas that are typically somewhat isolated.

This study aims to improve the understanding of how thin mat floating marshes respond to increased hydrodynamic stresses and, more specifically, how higher water velocities might increase the washout probability of this vegetation type. The presentation will be divided into three parts: (1) conceptual model of the interaction between the hydrodynamic stresses and thin mat material response; (2) experimental study of the material strength properties of thin mats, including a new apparatus for measuring the tensile strength of thin mats and the results from measurements made in Terrebonne Parish; and (3) numerical modeling of the flow through and around a thin mat, using Delft3D, and the effect on thin mat integrity. Results will be discussed and recommendations will be provided to begin the development of design guidelines to assess the washout potential due to increased hydrodynamic stresses on these systems.

Physical Modeling and River Studies

Implementation of the Expanded Small Scale Physical Model and Center for River Studies

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The primary goal of the Expanded Small Scale Physical Model (ESSPM) is to provide planning level information on the location and size parameters for Master Plan Sediment Diversions. Additionally, the model will be capable of providing qualitative insight on how regions of the Lower Mississippi River behave when several sediment diversion are operated simultaneously. Once constructed and calibrated, the ESSPM will be maintained and operated by Louisiana State University.

The ESSPM was developed by the Louisiana Coastal Protection and Restoration Authority (CPRA) as a replacement for a smaller physical model built in 2003. Due to the scale distortion (H=1':12000', V=1':500'; Distortion Factor=24) and limited domain (Myrtle Grove to GoM), the original model was only able to provide qualitative data pertaining to the feasibility of large scale (> 100,000 cfs) sediment diversions in the lowermost river. While valuable, it was recognized that a more scientifically defendable model would be more useful in improving our understanding of the river hydraulics and sediment transport. Improvements in the new ESSPM include an improved scale (H=1':6000', V=1':400'; Distortion Factor=15) and significant expansion of the domain (Donaldsonville to the GOM). In addition, careful study and optimization of the hydraulic and sediment scaling allow for significant improvements in the ability of the model to mimic the river sediment's re-suspension and transport characteristics.

This presentation will focus on CPRA's management of the planning, design, and construction of the model and the facility that will house it – the Center for River Studies. Specific topics to be discussed include the state-of-the-art CNC Router being used to fabricate the 216 high density foam panels that make up the model, the foundation design challenges and constraints associated with constructing a multi-story building near the Mississippi River levee, and the opportunity to be a centerpiece of the Water Campus.

The New and Improved (and Expanded) Small-Scale Physical Model of the Lowermost Mississippi River: Similitude and Modeling

Clint Willson [1], Ali Heidarizhaleh [1], Mauricio Hooper [1], Angela New [1], Linsey Olivier [1], Jonathan Puls [1], Christopher Turnipseed [1]

[1] Louisiana State University

The Expanded Small-Scale Physical Model (ESSPM), to be housed at the Center for River Studies on the Baton Rouge Water Campus, is a distorted-scale, movable-bed model that will complement ongoing numerical and field studies directed at studying various management strategies in the lower ~140 miles of the Mississippi River and their effect on flooding, navigation and coastal restoration. The ESSPM mean flow is designed to maintain Froude number (Fr) similarity between the prototype and the model, while the flow Reynolds number is relaxed, but still ensures rough turbulent conditions in the model. The distorted scale model covers a large domain using horizontal and vertical scales of 1:6000 and 1:400,

respectively, thus having a distortion of 15. These scales are chosen to achieve rough turbulent flow conditions and sediment movement for the prototype scenarios to be studied.

This presentation will first present the similarity laws used in the ESSPM design and what limitations are expected due to the use of a distorted scale. Following this will be a brief description of the 1-, 2- and 3-D numerical models that are being developed to assess the ESSPM capabilities to simulate the hydrodynamics and sediment transport processes, applicability to simulate prototype conditions and to complement other ongoing work. This discussion will lay the groundwork for several poster presentations designed to look more quantitatively at the ESSPM hydrodynamics and sediment transport.

Shifting Foundations: Exhibit Design for the Center for River Studies

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The Center for River Studies (CRS) is a research laboratory and outreach facility in Baton Rouge, LA supported by the State's Coastal Protection and Restoration Authority (CPRA). This new facility will house a large physical model of the Mississippi River Delta and an exhibition space. While the model is a scientific instrument used to study the sediment transport and distributary potential of the river, its physical presence is impressive and expected to attract significant interest. As such, a model viewing area is planned along with an explanatory exhibit that explores coastal issues. This exhibit acts as a primer in deltaic and riverine processes, while placing significant emphasis on the massive land loss occurring in Louisiana, the factors contributing to this crisis, and what's at stake. Key to the exhibit is a discussion of how evolving scientific understanding and coastal knowledge contributes to the state's efforts to protect and restore the coast. The exhibit is geared towards those who have some existing literacy in coastal science, from high school age and up.

The State of Louisiana's coastal restoration program calls for re-establishing hydrological connections between the Mississippi River and its delta. In so doing, the program calls for infrastructure that simulates the dynamic natural processes that originally built the delta. In order to understand and evaluate the merit of this strategy, it is essential that the public understand both the factors that are causing unprecedented land loss across the coast, as well as the scientific principles of the proposed protection and restoration strategies. The CRS exhibition seeks to educate and inform the public about the complex interactions of natural processes, land loss factors, and coastal infrastructure. The primary intent of the exhibition design is to draw connections between the technical, landscape principles of land loss, and what people encounter in their everyday experience of the coastal environment. This is done using clear visuals to convey a complex narrative, paired with evocative images of familiar landscapes, in order to foster a more robust understanding of the context in which the CPRA / state's protection and restoration work is being done.

This session will present the CRS design and outline the approach taken in communicating dynamic land building, land loss factors, and protection and restoration strategies in exhibition form. Compelling visual graphics, interactive displays, and physical models are all employed. This session will cover layout of the space, the exhibit content, and opportunities offered for engagement with relevant interest groups and the public.

Technical Analyses in the Feasibility Study of the Calcasieu River Salinity Controls Project

Data Collection and Baseline Assessments for the Calcasieu Salinity Control Measures Project

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The Calcasieu Ship Channel Salinity Control Measures is a large-scale hydrologic restoration project proposed as part of Louisiana's Comprehensive Master Plan for a Sustainable Coast (CPRA 2012). Beginning in 2013, CPRA conducted a feasibility study of the Calcasieu River Salinity Control Measures project. The study concluded in 2015 with identification of tentatively selected plan, and the project is transitioning into engineering and design.

To support the feasibility study, continuous and discrete measurements of water level, discharge, turbidity and salinity were collected to characterize upstream and estuarine boundary conditions and estuarine dynamics. These efforts resulted in robust datasets that have been used to calibrate and validate quantitative models that are capable of reproducing hydrodynamic and sediment transport conditions within the ship channel and estuary. These models supported alternative evaluation during the feasibility study and will continue to be used in future phases of the project.

During the engineering and design phase, data collection is focused on characterizing sediment transport dynamics to support development of a regional sediment budget. The sources of sediment into the system and the dynamics of sediment fluxes between the ship channel, the lake, adjacent wetlands and the Gulf are poorly understood. Most existing measurements rely on short-term synoptic data, are limited to the ship channel and are targeted at channel maintenance needs. Quantification of the sources, sinks and dynamics of suspended sediment transport is needed to support evaluation of the project's influence on navigation channel maintenance and resources including state oyster seed grounds in Calcasieu Lake.

Comprehensive Modeling Approach to Analyze the Calcasieu Ship Channel Salinity Control Measures Project

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A comprehensive modeling effort has been designed to analyze and evaluate the Calcasieu Ship Channel (CSC) Salinity Control Measures Project. The modeling effort provides guidance to this feasibility study from the initial alternative-screening phase, through engineering and design, and ultimately to permitting and construction. The modeling activities are focused to assess the salinity propagation into the CSC and surrounding regions, and to quantify the resultant effects on wetland morphology and

vegetation. A suite of existing models along with newly developed models was used to analyze the dynamics of the existing system and evaluate the proposed project alternatives. The models were validated using historical as well as new field observations collected as part of this study. There are three components to the modeling effort discussed here. The first component is the 2012 Master Plan (MP) models including the eco-hydrology model, the wetland morphology model, and the vegetation model. The MP models are used to assess the long-term and large-scale effects of the proposed project on ecology and morphology of the surrounding wetland areas. The second component is the existing dynamic (MIKE-FLOOD) model of the Chenier Plain region. The MIKE-FLOOD model is used to provide detailed information on the salinity and hydrodynamics and the potential impacts resulting from implementation of the various project alternatives. The Delft3D model is also used to investigate the sediment dynamics in the CSC and the Calcasieu Lake for the existing conditions as well as with the proposed project in place. Collectively, these modeling tools were used to screen initial alternatives, evaluate a final array of alternatives, and fully assess the tentatively selected project design.

Design Considerations in the Development of the Calcasieu Salinity Control Measures Project

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As part of the Calcasieu Salinity Control Measures Project Feasibility Study, technical and engineering analyses were conducted to support development of concepts that limit the passage of saline water from the Calcasieu Ship Channel into the surrounding wetlands. Salinity control concepts included a single barrier sector gate or lock, pass through gates, channelization berms and associated bypass sills, and perimeter control. Each of these concepts was evaluated with a suite of modeling tools including the 2012 Master Plan Eco-Hydrology Model, MIKE FLOOD, ADCIRC, and others to understand the salinity control benefits and associated changes in wetland morphology. Based on the results of the study, the Tentatively Selected Plan (TSP) consists of channelization berms, control structures on East and West Pass in the lower Calcasieu River, and bypass sills that allow for fisheries and recreational boat access throughout the estuary.

Engineering analyses considered various design criteria in recommending type, size, and location of features that would achieve the project objectives while balancing potential impacts to navigation and fisheries. This presentation will focus on the design criteria and subsequent analyses that led to recommendations for structure dimensions (widths and elevations) and structure operability (closure mechanisms) for the TSP. These include recommended dimensions of the design vessels navigating the ship channel and adjacent waterways, operational regimes to provide salinity control while minimizing impacts to navigation, and hydraulics and loads generated by winds, waves, storm surge, and tidal circulation. Future considerations for optimizing dimensions for salinity control (widths and elevations), minimizing impacts to navigation, addressing fish passage concerns, and incorporating projections of sea level rise and subsidence into the design will be discussed.

Geomorphic Evolution of Diversion Receiving Basins

Describing Delta Dynamics using Isopleths of Land:Water Ratio linked to changes in Ecosystem Services

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The survival of human settlement on Mississippi River Delta (MRD) is arguably coupled to a shifting equilibrium of the balance between land built by the Mississippi River and water occupied by the Gulf of Mexico. We will describe how the coastal basins of the MRD provides insights into how different river management strategies, with varying degrees of sediment delivery to coastal deltaic floodplains, change the patterns of how deltaic coasts and human settlement co-evolve. The Atchafalaya Bay (AB) continuously received sediment even though structures were built on the Atchafalaya River in 1944-1963 to allow control of water and sediment. In contrast, the Terrebonne Bay is an experimental basin where sediment supply from Mississippi River was eliminated in 1903. A measure of how coastal deltaic basins respond to river management decisions can be tracked by the relative land and water area changes that have occurred over the last 50 years under conditions of sediment delivery, sea level rise and subsidence. We use isopleths of where the land:water ration (*L:W* ratio) of 50% occurred along the coast indicate the transgression of Gulf of Mexico along MRD in response to changes in sediment delivery. We plotted the 50% isopleth for 1932 shoreline compared to 1971, 2000, and 2010 based on wetland loss rates across coastal basins, showing very strong transgression in coastal basins east and west of Mississippi River. We have digitized these isopleths and developed techniques to characterize migration rates spatially and temporally across coastal basins where migration of Gulf of Mexico waters occur at nearly 0.125 km per year in TB compared to actual aggradation of isopleths in AB. The migration of these isopleths and corresponding changes in coastal conditions such as wave formation (increased fetch) indicate that these linear migration patterns reflect nonlinear risks such as coastal flooding.

Understanding Hurricane-Induced Sedimentation in Wetlands Based on a Coupled Wave-Surge-Sediment Transport Model

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Although the time scale of the coastal processes driven by the high-energy events of tropical cyclones is short, it has been recognized that hurricanes are the major driving force of morphological changes in a micro-tide, low wave energy environment. Using satellite imagery, Barras (2006) estimated that approximately 562 km^2 of coastal wetlands in Louisiana were converted to water in areas impacted by

two hurricanes. Turner et al. (2006) reported that storm surges resulted in substantial sedimentation that could benefit coastal wetlands. The debate on the positive versus negative impacts of a hurricane on wetlands in the context of coastal sustainability and resiliency highlights the need for a better understanding of sediment erosion, transport and deposition during a storm event. Quantifying and predicting sediment dynamics in the mixed or heterogeneous sedimentary environment with vegetation during extreme wind events are intrinsically complex owing to the complex interactions of a wide range of co-existing fluid motions, vegetation, and sediments. With the rapid development of computer technology, however, significant advances in modeling storm surges and surface waves have been made, which allows for coupling spectral wave prediction and estuarine circulation models with an advanced sediment transport model for cohesive sediments to investigate sediment erosion, transport, and deposition caused by hurricanes. We use the Delft3D model guided by field observations of waves, surge, and sediment deposition to answer the following questions: 1) Where did the sediment observed in wetlands after a hurricane originate? 2) What percentage of the sediment deposition in wetlands came from the inner continental shelf and the estuaries? 3) Has the decrease in the land:water ratio of wetlands resulted in less sedimentation? 4) Was all the post-storm observed sediment net deposition? 5) What was the special and temporal variability of wetland sedimentation during a hurricane? Details will be presented at the conference.

Quantifying Storm Surge Attenuation along Coastal Louisiana via various Land Mass and Land Cover Scenarios

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Human migration patterns across coastal Louisiana may be linked to flood risk. If risk is defined as probability multiplied by consequence, this risk can be shown to have increased across coastal Louisiana since 1930 due to the transgression of the Gulf of Mexico into coastal marshlands. This transgression can be attributed to relative sea level rise (local subsidence and eustatic sea level rise), erosion, decreased sediment delivery and other additional factors. The relatively high frequency of hurricanes that make landfall along the Louisiana coast compared with other locations along the gulf coast contributes to flood risk. The time period of 1930 through 2015 coincides with the buildup of infrastructure to accommodate the shipping and offshore petroleum industries. This valuable infrastructure increases the risk of coastal flooding along coastal Louisiana. Southeast Louisiana has an undefined coastline due to the irregular shape of the marshland to gulf water interface. Aerial or satellite imagery have been employed to plot isopleths along the coast of Louisiana as a way to describe this interface. The 1%, 50%, and 99% land to water (L:W) ratio isopleths have been calculated and plotted for the years 1930, 1970, and 2010. These isopleths have been used to describe the various land elevations, extent, and vegetation types along the coast for the 1930, 1970, and 2010 eras. Results from storm surge simulations are used to quantify storm surge attenuation and assess factors contributing to increased storm surge heights and further inland extent by comparing and contrasting the results of these three eras. Hydrologic basins have been established to further analyze storm surge attenuation along the coast. The results of this analysis reveal which factors contribute to storm surge attenuation and flood risk reduction along coastal Louisiana. Insights into human migration along coastal Louisiana can then be obtained from this analysis.

What Lies Beneath: Partnership, Water Resources, and Geology

Alternative Delivery of Water Resource Projects

Robert Davis,[1] Michael Schmidt

[1]CDM Smith, New Orleans LA

"New normal" means that federal, municipal, and private agencies/utilities must do more with less. Adherence to cost and schedule constraints through efficiencies and synergies are essential for implementation of program-wide coastal and water resource improvements.

Alternative design-construction delivery such as design-build, construction management at risk, and public-private-partnerships offer considerable cost savings and leverage of funds to speed implementation and deliver multiple benefits. This presentation demonstrates three successful examples of these delivery methods to save costs and time for coastal ecosystem restoration and flood management.

Example 1 – Design-Build (DB) – St. Bernard Parish Louisiana Pump Station DB project for the U.S. Army Corps of Engineers New Orleans District – The project consisted of support structures, new pumps, emergency power, and tie ins to existing infrastructure. DB facilitated effective partnering between all stakeholders, rapid start-up and early completion, and use of innovative technology for successful delivery of this award-winning post-Katrina project.

Example 2 – Construction Management at Risk (CMAR) – City of Boynton Beach, Florida Downtown Watershed Regional Facility and Park – Use of a strong CMAR contractor facilitated integration of planning, modeling, designing, permitting, and construction of this integrated stormwater retention facility in the city's downtown area. The project treated, attenuated, and recharged stormwater through wells to reduce saltwater intrusion and the volume of freshwater discharged into the Intracoastal Waterway.

Example 3 – Public-Private-Partnership (PPP) - City of Rockledge, Florida Barton Park Manor Regional Facility and Wetlands Restoration – A successful comprehensive solution to retrofit and expand an existing lake to provide both water quality and quantity benefits was funded and delivered through a strong PPP that consisted of the City of Rockledge, the Federal Emergency Management Agency, the Florida Department of Transportation, Brevard County, a borrow pit operator, adjacent communities, local developers, and the designer-constructor.

The Depletion of the Chicot Aquifer: Farmer Decision-Making Concerning the Use of Ground vs Surface Water

JoAnne DeRouen [1] and Kari J. Smith [1]

[1]University of Louisiana at Lafayette

RESEARCH QUESTION: What attitudinal, objectives and behavioral factors influence farmer decision making? Can changes in farmer decision making and attendant farming practices influence present and future groundwater availability?

METHODS: Data collected through 80 semi-structured interviews with farmers across three coastal parishes in southwestern Louisiana sampled on the basis of access to surface water sources. Attitudinal questions/factors included achievement in farming, legislation, pessimism about farming, openness in farming, financial risk, chemical use, and policy communication. Farmer objectives/factors included success in farming, sustainability, quality of life, status and off-farm work. Farmer management behaviors/factors included production-oriented business behavior, environmentally oriented behavior, stressed behavior, and business development. Dependent variables included current use of groundwater versus surface water for irrigation, willingness to: 1) use surface water for irrigation, 2) consider alternative irrigation system designs and methods, and 3) implement alternative irrigation system designs and methods.

FINDINGS: Preliminary results suggest: a) that there are attitude-objective-behavior associations within domains of farming concerns, such as production and sustainability; and b) that some attitudes, such as those of achievement and openness, might serve as more general "drivers" of more than one goal/objective and behavior domain in farming, and c) the most influential factors affecting farmers' decisions concerning the use of groundwater versus surface water are: physical factors of surface water availability and proximity to sources, farmers' attitudes concerning achievement, openness and risk, farmer objectives concerning sustainability and farmer management behavior being environmentally oriented. Different farmer behavioral profiles can lead to different predictions of farmer decisions. Farmers more willing to consider/adopt new practices are those who interact more with other farmers, are less risk averse, quick to adjust their expectations, and slow to reduce their forecast confidence.

CONCLUSION: Further analysis will focus on multivariate (structural equation) modeling of these correlates in order to provide a richer picture of the associations.

Planning for What You Can't See

David Eley [1], Jas Singh [2]

[1] GeoEngineers, [2]CPRA

Louisiana's Coastal Master Plan contains significant infrastructure projects with substantial construction costs. Projects are selected based on scientific studies and models, that are updated regularly to select projects with the most benefit for our coast. In an effort to quantify cost for these projects, various parties have the unenviable task of developing conceptual designs and estimating costs based on limited information. A significant, but frequently over-looked component of project planning is subsurface conditions. Geologic features such as faults and the weak deltaic soil generally present throughout Louisiana's coast can have a significant impact on project location selection and cost. Some topics that will be explored in this presentation include: available geologic reference materials, geologic fault concerns, soil deposits along the Mississippi River and benefits/limitations, and common geotechnical design issues.

Session Block III, 3:30 – 5:00 p.m.

Monitoring Approaches II

Advancements on Coastal Marsh Edge Erosion Modeling through the Incorporation of Soil Properties

Cody L Johnson [1], Qin J. Chen [1], Arash Karimpour [1], Navid Jafari [1], Thomas Everett [1] and Kyle Parker [1]

[1] Louisiana State University

Coastal Louisiana is subject to some of the highest land loss rates in the world. Approximately one quarter of the total loss has been attributed to direct wave attack on the coastal marsh edge (Penland, 2001). Recently, attempts have been made to relate marsh edge retreat rate (m yr-1) to wave power (kW m-1) for regions of coastal Louisiana (Couvillion et al., 2015; Parker, 2014; Trosclair, 2013). These attempts have met with limited success which may be improved upon by accounting for the spatial heterogeneity of coastal marshes. Therefore, the consideration of additional factors which are site-specific is a logical step towards increasing the robustness of a marsh edge erosion model.

To this end, a multi-disciplinary field campaign was designed and undertaken in order to capture essential soil properties over a wide expanse of coastal wetlands in coastal Louisiana. Marsh edge topography is surveyed in Terrebonne Bay, LA and marsh edge cores are analyzed for sediment bulk density, grain size, and organic content at discrete depths. A previously measured yearlong wave record for the same basin is used to calibrate numerical and parametric models. To calculate the marsh edge retreat rate at the study sites, GIS techniques were used along with yearly aerial photography. The soil properties are then used to incorporate site-specific differences into the relationship between observed marsh edge retreat rate and modeled wave power.

Funding for this research has come from the National Science Foundation (NSF) and the Louisiana Coastal Restoration and Protection Authority (CPRA).

The Need for Effective Boom Monitoring Strategies during Oil Spill Response Activities

Justin Stein [1] and Kaylene Ritter [1]

[1]Abt Associates

As a part of the unprecedented response effort associated with the *Deepwater Horizon* (DWH) oil spill in the Gulf of Mexico, millions of linear feet of boom were deployed in an attempt to protect shorelines from the encroaching oil. Due to a variety of factors, some of the deployed boom became displaced and stranded along shorelines and within marsh and other habitats, resulting in potential harm to vegetation and biota. Tracking boom deployment, boom movement, and stranding presented an immense challenge to the recovery of stranded boom during DWH. Using a pilot area in Barataria Bay, we conducted a study to evaluate the use of orthorectified aerial and satellite photography to identify stranded boom and evaluate its effects in marsh habitats. We found that water-deployed boom, and boom stranded on shorelines and in marshes could be effectively identified in the imagery and quantified through digitization. Further, we determined that some adverse effects of the stranded

boom, including "scarring" of vegetated habitat, could also be detected in aerial imagery collected in the months after the boom was removed. Our study identified clear adverse impacts from stranded booms, suggesting that improved deployment and tracking of booms during oil spills is needed. We suggest boom monitoring methods that could be of assistance in future events, including front-end preparedness measures such as developing user-friendly applications for recording boom deployment and recovery in a grid-based tracking system, which could be coupled with boom tagging, by grid and deployment date. For impacts monitoring, we recommend regular collection of orthorectified aerial photography, supplemented with targeted post storm-event collections.

Vegetation Trajectories Following Coastal Wetland Restoration: Understanding Key Biotic and Abiotic Drivers of Planting Success and Natural Recruitment

Erik Yando [1], Michael Osland[2], and Mark Hester [3]

[1] Coastal Plant Ecology Laboratory, University of Louisiana at Lafayette, [2] Wetland and Aquatic Research Center, U.S. Geological Survey, [3] Institute for Coastal and Water Research, University of Louisiana at Lafayette

With proper planning, restoration projects can become valuable natural laboratories that provide key information for future restorative practices. Here we used a coastal wetland restoration project to examine how elevation, plant spacing, expansion, and natural recruitment may interact to determine successful plant community and soil development. On a site restored with dredge fill, we planted *Avicennia germinans* (black mangrove) and *Spartina alterniflora* (smooth cordgrass) at three different elevations that spanned the local tidal range. Within each of the three elevations, we manipulated *S. alterniflora* planting densities to examine the potential role of *S. alterniflora* in facilitating *A. germinans* establishment through the amelioration of stressful abiotic conditions. In a complementary study, we transplanted *A. germinans* and *S. alterniflora* in mono- and poly-specific plots to examine expansion, and we also measured natural recruitment into bare areas. Our findings clearly demonstrated the importance of elevation and resultant hydrology on the establishment success of these species. *A. germinans* survival and growth was optimal at low and moderate elevations, whereas the greatest *S. alterniflora* survival and growth was at the lowest elevations. Neither species performed well at the highest elevation where abiotic conditions hindered growth and survival. Where plantings were successful, expansion of *S. alterniflora* was rapid and plants were vigorous, whereas *A. germinans* expansion during this initial phase was not as extensive due to life history differences and morphology. After 6 months, we observed natural recruitment in bare area plots by both *S. alterniflora* and *A. germinans*, with *S. alterniflora* exhibiting greater percent cover. These complementary studies help to further identify optimal site conditions for wetland restoration success and illustrate the importance of understanding the role of hydrology, natural recruitment, and biotic interactions.

LCA Mississippi River Delta Management Study: Modeling Basin-Side Impacts of Large-Scale Restoration Projects

Mississippi River Hydrodynamic and Delta Management Study (MRHDM): Basin-Wide AdH Model Setup, Validation, and Application

Gary Brown [1], Kimberly Pevey [1], Jennifer McAlpin [1]

[1] United States Army Corps of Engineers Engineer Research and Development Center (ERDC)

The Mississippi River Hydrodynamic and Delta Management Study is a comprehensive effort, undertaken as a partnership between the State of Louisiana and the US Army Corps of Engineers, to develop tools and methods for use in managing the Lower Mississippi River and Delta. These tools and methods have been developed, and have been used to evaluate the effects of various proposed coastal restoration alternatives, including several proposed sediment diversions and dredge-and place land building alternatives. As part of the Corps of Engineers component of this effort, the Coastal and Hydraulics Laboratory, Engineer Research and Development Center, has developed an Adaptive Hydraulics (AdH) model of the Lower Mississippi River and the Mississippi River Delta. This model encompasses the entire lower River and Delta, and simulates hydrodynamics, salinity and (via a dynamic link to the SEDLIB sediment transport library) sediment transport, wetland vegetation, and wetland morphologic change. These dynamic processes are highly complex and nonlinear. These tools were developed in conjunction with sufficient quality field observations and robust conceptual models to characterize, parameterize and, crucially, bound both the uncertainty and the relative significance of each of the processes that govern the behavior of the system. Comparing and contrasting to companion modeling developed by the State of Louisiana (via partnership with the Water Institute of the Gulf) has provided critical insight into future land loss estimates and into possible outcomes of large scale water and sediment introductions into existing marshes.

Mississippi River Hydrodynamic and Delta Management Study (MRHDM): Basin-Wide Delft3D Model Setup, Validation, and Application

Ehab Meselhe[1], Melissa Baustian [1], Hoon Jung [1], Kazi Sadid [1], Fei Xing [1], Ashok Khadka[1], Mead Allison [1], Scott Duke-Sylvester [2], Jenneke Visser [2], Johannes Smith [3], Michel Jueken [3], Bas Van Maren [3]

[1]The Water Institute of the Gulf, [2]University of Louisiana-Lafayette, [3]Deltares

Sediment diversions and dedicated dredging were proposed as a large scale restoration tools in Louisiana's 2012 Coastal Master Plan by the State of Louisiana Coastal Protection and Restoration Authority. The primary goal of the proposed restoration strategies was to create new wetlands and replenish existing areas that were deteriorating as a result of many causes, including hydrological disconnection from the Lower Mississippi River. In addition to delivering sediment to the receiving basin intended to sustain and build new wetlands, some proposed sediment diversions could discharge a high volume (75,000 cubic feet per second of peak Mississippi River flow) of nutrient-rich fresh water into existing wetlands and bays. The overall goal of the analysis presented here is to improve our understanding of morphodynamic response of the large receiving basins and the ecosystem effects of discharge of freshwater and nutrients. The analysis includes performing an extensive field data

collection campaign, and setting up a numerical model capable of simulating: (1) morphological evolution processes resulting from direct placement of dredge material or from sediment diverted into wetland areas, and (2) salinity and nutrient-related effects to the wetland vegetation, soil, and the estuarine open water conditions of Breton Sound and Barataria Bay estuaries. While the model has been developed to support the immediate need of understanding the effects of sediment diversions, it can also be used to explore changes in the estuary solely due to change in future conditions, e g., subsidence or sea-level rise, the interactive effects of diversions with other restoration techniques, e.g. marsh creation using dredged material, and/or other restoration projects that influence the extent of wetlands within the estuary or estuarine hydrology and mixing.

Mississippi River Hydrodynamic and Delta Management Study (MRHDM): Fish and Shellfish Community Modeling Using Ecopath with Ecosim + Ecospace and CASM

David Lindquist [1], Kim de Mutsert [3,2], Kristy Lewis [2], Joe Buszowski [3], Jeroen Steenbeek [3], Scott Milroy [4], Kate Watkins [5], and S. E. Sable [5]

[1]Louisiana Coastal Protection and Restoration Authority (CPRA), [2]George Mason University, [3]Ecopath Research and Development Consortium, [4]University of Southern Mississippi, [5]Dynamic Solutions, LLC

Two fish and shellfish community models where developed in parallel to support the Mississippi River Delta Management (MRDM) Study, an Ecopath with Ecosim + Ecospace (EwE) model and a Comprehensive Aquatic Systems Model (CASM). The spatial domains of both models covered three Louisiana coastal basins (Pontchartrain, Breton, and Barataria). After calibration and validation to check that the models were able to reasonably replicate historical trends in fish biomass, the models were run for 50 years simulations of a future without project (FWOP) and various future with project (FWP) scenarios. The results of these simulations, relative changes in key species biomasses (e.g., brown shrimp, blue crab, red drum, gulf menhaden) over time, were evaluated for FWP compared to FWOP to assess effects of proposed large scale restoration projects on habitat and fish and shellfish throughout the region. The MRDM EwE model includes a food web of 70 groups (a combination of species and guilds) on a spatial resolution of 1 km^2 (over 40,000 grid cells), making this effort one of the largest spatially-explicit and time-dynamic EwE models developed to date. The CASM considers dynamic foodwebs for a similar list of species in 49 polygons. Initial conditions for the MRDM EwE model represent the ecosystem in 1995, and the model was balanced, calibrated, and validated over the period of 1995-2019. Similarly, the MRDM CASM was calibrated to seasonal species biomass trends under existing conditions (1995-2010) using LDWF and NFMS biomass data. Daily temperature, salinity, Chl a, and maps of marsh vegetation and open water generated by the MRDM Delft model were used to drive future simulations. Species responses were influenced by changes in environmental drivers and wide-ranging salinity and habitat preferences as well as effects on primary production and diet.

Advancements in Barrier Island Restoration and Monitoring

Evolution of Barrier Island Restoration in Coastal Louisiana

Michael Poff, Brett Borne , Greg Grandy, and Steve Dartez [1]

[1]Coastal Engineering Consultants, Inc., Baton Rouge, LA and Naples, FL, USA

Over the last several decades restoration efforts in coastal Louisiana have evolved from efforts known mostly to State and Parish officials and academic community to national recognition in the wake of Hurricanes Katrina and Rita and Macondo Oil Spill. Consolidated efforts of coastal restoration developed in the early years through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) enacted in the 1990's. Additional funding and organizational efforts include State funding; the Coastal Impact Assessment Program enacted in 2005 to provide grant funds generated derived from federal offshore lease revenues, and most recently the National Resource Damage Assessment and Gulf Environmental Benefit Fund from the penalties of the oil spill.

Barrier island restoration under CWPPRA began in the late 1990's targeting one or two island features with restored acreages in the mid to upper 200's. Present day efforts under the new programs restore complete island footprints exceeding 500 acres. Through lessons learned during construction, post-construction monitoring, and enhanced geologic studies; restoration designs are now developed with a more thorough understanding of subsidence and compaction, alongshore and cross shore sediment transport, and storm erosion losses. All of these elements contribute to restoration designs that restore the island's geomorphologic and ecological form and function. As more projects are constructed in an effort to stem the coastal land loss issues of Louisiana, the nearshore relict channel borrow channels previously used for restoration are becoming exhausted and more robust sand source investigations have led project teams to utilize sediments further offshore from historical deltaic shoals or the Mississippi River. Whereas the early project borrow areas were adjacent to or within a few miles of the restoration area, current project borrow areas now require pipeline distances of greater than 20 miles and in the case of hopper dredge or scow transport, greater than 30 miles.

Subsurface Compaction Due to Sediment Loading from Beach Restoration at the Caminada Headland in south Louisiana

Mark Byrnes [1], Chester Hedderman [2], Syed Khalil [3], Harry Roberts [4], and Steven Underwood [1]

[1]Applied Coastal Research and Engineering, Mashpee, MA and Baton Rouge, LA; [2]Gahagan & Bryant Associates, Houston, TX; [3]Coastal Protection and Restoration Authority, Baton Rouge, LA; [4]Louisiana State University, Baton Rouge, LA

Consolidation of deltaic sediment associated with overburden from beach restoration is a factor influencing project design elevations. An evaluation of localized sediment compaction associated with beach sand restoration along the Caminada-Moreau Headland in south Louisiana was initiated in February 2012. Target layers for installation of 10 subsurface monuments were determined based on lithology, gamma logging that accompanied lithologic descriptions, and geotechnical settlement analyses. A settlement plate also was installed at each monitoring station prior to sand fill placement. Settlement measurements at each plate recorded total elevation change resulting from sediment

consolidation beneath the fill plus natural subsidence due to Holocene sediment compaction. Elevation measurements associated with subsurface anchors recorded sediment consolidation for layers beneath each anchor, providing a means of differentiating variations in sediment compaction with depth. Additionally, high-accuracy elevation measurements at a control benchmark provided data on local natural subsidence. These data were used to remove the effect of natural subsidence when determining consolidation settlement associated with sand fill placement. Further, consolidation testing was performed to predict short-term and long-term expected settlement for each of the sampled subsurface layers. Calculated settlement is particularly important where project design elevations are critical for habitat restoration success (e.g., maintaining beach width and sand volume on the foreshore by limiting overwash for specific design events). Elevation changes were recorded at all depths, with greatest settlement occurring in clay layers between 25 and 75 ft below the surface. However, settlement was not consistent at all anchor locations within these clay layers. Measured changes in anchor monument elevations generally were greater than those predicted using geotechnical analyses, indicating that fill design elevations could be slightly higher to compensate for elevation change trends.

Assessment of Louisiana Barrier Island Restoration Trajectories through the Development and Implementation of a New Monitoring Protocol

[1] **Mark Hester** and [1] Jonathan Willis

[1]Institute for Coastal and Water Research, Dept. of Biology, University of Louisiana at Lafayette

Louisiana's barrier islands are important coastal features that have degraded through time due to a combination of natural processes and anthropogenic stressors, thereby necessitating restoration for their continued persistence. Post-project monitoring is an important component of restoration, and the development of more effective and adaptive barrier island monitoring protocols is necessary to adequately determine restoration success, as well as provide coast-wide reference and Masterplan model validation information. We developed an improved monitoring methodology and tested its efficacy at three differently-aged barrier island restoration sites (restoration dates of 1999, 2007, 2012) and one reference (natural-unrestored) barrier island site. Statistical differences were detected in the characteristics and restoration trajectories among barrier island habitat types, as well as differentiation of barrier island age post restoration. In particular, dune and swale habitats at the oldest barrier island restoration site were comparable in total and live vegetation cover to the reference site, whereas total and live vegetation cover were lower at the intermediately-aged barrier island site, and lowest at the most recently restored barrier island site. In contrast, total and live vegetation cover in back-barrier marshes were lowest at the recent restoration site, but comparable at all other barrier island sites, suggesting this habitat may approach reference vegetation levels more rapidly under proper conditions than other habitat types. Gradients of vegetation community composition were detected in dune and swale habitats that reflected post restoration age (i.e., restoration trajectory); however, gradients in back-barrier marshes were more strongly representative of environmental gradients (e.g., the gradient from high to low marsh habitat) than time post-restoration. Overall, this research has 1) demonstrated the effectiveness of a newly developed set of protocols to characterize vegetation communities in barrier island settings and 2) provided useful insights into the restoration trajectories of plant community development in the key habitats of barrier islands.

Species Considerations in Restoration of Wetland Vegetation

Recommendations for implementation of *Schoenoplectus californicus* in freshwater wetland restoration: Lessons Learned

Taylor M. Sloey [1], Jonathan Willis [2] Mark Hester [2]

[1.] Coastal Environments, Inc. Baton Rouge, LA
[2.] Institute for Coastal and Water Research, Department of Biology, University of Louisiana at Lafayette, Lafayette, LA.

Restoration and creation of freshwater marsh is desired in Louisiana to restore important ecological functions and services. Determining the optimal species for restoration efforts in a given location with specific environmental conditions, as well as understanding plant colonization and expansion dynamics, is essential to the development and implementation of effective restoration plans. *Schoenoplectus californicus* is a freshwater macrophyte that is selected for use in many freshwater restoration projects due to its ability to stabilize sediments and support fauna. *Schoenoplectus californicus* is utilized as a component of some Louisiana restoration plantings; however, a greater understanding of its physiological ecology may improve the success of these efforts. Through a combination of field experiments conducted in the Sacramento-San Joaquin Delta in California and greenhouse studies conducted in Louisiana, we present a comprehensive body of work to inform and enhance the effectiveness of *S. californicus* in restoration plantings. The results of our field studies suggest that *S. californicus* establishment and expansion is limited by hydrologic regime and wave energy exposure, depending on the life history stage of the plant. Our greenhouse studies revealed that adult individuals are tolerant to constant flooding, so long as a portion of the aboveground biomass remains emergent. Additionally, controlled studies demonstrated that regardless of flooding duration, *S. californicus* adults maintain stem strength, suggesting the *S. californicus* is a good candidate species to achieve wave attenuation. A nutrient experiment revealed that *S. californicus* individuals that receive a silica amendment in low nitrogen environments exhibit superior stem strength and reduced stem lodging. In summary, we recommend including *S. californicus* in fresh marsh restoration efforts, particularly in environments where flooding stress or high energy shorelines may preclude the use of other emergent plant species.

Interactive Effects of Created Salt Marsh Substrate Type, Elevation and Nutrient Regime on *Spartina alterniflora* and *Avicennia germinans* Productivity and Soil Development

Laura Hundy [1], Mark Hester [2]

[1] Coastal Plant Ecology Laboratory, University of Louisiana at Lafayette
[2] Institute for Coastal and Water Research, Dept. of Biology, University of Louisiana at Lafayette

Soil shear strength is an important soil property that should be considered in salt marsh restoration designs, as soils with higher shear strength may be more resistant to erosion. However, the relationship between soil properties, plant community composition, elevation, and soil shear strength in restored salt marshes has not been fully investigated. We conducted a controlled mesocosm experiment to examine the relationships between different types of soil, nutrients availability, and hydrology on the

growth response of smooth cordgrass (*Spartina alterniflora*) and black mangrove (*Avicennia germinans*) and the resultant influence on soil shear strength.

The findings of this study reinforce the current understanding of salt marsh zonation in southeast Louisiana in that *S. alterniflora* was significantly more flood tolerant than *A. germinans*, whereas *A. germinans* was more tolerant of a low water table and less sensitive to high soil salinities. Plant survival, productivity and soil shear strength were largely unaffected by the soil type treatments. Therefore, although suboptimal soils alone may not severely restrict the survival and growth of these species, the effect of soil properties, when combined with the stress of suboptimal elevation, may limit the successful colonization and growth of these species in restored marshes.

Importantly, the presence of both species conferred a small yet significant increase in soil shear strength as compared to unvegetated soils, suggesting that even small amounts of plant belowground biomass can contribute to soil shear strength. Thus, although previous studies have reported that soil properties, particularly soil texture, are the key factors controlling soil shear strength in established marshes, results of this study indicate that intertidal vegetation may provide a significant soil shear strength advantage by stabilizing newly placed sediments at restoration sites where the soil has not yet fully compacted.

Environmental Effects on Competitive Outcomes Between Two Monoculture-Forming Marsh Plants

Alex Ameen [1]

[1]Tulane University

Two common species found in the marshes of the Mississippi River Delta are the C3 sedge *Schoenoplectus deltarum* and the C4 grass *Phragmites australis*. Both species form dense monospecific stands as a result of belowground propagation. The seeds of *S. deltarum* make up a large proportion of the diets of canvasback ducks. The monoculture-forming haplotypes of *P. australis* originate from Europe and behave as an invasive species, although its large, dense stems may play a role in offsetting marsh edge erosion through wave attenuation.

Promoting the growth of one of these species over the other may be a useful strategy in future coastal erosion projects. We designed an additive pairwise competition experiment to test the effects of salinity, soil nitrogen, and soil organic matter on the competitive outcomes between the two species. We predict that *S. deltarum* will compete more effectively against *P. australis* when salinity, nitrogen, and organic content are lowest, due to *Schoenoplectus* having a lower salinity tolerance, and the C4 pathway of *Phragmites* having greater efficiency at converting nitrogen and carbon to biomass.

Developing Construction Costs for Restoration Projects

Techniques for Developing Restoration Project Construction Costs

Gordon Thomson [1], Glenn Ledet [2]

[1] CB&I, [2] Louisiana Coastal Protection and Restoration Authority

A critical element of planning, designing and ultimately constructing coastal restoration projects is to develop an accurate construction cost estimate or engineer's opinion of probable construction cost (commonly referred to as the engineer's estimate). When first developing a project concept, the performance and need of the project are considered but the overall project cost, and expected funding availability are also key factors. The size of the individual project elements and the cost are then iteratively developed during project design leading to a final construction cost estimate and issuance of plans and specifications for bid. "The engineer's estimate should reflect the amount that the contracting agency considers fair and reasonable and is willing to pay for performance of the contemplated work. Under-estimating causes project delay while additional funding has to be arranged to meet the contract costs. On the other hand, over-estimating causes inefficient use of funds that could be used for other projects. In addition, the engineer's estimate serves as the benchmark for analyzing bids and is an essential element in the project approval process. (Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation, 2004)."

There are three basic techniques or approaches to estimating: actual cost, historic data, and a combination of historic data and actual cost. There are also several key factors that can have significant impacts of cost estimates and should be taken into considerations such as trends in material costs, wage rates, site conditions, inflation, bid timing, project schedule, detail of plans and specifications, regulatory requirements, project size, insurance requirements, etc.

This presentation will discuss these key factors and the various techniques and approaches used to successfully develop construction cost for numerous restoration projects including but not limited to Shell Island West, Chenier Ronquille, Shell Island East, West Belle Pass Barrier Headland, Pelican Island, East Grand Terre, and Chaland Headland.

Modifications and Improvements to the 2017 Master Plan Project Costs and Attributes

Travis Byland [1], Rudy Simoneaux [1], Brett McMann [2]

[1]Louisiana Coastal Protection and Restoration Authority, [2]ARCADIS

Following Hurricanes Katrina and Rita in 2005, the Louisiana Legislature created the CPRA and tasked it with coordinating the local, state, and federal efforts to achieve comprehensive coastal protection and restoration. To accomplish these goals, the CPRA was charged with developing a Coastal Master Plan to guide our work toward a sustainable coast. Developed using the best available science and engineering, the Coastal Master Plan focuses our efforts and guides the actions needed to sustain our coastal ecosystem, safeguard coastal populations, and protect vital economic and cultural resources.

The 2012 Coastal Master Plan included project cost worksheets for all projects that were considered, analyzed, and selected. The approach for developing these costs was very general and much of the analysis was performed on a very broad scale. During early planning discussions for the 2017 Coastal Master Plan the CPRA team decided to look for opportunities to make improvements and modifications to their approach on project cost development. This included a fresh look at all project templates, revisiting the availability and location of borrow areas for dredging projects, reanalyzing the unit costs of dredging for Marsh Creation and Barrier Island/Headland projects, and utilizing completed planning and design efforts to gain a better understanding of Sediment Diversion features and costs. This presentation will discuss these modifications in detail, and highlight how the cost tools that were developed for the 2017 Coastal Master Plan can be utilized for other planning and design efforts.

Lessons Learned – An Analysis of Recent Bid Data

Glenn Ledet [1], Jacques Boudreaux[1]

[1] CPRA

A critical element of planning, designing and ultimately constructing coastal restoration projects is to develop an accurate construction cost estimate or engineer's opinion of probable construction cost (commonly referred to as the engineer's estimate). "The engineer's estimate should reflect the amount that the contracting agency considers fair and reasonable and is willing to pay for performance of the contemplated work. In addition, the engineer's estimate serves as the benchmark for analyzing bids and is an essential element in the project approval process. (Guidelines on Preparing Engineer's Estimate, Bid Reviews and Evaluation, 2004)."

One of the primary approaches to develop an accurate and reliable estimate is through an analysis of historic data from recently awarded contracts. Under this approach, bid data is summarized and adjusted for project conditions (i.e., project location, size, quantities, etc.) and the general market conditions. This approach is usually very efficient and produces an adequate estimate, as long as good range of competitive bid price data is used.

This presentation will review the historic and recent trends in bid prices, particularly unit costs of dredging for restoration projects. This section will cover various types of projects such as barrier island, barrier headland, and marsh creation as well as various types of borrow sources and the corresponding distance from the fill site. Additionally, this presentation will cover lessons learned in developing the engineer's estimate including key factors that should be considered (site conditions, inflation, bid timing, project schedule, flexibility in design/means and methods, etc.).

Restoration Physical Processes

Laboratory Study of a Novel Marsh Shoreline Protection Device: Sand Collection

Grant Besse [1], Nicholas McCoy, and Daniel Gang PhD[1]

[1] University of Louisiana at Lafayette, [2]

Erosion along shorelines in open water bodies and waterways is a major cause in conversion of wetlands and uplands to open water. Conventional shoreline protection structures are expensive to construct in these environments and may impede environmental exchanges that are essential for connectivity and functionality. A new shoreline protection device, the Wave Suppression and Sediment Collection (WSSC) device, is an alternative to conventional methods for shoreline protection. Laboratory studies were carried out in a wave tank to determine the governing parameters of sediment collection and wave reduction capacity of this device. Differences between the three devices include pipe diameter and open area. Three different devices were tested for their sand collection efficiency. Overall, all of the devices show sand accumulation behind them. The collection rates of two of the three devices are directly comparable due to the same open area. Devices 1, 2, and 3 have collection rates of 0.614, 0.315, 0.670 kg per hour, respectively. Collection efficiencies were obtained and its relation to pipe size and open area were compared. Devices 1, 2, and 3 collected 0.29, 0.15, and 0.10 kilograms per cm^2 respectively. Through the sand collection study, it was seen that all three devices have potential for accumulating sand. Within the study, differences in sand collection were found between the three devices. Location and open area of pipes beneath the standing water line seem to have a greater effect on sand accumulation than total open area. Results show the device is capable of reducing wave energy for shoreline protection, while at the same time collecting sand and restoring coastal wetlands.

Modeling Wave Dissipation by Vegetation Using a Non-Hydrostatic Flow Model

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Flooding caused by storms and hurricanes is a major hazard in many coastal areas. The low elevation of coastal areas makes lands and infrastructures vulnerable to inundation by storm surge and wave impacts. Coastal wetlands, serving as a buffer zone between open water and dry lands, can reduce storm surge and waves and protect coastal infrastructures. This work presents a case study of using a non-hydrostatic wave model NHWAVE (Non Hydrostatic WAVE) to model wave attenuation, spectral energy dissipation of random waves due to vegetation, and the nearshore current during Tropical Storm Lee (September 3–4, 2011).

Ma et al. (2013) developed a non-hydrostatic RANS model based on NHWAVE to study the wave damping over vegetation and turbulent vegetated flow structure. A two-equation κ-ε turbulence closure accounting for vegetation-induced turbulence production is employed to simulate turbulent flow within the vegetation canopy. The vegetation induced resistance force on flow is approximated as a summation of inertia and drag, which is modeled with a quadratic law.

In this work, NHWAVE is utilized to model wave attenuation through salt marsh vegetation during Tropical Storm Lee. The spectral energy dissipation of random waves due to wetland will be studied and compared with the field data collected at three wave gages, deployed on a vegetated platform marsh along a north–south transect (28 m long) approximately perpendicular to the salt marsh edge. Also the effect of the presence of wetland on nearshore current will be investigated. Detailed results will be presented at the conference. Funding for the research has been provided by the National Science Foundation.

Bottom Boundary Layer Sediment Transport Processes in Fourleague Bay of Louisiana and Their Implication to Sediment Diversion and Coastal Restoration

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Building land with a rising sea is a challenging problem in many major deltaic systems around the world. The Atchafalaya deltaic area is one of only a few growing sites in Louisiana coast. In order to better understand the far-field dispersal and deposition of fine sediments in the Atchafalaya system, two tripods were used to study the hydrodynamics and sediment dynamics at two stations in Fourleague Bay, which are 15 km southeast of Atchafalaya Delta. One tripod was located at the middle of the bay, and the other was near the marsh edge. Six sensors including OBS3A, OBS5+, ADVOcean, Argonaut ADV, and two wave gauges were planned to deploy in the early summer and winter of 2015 for a month, respectively. Our study was focused on the near-bed sediment transport to wetlands under fair weather and event condition. Based on the seasonal surface suspended sediment concentration (SSC), salinity, as well as turbidity, wave and current data, we have investigated the bottom boundary layer sediment dynamics, in order to illustrate sediment deposition and erosion processes under fair weather and energetic conditions in the bay. During an energetic event in early summer 2015, strong southeasterly wind waves carried salty water from inner Louisiana shelf northwestward into the bay, and led to increasing wave height, bottom shear stress, salinity, and near-bed turbidity. After the event, there was apparent decreasing of these parameters. SSC data in the bay showed an increasing trend since April, which is probably related to the fine sediment dispersal from the deltaic area due to the river flow. These onshore and alongshore transport events play a key role in trapping fine grained sediment and thus nourishing land in coastal Louisiana.

Understanding Sediment Properties in Receiving Basins

Evaluation of Settling Velocity of Fine-Grained Dredged Sediments Used in Louisiana Coastal Restoration Projects

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Southern Louisiana and similar coastal communities are seeing wetland loss and reduced storm and surge protection, resulting from coastal property development, global climate change, oil and water extraction, and other natural and man-made factors. Sea level rise, coastal land subsidence, barrier island loss, increasing intensity of storm systems, and other natural and human hazards are exposing more communities and infrastructure (Reed 2004). One of the goals towards reestablishing a healthy coastal ecosystem is to rebuild wetlands with river diversion or sediment conveyance projects that optimally manage and allocate sediments, minimally impact native flora and fauna, and positively affect the water quality. Restoring the marshes through deposition of dredged material from adjoining ocean, navigation canals and river beds and subsequent reestablishment of emergent wetland vegetation will help to protect the coastal properties and infrastructure systems from accumulated damage due to elevated water levels and storm surge forces as well as create a sustainable coastal environment to booster vital economic, social, and recreational opportunities for thousands of coastal habitants. Engineering properties and material characteristics of the dredged material and foundation soils are input parameters in several mathematical models used to predict the long term behavior of the dredged material and foundation soil. The sedimentation characteristics and settling velocity of the dredged sediments as well as their effects on the time rate of settlement of the suspended solid particles and underlying foundation soil depend, among other factors, on the (a) grain size distribution of the dredged material, (b) salinity (fresh, brackish, or saltwater environment) of the composite slurry, and (c) concentration of the solid particles in the slurry. This presentation will summarize the results from laboratory experiments performed on fine grained dredged sediments obtained from multiple coastal restoration projects in Louisiana. The effects of salinity and particle concentration on the sediment's settling velocity will be evaluated.

Implications of Texture and Erodibility for Sediment Retention in Receiving Basins of Coastal Louisiana Diversions: West Bay and Caernarvon as Examples

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Although the Mississippi River deltaic plain has been the subject of abundant research over recent decades, there is a paucity of data of field measurement of sediment erodibility in Louisiana estuaries. Two contrasting receiving basins for active diversions were studied: West Bay on the western part of Mississippi River Delta and Big Mar which is the receiving basin for Caernarvon freshwater diversion. Push cores and water samples were collected at six stations in West Bay and six stations in Big Mar. The average erodibility of Big Mar sediment was similar to that of Louisiana shelf sediment, but was higher than that of West Bay. Critical shear stress to suspend sediment in both West Bay and Big Mar receiving basins was around 0.2 Pa. A synthesis of 1,191 laser grain size data of surficial and down-core sediment reveals that silt (4-63 μm) is the largest fraction of retention sediment in receiving basins, larger than the total of sand (>63 μm) and clay (<4 μm). There seems to be an inverse relationship between river kilometer and retention rate based on a synthesis of multiple past and ongoing studies. Since the retention rate is high in more landward receiving basins, preferential delivery of fine grained materials to more landward and protected receiving basins would greatly enhance mud retention. Under a variety of conditions of fetches, depths and wind speeds, >0.2 Pa can be generated in many Louisiana bays and estuaries. The fragmentation of large receiving basins can help decrease the fetch sizes and minimize wave-induced sediment resuspension.

Geological and Geotechnical Characterization of the Middle Barataria Bay and Middle Breton Sound Diversion Receiving Basins

Samuel Bentley [1], Ethan Hughes [1], Jeff Bomer [1], Cody Johnson [2], Kehui Xu [3], Qin J. Chen [2], Arash Karimpour [2], Abigail Heath [1], and Frances Crawford [1]

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River-sediment diversions are key components for land building in Louisiana's Coastal Master Plan. The rate and locus of land building from diversions will be strongly influenced by both diversion flows of water and sediment, as well as receiving-basin hydrodynamic and geological conditions. In conjunction the Water Institute of the Gulf and funded by CPRA, we have conducted a major core collection and analysis program to determine the geological and geotechnical properties of substrates in the Middle Barataria Bay and Middle Breton Sound diversion receiving basins. Over a region of ~210 square kilometers in both receiving basins, 50 vibracores (to 5.5 m in length), 50 piston cores (to 1.5 m in length), and 50 in situ vane-shear profiles were collected in summer and early fall of 2016. Cores were collected from a representative range of wetland and open-water environments, using an airboat-mounted vibrator and lift boom. Cores were logged for bulk density and imaged with a Geotek Multi Sensor Core Logger. Split cores were then subsampled for grain size, organic content, and measured for sediment strength using a laboratory vane shear device and a cohesive strength meter. More detailed analysis and interpretation is under way (including extensive ^{14}C dating), but initial results reveal that both receiving basins are characterized by relatively weak peat-rich surficial strata, underlain by stronger mineral rich interbedded muds and sands. In both basins, some cores contain deeper peaty strata interbedded within muds and sands. Surficial peats in Breton Sound are generally <1.5m thick, whereas surficial peats in Barataria Bay are generally < 2m thick. Peaty surficial strata in both basins are more likely to erode and compact under the influence of diversion flows, but deeper mineral-rich strata are likely to be more resistant to compaction and erosion.

Sustainable Water Systems: The Impact of Changing Water Availability, Demands, and Water Quality on Louisiana's Coast

A Geospatial Framework to Elucidate the Dynamics of Groundwater and Surface Water Use in Louisiana

Whitney Broussard III[1], David Borrok [1], Emad Habib [1], Jian Chen [1], David Stevens [1], Fabiane Santos [1], Hisham Eldardiry [1], Morgan Pellegran [1], and Daniel Conlin [1]

[1] University of Louisiana at Lafayette

A sustainable strategy for water management in Louisiana must integrate the needs of groundwater and surface water users while not impeding basic ecosystem services. This changing paradigm and the need for a holistic approach to water management is reflected in the hydrologic connectivity between surface water management strategies in coastal watersheds and the freshwater needs of the coastal receiving basins, and groundwater pumping in upland terraces and salt encroachment into coastal aquifer systems. One critical step in evaluating this system is to develop methods for quantifying water supply and demand in a geospatial framework. Here we will report on new applications for dasymetric mapping techniques used to spatially disaggregate groundwater and surface water use data. Collected at the county-level, water use information has been disaggregated into more meaningful, spatially explicit enumeration units. These include individual groundwater wells, 12-digit Hydrologic Unit Code boundaries, or raster grids based on various ground sample distances. Results include the quantification of spatial and temporal patterns in the distribution of water use, statistical analysis of water use distributions, and groundwater elevation maps for the major aquifers. Maintaining the spatial heterogeneity of water use information is a critical component in any water management framework and the fundamental driver of the research presented here. The resulting water use information, methods, and analyses will be useful tools for policy makers, managers, and modelers interested in integrated groundwater and surface water systems.

Water Sustainability and the Coast

Hisham Eldardiry [1], Emad Habib [1], David Borrok [1], Whitney Broussard III[1]
[1]University of Louisiana at Lafayette

The Chicot aquifer system is the principal source of fresh groundwater in Southwest Louisiana. Since 1990, water use in this region has been dominated by groundwater withdrawals, while less surface water is being used despite abundant rainfall and surface water availability. The current study evaluates water stresses in the Chicot aquifer system based on the balance between availability of surface and groundwater resources, and the collective groundwater and surface water use by different sectors including public supply, rural domestic, industrial, power generation, and irrigation. Stresses on water systems are usually quantitatively assessed through indices that account for water demand relative to water availability and consider economic and social impacts (e.g., Falkenmark indicator, Social Water Stress Index (SWSI), and Water Supply Stress Index (WaSSI)). However, water demand and supply are stochastic variables that are highly uncertain and exhibit significant variability in both time and space. The current study focuses on assessing the effects of such uncertainties under current and future scenarios of water availability and demand. The analysis is performed on a watershed scale representing

Hydrological Unit Code boundaries (HUC12). Two different datasets are used for estimating surface water availability: the National Hydrography Dataset (NHDPlus), and the second phase of North American Land Data Assimilation System (NLDAS-2). The NHDPlus dataset, which provides estimates of mean monthly and annual streamflow information (averaged over 1970-2000), is used to assess water stresses under climatologically average conditions of water availability. The hourly streamflow estimates from NLDAS-2 dataset (available for 1979-present) are used to incorporate intra-annual and inter-annual variability in surface water availability and the impact on water stress calculations at different temporal scales (seasonal and annual). The results of these water stress indices suggest new opportunities for reallocation of surface water use to reduce groundwater over pumping and improve water sustainability in the region.

Evolution of the Geochemistry of Groundwater and Surface Water in Southwest Louisiana, Including the Chenier Plain

David Borrok [1], Whitney Broussard III[1], Daniel Conlin [1], John E. Jennings [2], Tiffani Cravens Barth [2]

[1]University of Louisiana at Lafayette, [2]Louisiana Department of Environmental Quality, Baton Rouge, Louisiana

Overdrafting of groundwater in coastal aquifers can lead to saltwater intrusion. In some cases it may be feasible to curtail groundwater use by using surface water instead. A possible hindrance to this effort, however, is poor surface water quality. In this study, we evaluated the geochemistry of the 23,000 km^2 Chicot aquifer and neighboring surface waters in Southwest, Louisiana. The Chicot is currently being overdrafted by about 350 million gallons per day. Bulk geochemical data (pH, T, salinity, Na, Mg, Ca, HCO_3, Cl) were compiled from samples collected from 20 wells in the Chicot aquifer over a 10 to 20 year period. Oxygen and H isotope measurements were additionally completed for samples collected in 2014. For evaluation of changes in surface water quality (nutrients, suspended solids, and salinity) a new searchable (also updatable and expandable) database was developed that combines existing USGS and EPA data.

Three zones of groundwater with distinctive geochemical character were identified, including northern and southeastern zones of recharge, and a zone of groundwater in the south and central parts of the aquifer system that exhibited a higher temperature and approximately a 1:1 Na/Cl ratio. The extent of salt water intrusion in the Chicot aquifer is limited to the south and southcentral areas and has remained relatively stable over the last 20 years. Using the newly-constructed database, we are currently examining the spatial extent of surface water quality parameters and how they have changed over time. Our hope is that this geochemical analysis can help within the overall effort to identify opportunities where surface water might be used to offset groundwater use in Southwest Louisiana.

Thursday, June 2nd

Session Block IV, 8:30 – 10:00 a.m.

Crabs, Clams, Oysters, and Climate

Effects of ocean acidification on the growth and survival of two life stages of the blue crab, *Callinectes sapidus*.

Sarah Giltz [1], Caz Taylor [1]

[1]Tulane University

Blue crabs, *Callinectes sapidus*, begin their larval phase offshore and circulate for approximately 30 days before settling near shore. As crabs transition to the juvenile stage, they move into coastal or estuarine environments characterized by lower salinity. Presently the average pH of the ocean is 8.1, 30% down from the beginning of the industrial revolution and is forecasted to drop to 7.8 by 2100. Decreasing pH causes dissolution of calcium carbonate shells, but the overall effects on crustaceans remain to be seen. The effects of acidification on blue crabs are unknown. This study investigated the effect of a lower pH environment on the growth, survival, carapace hardness and molt frequency of larval and juvenile blue crabs in the Northern Gulf of Mexico. Larval crabs showed delayed growth under lower pH conditions compared to crabs in a control (present day) pH environment as well as a greater probability of the experimental population crashing. Under low pH conditions the intermolt duration decreased in juveniles, but the body length and weight did not differ from crabs raised in the control pH. Larvae and juveniles did not experience increased mortality from a lower pH, but there do appear to be sublethal effects on growth and molting that differ between life history stages.

***Rangia* clam decline in Lake Pontchartrain from 2001 to 2014 after an El Niño Southern Oscillation shift followed by a period of high hurricane activity**

Michael Poirrier [1] and Claire Caputo

[1]Department of Biological Sciences, University of New Orleans

Prior to 2001, the clam, *Rangia cuneata*, was abundant in Lake Pontchartrain, a large, shallow, oligohaline estuary. Clam density abruptly decreased by 96% in 2001 after a drought from an El Niño Southern Oscillation (ENSO) shift (1998-2000). Long periods without episodes of low salinity resulted in the establishment of higher salinity communities which, through competition, resulted in the *Rangia* decline. The hooked mussel, *Ischadium recurvum*, colonized live *Rangia* and appeared to be a major cause of clam decline. Rapid recovery following the drought did not occur due to a period of high hurricane frequency and intensity. Densities remained low due to declines from hurricane disturbances by Katrina and Rita in 2005, Ike and Gustav in 2008 and Isaac in 2012. Density and biomass recovered to baseline years (1954 and 1997) in 2014 after two years without severe hurricane effects. Recovery indicated that clam loss was not permanent, but caused by a series of climatic disturbances. Chandeleur Island erosion caused by Hurricane Georges in 1998 and adverse effects of the ENSO drought on Biloxi Marsh wetlands may have set the stage for increased effects of subsequent hurricanes. Increasing

relative sea level rise, wetland loss and erosion of barrier islands, which occurred with each successive storm, potentially increased the size of surges. Hurricane surges resuspended sediments that buried clams and abruptly increased salinity and lowered dissolved oxygen. Salinity stratification persisted after storms and caused hypoxia in bottom waters. Storm surge interactions with the Bonnet Carré Spillway, a Mississippi River flood diversion structure, and the MRGO, a ship channel, also worsened hurricane effects. Results of this study provide a better understanding of potential effects of global climate change in the oligohaline zone of Gulf of Mexico estuaries.

Predicting Potential Growth of Oysters in the Barataria Bay (Louisiana, USA) Through a Dynamic Energy Budget Model Under Scenarios of Climate Change and River Management

Romain Lavaud [1], Megan La Peyre [2], Dubravko Justic [3], Lixia Wang [3], Cedric Bacher [4], Jerome La Peyre [5]

[1] School of Renewable Natural Resources, Louisiana State University Agricultural Center; [2] U.S. Geological Survey, Louisiana Cooperative Fish and Wildlife Research Unit, School of Renewable Natural Resources, Louisiana State University AgCenter; [3] Department of Oceanography and Coastal Sciences, Louisiana State University; [4] Research Unit on Coastal Environment Dynamics, IFREMER Centre Bretagne (France); [5] Veterinary Science Unit, School of Animal Sciences, Louisiana State University Agricultural Cen

Louisiana leads the nation in production of oysters, and is currently developing off-bottom aquaculture to complement their on-bottom production. Oysters growing in this region have to cope with considerable salinity variations from natural climate events (rainfall and stream runoff pushing isohalines offshore, storm fronts pushing isohalines inshore) and human-made diversions and siphons releasing freshwater from the Mississippi River. These salinity variations are predicted to increase with future climate scenarios because of increased frequency of stronger storms and also in response to proposed large river diversions. Increased Mississippi River flow into coastal estuaries from river diversions, along with potential changes in rainfall and stream run-off from climate change will alter the spatial and temporal salinity patterns. Changes in location and timing of high and low salinities have the potential to significantly impact oyster production, including the distribution of productive oyster beds. Specifically, salinity changes might affect the energy budget of oysters through reduced feeding activity, energetic costs linked to cell volume regulation and disturbed larval development. Using an individual bioenergetic model based on the Dynamic Energy Budget theory to predict bioenergetics throughout the whole life cycle of the eastern oyster, this study aims to provide a predicted potential oyster growth across the salinity gradient in Barataria Bay under different climate and river management scenarios. Under scenarios of an average year, a wet year (fresher), a dry year (saltier), and with proposed river diversions, a 3-D coupled hydrodynamic-water quality model (FVCOM Barataria) developed on the entire area of the bay will provide temperature and salinity fields as inputs for specific locations across Barataria Bay for the individual DEB model. DEB model outputs will identify locations of optimal oyster production areas which will help managers in identifying locations for future production.

Linking Social and Economic Processes in River Diversions I

The Impact of the Davis Pond Freshwater Diversion on Water and Sediment Exchange in Barataria Basin

Cyndhia Ramatchandirane [1], Mead Allison [1,2], Brendan Yuill [1,2], Melissa Baustian [1], Ehab Meselhe [1], Nan Walker [3]

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The Louisiana Coastal Protection and Restoration Authority has recently approved moving forward on the design and construction planning for the Mid-Barataria Sediment Diversion (MBSD) of the Mississippi River into Barataria Basin (BB). The goal of this structure is to divert up to 75,000 cfs of freshwater and fluvial sediment into mid-Barataria to build and sustain wetlands, offsetting predicted high rates of subsidence, coastal erosion, and sea level rise. To provide baseline data for the modeling effort of future scenarios in BB, the Water Institute (WI) conducted a large data collection campaign utilizing fixed stations and synoptic basinwide transects in 2014-2015. This effort gave insight into the present circulation and sediment transport conditions in BB as well as into the relative impact of an existing small freshwater diversion in upper BB. While not specifically engineered to divert sediment, the Davis Pond Freshwater Diversion (DPFD) is operated seasonally every year up to 10,000 cfs, and is the closest analog in BB for investigating the potential effects of the MBSD. A basinwide exchange analysis was conducted to de-convolve the relative impacts of major regional physical forcings from 2009 to 2015 using data from the WI and other fixed stations in BB. This analysis determined that the primary drivers of freshwater and sediment exchange in BB, as well as of water level and temperature, are cold fronts, astronomical tides, and Mississippi River discharge, with a lesser impact from the DPFD. This study also utilized MODIS satellite imagery to track suspended sediments in BB in 2014-2015. Time-series imagery revealed that plumes delineated a sediment transport pathway into upper BB during DPFD openings, and that the spatial distribution of these plumes were largely controlled by wind effects. The insights gained from this study can potentially inform the operational strategy of the MBSD to optimize restoration efforts.

Syngerism of Seasonal Salinity and Water Temperature on Oysters and How a Fishery Responds

Earl Melancon, Jr.

Department of Biological Sciences
Nicholls State University

The synergism of salinity and water temperature has significantly different influences on oyster populations through an annual cycle. Through field-collected measurements within the Barataria Estuary the influence of those seasonal differences are explained for oyster survival or death, recruitment failure or success, and for individual and population growth rates. During summer, oysters died according to up-estuary to down-estuary distances from the low-salinity source, but in winter oysters survived in similar low salinities. Low salinity resulted in a spring recruitment failure along the

same salinity gradient that caused deaths, but as salinity rebounded in fall a successful recruitment occurred at all sites within the Bay from larvae transported by currents to the dead reefs from elsewhere down-estuary live populations. Simultaneously during the fall recruitment, oysters grew to seed size and sack size based on the prevailing salinities at two sites. The way an oyster responds to these seasonal differences determines how the fishery responds. Oystermen may respond by moving up and down estuary to harvest market-sized oysters from different regions of the estuary as salinity habitat changes through annual cycles. Others may harvest an area every other year if salinity remains relatively low and growth to market size is slow, and some oystermen may harvest seed oysters for relay to other oyster grounds for grow out to market size. Nevertheless, for any scenario to work, salinity must remain within an oyster's physiological safe range for a period to allow for reproduction and recruitment, which is a function of the seasonal timing of flow and the residence time of the low-salinity conditions that may result from a diversion outfall.

Freshwater Diversions: "No Good Deed Goes Unpunished"
Andrew Wilson[1]

[1]Simon, Peragine, Smith & Redfearn, LLP

Despite the State's good intentions, the State's early efforts to implement major freshwater diversion projects to save the State's coast ran into significant resistance from the outset. Affected stakeholders sought to have the projects operate primarily for their own benefit to the detriment of others. If they could not get their way, they demanded significant compensation for any alleged, adverse effects from each project which, if allowed, would have rendered many projects fiscally impossible. The primary opposing stakeholder group was the oyster industry. The State had offered assistance to oyster fishermen who held oyster leases on State water bottoms enabling them to relocate their leases to areas more distant from the freshwater outfall of the projects to offset any adverse effects but received limited participation from the oyster industry. Instead, the oyster industry filed suit in multiple courts based upon various theories of recovery. The litigation dragged on for over 14 years and the government prevailed. But during that time, due to the litigation, many of the diversion projects were operated at minimum efficiency and were not allowed to achieve their coastal restoration goals. Sadly, just three months after the major elements of the litigation ended, Hurricane Katrina would roar ashore in the Parishes of Plaquemines and St. Bernard in the exact project benefit area of the Caernarvon structure, sweeping into New Orleans through the non-existent wetlands that had yet to be created. Now, as the State moves forward with major diversion projects the State should consider the lessons of the litigation, and prevent a recurrence by: (1) better communicating to stakeholders the goals and impacts of each project ahead of time with precision; (2) addressing and mitigating the legitimate economic concerns of affected persons and/or industries; and, (3) address unfounded claims for compensation ahead of time.

Marsh Creation Design I: Design Criteria, Data Collection, and Analysis

Proper Use of Tidal Datum and Marsh Inundation Frequency for Marsh Creation Elevation Design

Julia Wall [1], Stuart Brown [1]

[1] Louisiana Coastal Protection and Restoration Authority

The vertical position of marsh platforms and the frequency of marsh floods are strongly influential on plant communities and marsh health. Typically, tidal datum has been used to estimate local water levels and thereby determine the constructed marsh elevation. Using tidal datum, a healthy marsh elevation would be determined by maintaining an intertidal elevation throughout the marsh life (or 20-year project life). Tidal datum is a standard elevation defined by certain phases in the oceanic tide; it is expressed in terms of Mean High Water (MHW) and Mean Low Water (MLW) over an observed tidal epoch. Marsh creation elevations were generally designed based on the intertidal zone, and a created marsh was typically considered healthy if it stays within this elevation range.

Historically, tidal range worked well in determining the constructed marsh elevation of tidal salt marshes, where most of the water level variability is due to astronomical tides. Across Louisiana's coastal wetlands, however, non-tidal influences such as meteorological events, river discharge, impoundment features, and management regimes often have significantly more influence on water levels than tides.

An alternative methodology to determine constructed marsh elevation is percent inundation. Percent inundation refers to the percentage of the year at which a certain elevation of land will flood based on the water levels found in that region. Generally, a healthy marsh elevation is selected by maintaining a certain frequency of flooding throughout the marsh life, as determined by the percent inundation method. The frequency at which marsh at a given elevation floods is more representative of predicted local water levels which are not tidally influenced.

A case study of several projects currently in design phase will be shown as an example of how management regimes and lack of oceanic tidal influence effect the determination of constructed marsh elevations.

Mississippi River Borrow Areas: Delineation, Competing Interests, and Coordination

Kodi Guillory [1], Nick Cox [2]

[1] Coastal Protection and Restoration Authority, [2] Moffatt & Nichol

One of the cornerstones of the 2012 State of Louisiana's Comprehensive Master Plan for a Sustainable Coast is the use of the Mississippi River as a renewable resource to restore adjacent areas of degraded marsh. The Master Plan has identified several marsh creation projects that are adjacent to the Mississippi River to be restored using borrow areas that are located in the Mississippi River. These Borrow Areas must be delineated to maximize the sediment available within the Borrow Area while maintaining the integrity of the Mississippi River &Tributary levee system and also adhere to the *Limits of Permissible Excavation in the Mississippi River* established by the USACE.

The first project to dredge the Alliance Anchorage Borrow Area (located at River mile 65) was the Bayou Dupont Marsh Creation Project (BA-39) between 2009 and 2010. Since then, this Borrow Area has been routinely dredged to construct the Bayou Dupont Marsh and Ridge Creation Project (BA-48), the Mississippi River Long Distance Sediment Pipeline Project (BA-43 EB), and has also been used by the USACE to construct the Salt Water Barrier Sill in 2012. In addition to these recently constructed projects, there are future projects planned along the Barataria Landbridge Region that have identified the Alliance Anchorage Borrow Area as the primary borrow source for construction.

Competing interests and use of this valuable renewable resource requires close coordination between all interested stakeholders. In addition, close coordination with Mississippi River pilots and MNSA is required to ensure safety because the River serves as a resource to many people with varying interests and uses. Because of competing interests, permitting requirements, and navigation safety, the Alliance Anchorage Borrow Area was delineated numerous times before the final borrow area layout was chosen for the BA-48 and BA-43 EB projects.

Design of a Two-Lift Marsh Creation Project – Grand Liard Marsh and Ridge Restoration

Tye Fitzgerald [1], Rudy Simoneaux [1], Jerry Carroll [1]

[1] Louisiana Coastal Protection and Restoration Authority

Louisiana's coastal marshes are a dynamic and diverse environment. There is no one "simple" restoration practice that is applicable across the coast. A common occurrence is locally changing surface and subsurface conditions which can make construction difficult; challenging a design team to anticipate, identify and resolve these issues before they arise. A two-lift marsh creation design is one solution where peaty/organic weak soils are present and the more conventional single lift is not constructible.

The Louisiana Coastal Protection and Restoration Authority began work on the Grand Liard Marsh and Ridge Restoration Project (BA-68) in 2009. This project is designed to utilize local, in situ material to restore the earthen ridge, and offshore borrow material to build the marsh platform. It is one of the first projects to incorporate two lifts for marsh fill early in the design phase. This design methodology required the project team to overcome multiple challenges throughout design, many of which continued into construction. Construction of BA-68 began in July of 2014 and was completed June 2015. This restoration project was funded through the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA). The National Oceanic and Atmospheric Administration (NOAA) led the planning and project management efforts as the Federal Sponsor. The CPRA performed engineering and design (in-house), land rights services and construction oversight.

This presentation will focus on the background and purpose of a two-lift design, the analysis that was performed, and the data collection required to perform the analysis. Also to be discussed are the observations that were made once construction started, and how those observations spurred a re-design during construction that allowed for the ultimate success of the project.

Deltaic Processes

Modelling Plant Community Dynamics in a Hydrogeomorphodynamic System

Christopher Fontenot,[1] Dr. Scott Duke-Sylvester [1]

[1]The University of Louisiana at Lafayette

Wax Lake Delta is one of Louisiana's few coastal zones to buck a statewide trend of land loss, making it the focus of intense research into deltaic formation. Our goal is to find out how plant communities respond to and influence delta formation generally and in Wax Lake Delta specifically. We pursue this goal by modelling the study area's plant community dynamics in the context of an outside team's hydrogeomorphodynamic model. In order to determine model parameters for plant community response, we combined CRMS data for coastal Louisiana hydrology & water conditions with CRMS species surveys from the same period & locations. Establishment and senescence patterns for Wax Lake Delta's most prominent species were analyzed and built into species response parameters. Those were used to simulate plant community response to conditions in the hydrogeomorphodynamic simulation. Our model then output vegetation distribution maps for the hydrogeomorphodynamic model, so that it can more accurately account for vegetation's influence on flow rate, deposition, and soil retention in its next timestep. This process will be repeated for each timestep in the modelling time period, to create a more accurate model overall. Modelling results, profiles, and plant community maps will be presented.

Influences of Hurricanes, Floods, and Organic Production on River-Delta Evolution

Crawford White [1] and Samuel Bentley [1]

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The modern Mississippi River Delta plain has been largely disconnected from the main distributary by a highly engineered system of levees and floodways. This vast and fragile landscape is experiencing land-loss and is increasingly susceptible to inundation. Intense debate exists in the scientific community as to whether direct fluvial or hurricane-driven re-suspension and sedimentation are the present dominant sources of mineral sediment to the wetland surfaces of the modern delta complex. The relative importance of these sources remains a matter of public discussion and scientific debate, and this lack of clarity strongly influences development of tools, strategies, and policies to conserve coastal Mississippi River Delta lands.

Research fueling this debate has been restricted both spatially and temporally thus far. Furthermore, the contribution of organic production is unknown at these scales. A comprehensive study of the Lafourche and Plaquemine-Balize Mississippi River Delta complexes at a temporal scale similar to that of natural deltaic cycles (102 - 103 years) is being completed to address the deficiencies in our current understanding. A suite of 38 5m vibracores and 33 co-located 1m piston cores are being analyzed at moderate- to high- resolution for bulk density, grain-size, organic matter, magnetic susceptibility, and X-ray fluorescence to create the recognition criteria necessary to distinguish sedimentary sources for this time period.

210Pb and 137Cs data show that despite rapid subsidence and sea-level rise, many studied wetlands are still able to maintain their elevations. Sedimentary accumulation rates in the subaerial components of the Lafourche complex would seem to indicate that following distributary abandonment/cutoff and the elimination of pre-levee and overbank flooding and crevasse sediments, resuspension by cold fronts and hurricanes has become the primary sediment source for affected wetlands.

Soil Bulk Density Profiles From Marshes and Water Bottoms Influenced by the Caernarvon Freshwater Diversion

Ronald Paille [1], Craig Fischenich [2], Bobby McComas [2], Mike Channell [2]

[1] USFWS, [2]ERDC

Forty one-meter-long soil cores were collected from marshes and water bottoms in areas thought to be receiving riverine sediment from the Caernarvon Freshwater Diversion. Bulk densities were measured in 4-cm thick sections from upper portions of each core, and 8-cm thick sections from lower portions of each core. Cores from Big Mar and marshes immediately south of Big Mar exhibited the greatest accumulations of mineral sediment. Cores from marshes east of Bayou Mandeville exhibited lesser accumulations of mineral sediment. Marsh and water bottom cores were collected along the axis of 3 linear hurricane scour features located south of Big Mar. Some mineral sediment deposition was found on the bottom of the northernmost scour feature, but little at the other two scours. Sediment rich areas included sites that became open water following Hurricane Katrina (2005), and sites that did not. Where Katrina scoured out the marsh, a layer of very heavy mineral material was observed at depths ranging from 36 to 94 cm deep. Above that heavy soil layer, soils of moderate bulk density extended to near the current marsh surface. Most of these 2005 open water sites were marsh in 2008 following Hurricane Gustav. The creation of marshes at those sites may be due to Gustav sediments, sediments from the Caernarvon Diversion, or a combination of both. Sites that did not become open water following Katrina or Gustav, exhibited a thinner and lighter mineral soil layer at depth, and lesser bulk densities extending toward the surface.

Monitoring Programs I

Development of the Gulf of Mexico Habitat and Water Quality and Quantity Monitoring and Assessment Program for the RESTORE Council

Greg Steyer [1], Mark Monaco [2], Mike Lee [1], Steve Giordano [2], Alyssa Dausman [3], and Jessica Henkel [2]

[1] U.S. Geological Survey, [2] National Oceanic and Atmospheric Administration, [3] Gulf Coast Ecosystem Restoration Council

A comprehensive environmental monitoring network is a foundational element necessary to make scientifically-sound decisions regarding the health and viability of the Gulf of Mexico ecosystem. Under the RESTORE Act, the RESTORE Council (Gulf Coast Ecosystem Restoration Council) has statutory reporting requirements to monitor its funded projects. In order to provide the Council the information that it needs to meet its commitments, the monitoring and assessment program, administered jointly by NOAA and USGS, aims to develop the basic foundational components for Gulf region-wide monitoring in order to measure beneficial effects of investments in restoration. Through collaboration with the Gulf States, Federal and local partners, academia, non-governmental/non-profit organizations, and industry, the program will utilize a Council Monitoring & Assessment Work Group and a Community of Practice to leverage existing resources, capacities, and expertise and build on existing monitoring data and programs. This initial program will lay the foundation for a coordination structure and implementation strategy for an integrated network that leverages the breadth of current state, federal, or other regional programs to acquire existing and new habitat and water quality data, ensures quality assurance/quality control, and enhances data sharing and preservation. The program will establish consistent baselines that will effectively detect and track changes at the project level and landscape scale arising from planned activities (conservation, restoration), extreme weather events (storms, cold snaps), climate change/sea level rise, and accidents (ship groundings, oil spills). The monitoring network will be designed in accordance with adaptive management principles to insure strong connections with restoration decision-making and maximize opportunities for learning. Cross-institutional support will be garnered by inclusive management, data collection, open access to standardized data, involvement of Gulf-wide experts, active stakeholder involvement, and a system that is adaptable to changing needs and priorities.

System Wide Assessment and Monitoring Program (SWAMP) Update

Richard Raynie [1], Ann Hijuelos [2], and Scott Hemmerling [2]

[1]Coastal Protection and Restoration Authority, Baton Rouge, LA,
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Future conditions of coastal Louisiana are highly uncertain, due to the dynamics of riverine and marine processes, storm events, climate change, population growth, economic activity, and ongoing human reliance on the natural resources the coast provides. Managing such a complex system in which the natural and socio-economic systems are highly integrated is inherently difficult.

The System-Wide Assessment and Monitoring Program (SWAMP) has been developed as a long-term monitoring program to ensure that a comprehensive network of coastal data collection activities is in

place to support the development, implementation, and adaptive management of the coastal protection and restoration program within coastal Louisiana. SWAMP incorporates the Coastwide Reference Monitoring System (CRMS), the Barrier Island Comprehensive Monitoring (BICM) program, and fisheries data collected by the Louisiana Department of Wildlife and Fisheries (LDWF) in addition to other aspects of system dynamics, including offshore and inland water-body boundary conditions, water quality, risk status, and protection performance which have historically not been the subject of CPRA-coordinated monitoring.

A high-level programmatic monitoring plan was developed in 2015 for evaluating the effectiveness of the coastal protection and restoration program on a coastwide scale, and a detailed Barataria Basin Pilot is currently being implemented while detailed SWAMP monitoring plans are being designed in other basins. Monitoring plans were developed for both the natural and human systems using an iterative process to identify the monitoring variables, objectives, and sampling design. The monitoring variables and objectives identified fall under the general categories of weather and climate, biotic integrity, water quality, hydrology, physical terrain, population and demographics, housing and community characteristics, economy and employment, ecosystem dependency, residential properties protection, and critical infrastructure and essential services protection. The plan relies heavily on the use of existing data, thus coordination with other agencies and CPRA's existing monitoring programs is critical to the plan's success. This presentation will provide an overview of SWAMP development and implementation activities to date.

A Monitoring and Adaptive Management Framework to Support the Restoration of Resources Injured by the Deepwater Horizon Oil Spill

Melissa Vernon Carle [1,2], Karen Carney [3], Jean Cowan [2], Theresa Davenport [1,2], Terill Hollweg [3], Jamey Redding [1,2]

[1]Earth Resources Technology, Inc., [2]NOAA Restoration Center, [3]Abt Associates

Nutrients and Diversions

Importance of Hydrodynamic Forcing in Modeling the Fate of Nitrate in a Deltaic Floodplain

Alexandra Christensen [1,2,] Robert Twilley [1,4,] Clint Willson [2,4,] Ehab Meselhe [3,] Edward Castaneda [1,] Leanna Heffner [1]

[1]Department of Oceanography and Coastal Sciences, Louisiana State University, [2]Department of Civil and Environmental Engineering, Louisiana State University, [3]The Water Institute of the Gulf, Baton Rouge, LA, [4]Coastal Studies Institute, Louisiana State University

Newly emergent landscapes offer a unique opportunity to study the physical, biological, and chemical drivers of ecosystem development. Deltaic floodplains are one example, with new subaerial land emerging each year, fed mostly by river sediment. These dynamic systems are dominated by the force of the river, but influenced to some degree by the power of waves and tides. Variation in physical (topography) and biological (vegetation composition) characteristics throughout the delta leads to variation in response to those forcing functions. Due to a small elevation range, micro-topography of deltaic islands has a large effect on water flow paths. Vegetation creates flow resistance that can similarly direct the flow of water. Incorporating high-resolution topography and vegetation composition has been key to correctly modeling the hydrodynamics of individual deltaic islands. Focus on these islands stems from the important biogeochemical processes that occur here and the capacity of these wetlands to remove excess nutrients from river water. Correctly modeling the fate of nitrate depends on accurate hydrodynamic results, but also on specific reaction rates from experiments carried out in the laboratory. Wax Lake Delta (WLD), a prograding delta in southeastern Louisiana, was used as a model for testing the capability of Delft3D to reproduce water quality observations seen in the field. Data from our delta observatory at WLD show a pattern of high nitrate removal in regions where higher residence time and higher temperatures reduce river nitrate from 100 to <20 uM within 1.5 km distance. Two modules, Flow and Water Quality, were run in couple to simulate the fate of nitrate. The model was calibrated using monthly field measurements and validated using continuous data from stations on an individual island, Mike Island. Employing this model for research will lead to more precise nitrogen budget calculations and a better understanding of the function of deltaic floodplains.

Davis Pond River Diversion Project: Pre- and Post-Diversion Trends for Salinity Intrusion and Nutrient Removal

Andrew Stoddard [1], Chuck Villarubia [2], Silong Lu [1], Christopher Wallen [1], and Erol Karadogan [1]

[1]Dynamic Solutions, LLC, Knoxville, TN [2]Coastal Protection and Restoration Authority of Louisiana, Baton Rouge, LA

Draining 40% of the conterminous United States, nutrient loading from the Mississippi River basin has been identified as a contributing factor for the occurrence of widespread hypoxic “Dead Zone” conditions in the Northern Gulf of Mexico. Regulatory policies and management controls are needed to reduce nutrient sources from all upriver states of the basin as well as local nutrient management strategies in Louisiana. Mississippi River diversion projects, originally designed for restoration of the coastal wetlands of Louisiana and mitigation of salinity intrusion, have also been shown to be effective for nutrient assimilation and reduction of nutrient loading to the Gulf of Mexico. River diversion projects have thus emerged as a key component of Louisiana’s Nutrient Management Strategy and the 2012 Coastal Master Plan. One strategic action for Status and Trends of the Nutrient Management Strategy is the evaluation of trends in nutrients related to river diversions.

Using data from the USACE, USGS, EPA, NOAA, and Louisiana CPRA, water quality distributions before and after river diversion is used to evaluate the effectiveness of the 3,760-ha Davis Pond diversion project for nutrient removal and control of salinity intrusion in a freshwater marsh and wetland. The outflow from the diversion enters Lake Cataouatche and Lake Salvador and is routed through Barataria Bay into the Gulf of Mexico. Data to be presented includes: (a) nutrient removal efficiency; (b) one-dimensional path of salinity, nutrients and chlorophyll from Davis Pond to the Gulf of Mexico; and (c) mixing diagrams of salinity vs. nutrients. A key feature of the trends analysis is that water quality data has been filtered for low, normal and high Mississippi River flow and diversion flow conditions to detect pre- and post-diversion “signals” of seasonal and inter-annual changes from the “noise” of data collected from 1997-2010.

Impact of Mississippi River Diversions on Salinity Gradients and Estuarine Residence Time in Coastal Louisiana: A Numerical Modeling Study

Linlin Cui [1], **Haosheng Huang** [1]

[1] Louisiana State University

The recently released Louisiana’s Comprehensive Master Plan for a Sustainable Coast (2012) proposed to use river diversions that would convey orders of magnitude more fresh water to the coastal wetlands than the existing ones. These proposed sediment diversions may cause significant displacement and salinity stress to commercially and recreationally important fish and shellfish species due to the wide-spread and prolonged freshening of habitats. In this study, a three-dimensional, unstructured grid, Finite Volume Coastal Ocean Model (FVCOM) is developed to study the effect of the proposed diversions on salinity distribution and to infer their influence on fisheries within the Barataria Basin. To accurately consider the impact of coastal ocean processes on bay salinity variation, the estuary-scale FVCOM is coupled with the output product from Navy near real-time 1/12° Atlantic HYCOM ocean forecasting system. Thus, the effect of tidal- and wind-driven circulation over the Louisiana continental shelf that bring saline oceanic waters into the deltaic estuary can also be considered.

The numerical model domain covers most of the Alabama-Mississippi-Louisiana-Texas continental shelf with very high horizontal resolution (on the order of 15 meters) in Barataria Bay. Model simulation results are compared with observational data for model calibration and validation. A number of different diversion scenarios are assessed, including individual and concurrent operations of Davis Pond, mid-Barataria, and lower-Barataria diversions. Numerical modeling results indicate that river diversions

and coastal ocean processes both have the potential to greatly alter bay salinity regime and strongly influence estuarine residence times. This model can provide policy-makers and resource managers an important tool in coastal restoration planning.

Atchafalaya Perspectives; Exploring the Potential of the Mississippi River's Largest Diversion

Current Challenges and Opportunities for Atchafalaya Basin Sediment Utilization

April Newman [1], Don Haydel [1], and Charles Reulet [1]

[1] State of Louisiana, Department of Natural Resources, Atchafalaya Basin Program

The freshwater swamps of the Atchafalaya Basin have undergone major changes in recent decades as hydrologic alterations have affected the routing of water and sediment among a vast network of canals, natural bayous, and backswamps. Major channel realignment for flood control efforts as well as dredging of oil and gas canals have created and maintained an unnatural drainage network, while natural bayous, lakes, and swamps have filled with sediment. The overall effect has been degradation of habitats and water quality and decreased public access. The Atchafalaya Basin Program has been working since 1998 to find and implement solutions to these problems and has overcome many challenges to project implementation. This presentation will highlight some of the current initiatives and strategies of the Atchafalaya Basin Program to restore hydrologic functions and control sediment.

The Atchafalaya Basin Program works closely with the Louisiana Office of Coastal Management to ensure that all activities conducted within the Louisiana Coastal Zone are designed to minimize environmental impacts. We will provide a spatial analysis of the sediment generated by such projects within the Atchafalaya Basin within the last three years and suggest methods for more effectively utilizing these sediments. Additionally, we will identify specific areas in the Atchafalaya Basin where depth-restoration projects may contribute large quantities of sediment that may be utilized for coastal restoration.

Feasibility Study of the Increase Atchafalaya Flow to Terrebonne Project

Austin Feldbaum [1]

[1] State of Louisiana, Coastal Protection and Restoration Authority

Roughly fifteen percent of the Mississippi River's flow passes through the Lower Atchafalaya River at Morgan City. Sediment carried by this flow is filling in Atchafalaya Bay, expanding the delta that is one of the few areas of wetland expansion in coastal Louisiana. Marshes closest to the river's influence are relatively stable; in some cases marshes are expanding into open water as sediment settles in channel margins and shallow ponds. In contrast, Terrebonne marshes isolated from river inflow are critically starved of freshwater and sediment resulting in extensive wetland loss. Over the next 50 years significant land loss is expected across much of the basin.

The Increase Atchafalaya Flow to Terrebonne project will utilize freshwater and sediment from the Atchafalaya River in order to prevent wetland loss within the Terrebonne Basin. With funding from the National Fish and Wildlife Foundation as part of the oil spill restoration plan, Louisiana Coastal Protection and Restoration Authority conducted a feasibility study to advance the project towards implementation. The study area encompasses over 900,000 acres, including coastal marsh south of the

GIWW at Morgan City eastward to the Houma Navigational Canal. The tentatively recommended plan for the project includes installation of a bypass structure at the Bayou Boeuf Lock, dredging to increase the conveyance capacity of the GIWW and southward distributary channels, and beneficial use of dredged material.

Contingent to the success of introducing sediment and freshwater into the system is the ability to integrate this restoration project with a comprehensive flood protection system and existing navigation systems. Study efforts to date include substantial field data collection, use of quantitative models and engineering analyses. The findings of this study highlight future adaptive management needs and offer a perspective on comprehensive management of the Atchafalaya River. Currently, this project is in the preliminary engineering phase.

Responsive Ecological Infrastructures

Bradley Cantrell [1]

[1] Harvard Graduate School of Design

Responsive ecological infrastructures offer a method of re-envisioning solutions to the problem of sediment transport from the Mississippi River to the Louisiana coast via the Atchafalaya River. Responsive technologies is a general term for devices or components that enable methods of sensing, monitoring, processing, and feedback. There are nascent efforts across multiple disciplines that are engaging ecological systems with forms of real-time simulation and responsive technologies. These efforts range from drone seed dispersal to autonomous terrain grading to in-situ genetic manipulation of biological systems. Each of these efforts alters the current paradigm of design, evaluation, and construction and offer entry points for an adaptive method of ecological manipulation.

The work of the Responsive Environments and Artifacts Lab (REAL) at the Harvard Graduate School of Design is researching methods of design that are predicated on the design of adaptive infrastructures within dynamic ecological systems. This work takes place primarily within the lab through the use of a physical geomorphology model that simulates the flow of water and sediment across a surface. The model is not a surrogate for a particular physical landscape but operates as a miniaturized landscape with a limited set of variables, i.e. water flow, sediment size, and slope. The physical model is equipped with sensors that record the surface morphology at multiple fidelities, monitor water velocities, sense moisture levels within the sediment, and capture images from multiple angles, all of which are all analyzed in real-time. The datasets that are gathered from the sensors are used to create abstractions of the sediment and water flows. Abstracting the data provides optimized representations of complex phenomena allowing it to be visualized or interpreted by devices that modify the sediment.

Session Block V, 10:30 – 12:00 noon

Vertebrate Coastal Ecology and Restoration

Coastal Ecology of Louisiana Carnivores

Mirka Zapletal, Paul Leberg

University of Louisiana at Lafayette

Carnivore distribution and assemblage have been little studied in coastal Louisiana, and responses to human activity and habitat change within this rapidly evolving ecosystem are largely unknown. Better understanding of carnivore biogeography within the coastal environment will facilitate management of both carnivore and prey populations in the face of long-term climate change. This study investigated carnivore species distribution at mainland and barrier island sites in Vermilion, Terrebonne, and Barataria Bays to develop current baselines of carnivore ecology for coastal Louisiana and models for carnivore presence at Gulf-facing sites in Louisiana.

Track plates, cameras, trapping sessions, and opportunistic records determined carnivore species distribution. Species fulfilling ecological carnivore roles (e.g. *Rattus* spp.) were included in analyses. Prey surveys (e.i. crab counts, bird counts, etc.), vegetation plots, beach surveys, and GIS data (e.i. site size, distance to nearest landmass, etc.) provided environmental data for locations with and without carnivore species. AIC model selection for carnivore species together and individually provided environmental characteristics most indicative of carnivore presence.

Carnivore presence in coastal Louisiana is responsive to a variety of factors, including vegetative complexity, proximity to other landmasses, and human presence. At the species level, correlates of raccoon presence differed from correlates of coyote presence which differed from correlates of rodent presence. This information suggests that planning for ecosystem maintenance in coastal Louisiana cannot utilize a “one size fits all” approach for either removal or support of carnivore species. Projected impacts of climate change will alter carnivore distribution within Louisiana’s coastal zone, and AIC model selection suggests that carnivore species will respond individually to future conditions.

Nekton Utilization of Dredged Material Marshes.

Scott Harlamert, John Nyman, and Megan La Peyre.

School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA.

There has been a considerable amount of effort creating marshes with dredged material as areas such as Louisiana have experienced significant loss of coastal marshes. Using dredged material to create marshes quickly provides structural protection and ecosystem services that may have otherwise been lost when wetlands converted to open water. Creating marshes that are structurally and ecologically beneficial to the coast is a goal of Dredged Material Marshes (hereafter DMM) but we currently understand little about how successfully these projects meet coastal restoration goals. DMM are assumed to create marshes that support similar amounts of nekton (fishes and decapod crustaceans) as

natural marshes, but there are no empirical data that can be used to compare nekton among DMM, open water, and natural marshes in Louisiana. We are comparing nekton abundance, biomass, and species composition at four DMM sites and adjacent natural marsh and open water sites. We use a 1-m^2 throw trap at each site, sampling seasonally at three plots along a transect for each DMM, and similarly replicated transects at adjacent open water and natural marsh locations. Preliminary examination of the data suggests that DMM sites support fewer nekton than natural marshes because DMM sites flood much less than natural marshes.

[Presentation Requested]

Linking Social and Economic Processes in River Diversions II

Using River Diversions to Maximize Elevation Capital: Active vs. Inactive Deltaic Settings

Greg Snedden [1]

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The ability of Mississippi River diversions to deliver inorganic sediments in sufficient quantities to build new deltaic wetlands in shallow, open-water receiving basins has been observed at several locations across the delta plain over the last several decades. In addition to facilitating sediment delivery, when discharging into existing deltaic wetlands, river diversions can also deliver sufficient volumes of water to induce widespread inundation to emergent vegetation. Because many regions of the deltaic plain are dominated by flood-intolerant vegetation species, prolonged inundation in these areas can impair belowground production and soil development, and ultimately offset gains in elevation capital realized through direct mineral sediment deposition. A variety of stages of deltaic development and ecological succession exist across the delta plain, with each stage relying on varying relative contributions of mineral and organic matter to accrue and maintain elevation capital. This study examines the relative importance of hydrologic and ecological processes in creating and maintaining elevation capital across the Mississippi River delta plain. Across the inactive regions of the delta plain, volumetric leverage from organic accumulation is significantly higher than that obtained from inorganic accumulation. In contrast, on the active regions of the delta plain soil volume is comprised of primarily inorganic matter, and porespace is substantially reduced. These circumstances clearly exemplify the need for restoration planning within the context of delta development and ecological succession, and illustrate the importance of locating and operating diversions in a manner that maximizes the site-specific processes most important for accrual and maintenance of elevation capital.

Which Voices? Who Decides? River Diversions and the Future of the Coast

Pamela Jenkins

[1] Department of Sociology University of New Orleans,

As more tangible solutions about the fate of the coast are proposed, decisions about river diversions are quickly moving to the forefront of state and local discussions. These decisions will impact communities, residents, and their livelihoods in significant ways. Yet, the shape of the river diversions and the future of the coast are choices considered by a number of stakeholders. This paper explores how the positions of stakeholders in these decisions vary. While river diversions, on the surface, are decisions based on best practices and methodologies of science, the roles of planners and scientists are influenced by other stakeholders. In the wake of cascading hurricane events and the Deepwater Horizon oil spill, citizen involvement and understanding of coastal issues has increased. Using interviews, archival materials and other secondary data, this project documents the competing views of river diversions and their consequences. The opposing positions are not new, but have taken on increasing importance as solutions and proposals become more urgent. Content analysis of the divergent views will provide a conceptual map of stakeholders' position. This map may provide a guide to policy that includes more voices and positions. How all stakeholders understand and respond to the challenges of sea level rise

and climate change will provide possible strategies and recommendations for local and state policy choices, including river diversions.

Evolving Economics: Towards near term impact assessments of river diversion projects

Rex Caffey [1]

[1]LSU AgCenter

The scientific assessment of river diversions in coastal restoration has historically focused on technical considerations of hydrology, geomorphology, structural engineering, and ecological response. To date, economic analysis has been limited to programmatic justification and relative cost-efficacy comparisons between competing projects. Accordingly, baseline socioeconomic data has been collected and analyzed over fairly large spatial and temporal scales (e.g. basin-wide, coast-wide; decadal, 20y, 50y). As programmatic emphasis transitions into engineering and design; however, the resolution and analysis of socioeconomic data must increase to address more detailed questions related to project feasibility, efficiency, and the trade-offs in ecosystem services for varying operational regimes. This presentation examines the history and evolution of economics in support of, and in response to, Louisiana's coastal restoration efforts over the past three decades. Specific focus centers on the outcome of diversion socioeconomic workshops sponsored by NOAA in July 2014 and October 2015 - at which participants discussed the merits and mechanics of commissioning near-term (1-5y) socioeconomic analyses to complement to long-term projections of diversion-based net benefits and costs. Implemented at sub-basin scale, and for specific sectors, near-term impact analyses can help to address distributional and transition effects (positive and negative) to private property and commercial operations. The presentation concludes with a conceptual overview of the biophysical linkages needed to inform such assessments, and the various economic methods through which impacts might be examined under various contexts (e.g. NEPA compliance, mitigation, dispute resolution, compensation).

Time Scales in Subsidence and Landscape Evolution

Threshold-level Land Building at the West Bay Mississippi River Diversion

Alex Kolker [1,2] Alex Ameen [2,1], Mead Allison [3,2], Ashok Khada [3], Ehab Meselhe [3]
Cyndhia Ramatchandirane [3], H. Dallon Weathers [3], Jason Weick [1], Brendan Yuill [3] Fei Xing [3].

[1.] Louisiana Universities Marine Consortium, [2.] Tulane University, [3.] The Water Institute of the Gulf

Plans to restore Louisiana's coast rely heavily on river diversions that aim to shunt freshwater and sediments into degrading wetlands, thereby reinitiating the natural delta-building processes that originally built the Mississippi River Delta. However, there is relatively little field evidence regarding sedimentary and land building processes in the large (~ 50,000 cfs) diversion that are envisioned in Louisiana's Master Plan (MP) for a Sustainable Coast. The West Bay Mississippi River Diversion (WBMRD) one place to study such processes, as it is similar in scale to the large diversions envisioned by the MP. This study examined sedimentation rates, particle trapping efficiency, and subsidence rates in the WBMRD through analyses of sediment cores, surface samples, and numerical models. Flow from Grand Pass (which forms the western border of West Bay) and wrap-around discharge from Southwest Pass play important roles in both the pre-diversion system and the modern system. The modern system is strongly shaped by the WBMRD and a suite of artificial islands, “sediment retention devices (SREDs),” which trap sediments and alter embayment hydrodynamics that sort sediments. Both subsidence rates and sedimentation rates are in the 2-5 cm yr^{-1} range. While sedimentation rates are controlled largely by the WBMRD and from the modern distributaries connected to Grand Pass, subsidence rates are mainly controlled by the thickness of sedimentary deposits related the 1838 crevasse that formed Grand Pass. Results indicate that West Bay is currently a "threshold system" in which subsidence is approximately balanced by sediment deposition, and relatively modest changes in either of these rates can result in the emergence or submergence of land. Future diversions will be most successful if they can yield West Bay-style sediment accumulation rates in systems with substantially slower subsidence rates.

Load-Driven Compaction in the Mississippi Delta

Elizabeth Chamberlain [1], Z. Shen [2], B. Mauz [3], and T.E. Törnqvist [1]

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Compaction of unconsolidated Holocene sediments is a major mechanism driving subsidence in large deltas. Previous studies have suggested that compaction-driven subsidence rates in the Mississippi Delta can reach 1 cm/yr. A correlation between geodetically derived subsidence rates (mostly from GPS measurements) and the thickness of Holocene sediments in the Mississippi Delta has been used to argue for a causal relationship between the two. So far, no geological data have been used to test this hypothesis.

Here we present rates of natural compaction of Holocene sediments beneath the transition from mouthbar sand to overbank mud at 1 to 8 m below the surface along the downstream portion of Bayou Lafourche, an abandoned Mississippi River course. We find that these rates, averaged over 600 to 1500

years, are generally <2 mm/yr, smaller than mean compaction rates (1 to 5 mm/yr) reported at localities farther upstream along Bayou Lafourche. Rates of natural compaction in this unit decrease coastward and are positively correlated with the thickness of the overbank mud, but not the thickness of underlying Holocene strata. This suggests that the weight of the overburden exerts a first-order control on the measured compaction. Previous studies have demonstrated that load-driven compaction is highest at the onset of loading and decreases exponentially with time. This suggests that present-day compaction rates in the unit we observe are likely lower than the millennial to centennial average produced by our method, because sedimentation in Lafourche largely ceased 600 years ago when the system was abandoned.

Our findings have major implications for coastal restoration through river diversions. Introducing new sediment to quiescent regions of the Mississippi Delta will likely accelerate compaction in those areas. Predictions of land production through river diversions must account not just for elevation gained through sediment capture, but also for elevation lost through load-driven compaction.

Causes of Accelerated Wetlands Loss in the Late 20th Century

Chris McLindon

New Orleans Geological Society

Kolker et al. (2011) found a tight coupling between patterns of land loss measured in the Barataria Basin by Couvillion et al. (2011) and their interpretation of subsidence from the historical record of the Grand Isle tidal gauge. The relationship between subsidence and land loss in the temporal domain determined by Kolker et al. (2011) can be extended to the spatial domain using the Land Area Change Map produced by Couvillion et al. (2011). Extrapolating from the tightly bound relationship between temporal patterns of land loss and the measurement of subsidence in the Barataria Basin across the SE Louisiana coastal plain provides a first order approximation of a subsidence map. This map is integrated with a first order approximation of the traces of active faults across the surface of the coastal plain to yield a pattern of hot spots of subsidence caused by the vertical movement of faults. This pattern of hot spot subsidence (and land loss) is integrated with a map of the distributary channels of the lower Mississippi River system that were likely to have been active between the late 18th and early 20th centuries to suggest that sedimentary loading during the period of elevated suspended load of the river system (Tweel and Turner, 2012) may have triggered a period of fault movement that is responsible for the mid to late 20ths century period of accelerated land loss on the coastal plain.

Marsh Creation Design II: Using Construction Observations and Monitoring Data to Improve Marsh Creation Design

The Impacts of In-Situ Soil Displacements on Settlement and Consolidation of Marsh Creation Fill – Lake Hermitage Marsh Creation

Rudy Simoneaux [1], Barry Richard [1], Kristi Cantu [1], Kevin Roy [2]

[1] Louisiana Coastal Protection and Restoration Authority, [2] United States Fish and Wildlife Service

Creating over 1000 acres of new wetlands, the Lake Hermitage Marsh Creation Project is one of the largest restoration projects to be built in Louisiana, and only the second Marsh Creation project to be constructed using Mississippi River sediment. Planning and project management was led by the United States Fish and Wildlife Service (USFWS), which served as the Federal Sponsor. The Louisiana Coastal Protection and Restoration Authority (CPRA) performed engineering and design (in-house), as well as landrights services and environmental support.

This presentation will provide a 'lessons learned' perspective on the multiple aspects and phases of the project from planning and design, through permitting, to construction. The Lake Hermitage project is composed of two primary fill sites. Both sites are underlined with soft, organic in-situ soils. This was first observed during design once the geotechnical investigation and analysis was complete. However, the magnitude of lateral displacement of these soft organic soils after fill material placement (aka 'mudwaving') was grossly underestimated. These displacements may be cause for rethinking how we approach the settlement and consolidation estimates for these projects.

The primary focus of the presentation will be a comparison of the geotechnical analysis performed during design to the field observations that were made during construction. Ideas on how to monitor and measure these displacements to improve future designs will also be discussed. The presentation will also include engineering and design process, the steps that were taken to ensure environmental compliance and landowner cooperation, the challenges that were encountered during construction, and lastly, the project team's 'on-the-fly' management and design effort that took place during construction to double the acres and benefits of the project.

Analysis, Design, and Construction of Breach Repairs at the Scofield Island Back Barrier Marsh

Russ Joffrion [1], Michael Poff[2]

[1] Louisiana Coastal Protection and Restoration Authority, [2] Coastal Engineering Consultants, Inc.

The mission of the Louisiana Coastal Protection and Restoration Authority is to protect, conserve, and restore coastal Louisiana through a comprehensive and integrated program approach, which includes the implementation of restoration and flood protection projects through the application of the 2012 Louisiana's Comprehensive Master Plan for a Sustainable Coast.

The Riverine Sand Mining Scofield Island Restoration Project (BA-40) is the eastern most part of the greater Barataria Pass to Sandy Point Barrier Island Restoration Master Plan Project, which will restore and preserve the structural integrity of the Barataria Basin shoreline through storm and wave

attenuation. These goals were accomplished by restoring the beach, dune, and back barrier marsh habitat features utilizing the renewable sediment source from the Mississippi River.

The success of CPRA's implementation of Master Plan Projects is reliant on advances in engineering solutions, local experience, and lessons learned from constructed projects. These primary concepts along with project teamwork were utilized to evaluate and efficiently implement solutions for containment dike breach repairs that occurred during the construction of the earthen containment dikes for the Back Barrier Marsh component of Scofield Island. A quick response to these failures resulted in a reduction in project downtime and overall project costs. This presentation will highlight the failure mechanisms associated with these breach failures, the analysis that went into the proposed repair solution, and the coordination with the construction contractor that lead to the successful implementation of the repairs.

Using Construction Monitoring Devices to Calibrate and Validate Settlement and Consolidation Models

Gregory Mattson II[1], Shannon Haynes [1], Jas Singh [1]

[1] Louisiana Coastal Protection and Restoration Authority

One of the key parameters in designing marsh creation projects is the target marsh elevation. The variability of the hydraulic material that is pumped and used to construct these projects can make determining this elevation challenging. This elevation is determined by analyzing geotechnical properties and executing various settlement and consolidation models. However, once the project transitions into the construction phase little is done to monitor the actual settlement and consolidation rates in the field. Past attempts have been made, but the rigorous nature of construction activities as well as unpredictable weather events has seen these efforts provide limited results.

The Louisiana Coastal Protection and Restoration Authority has designed a construction monitoring program that uses several geotechnical instrumentation devices and physical sampling to record and analyze settlement and consolidation. The presentation will discuss the models currently used, previous efforts conducted, lessons learned, as well as the detailed program that has been designed for an upcoming project.

Floating Medium: Web-Based Communication Tools

CPRA's Flood Risk and Resilience Viewer

Andrea Galinski [1], Melanie Saucier [1], and Mandy Green [1]

[1] Coastal Protection and Restoration Authority

As coastal Louisiana and other communities across the nation face increasing threats from flooding and sea level rise, there is a great need to provide accurate information about current flood risk, how this risk may change over time, as well as possible solutions to increase resilience. The Coastal Protection and Restoration Authority (CPRA) has developed an innovative "Flood Risk and Resilience Viewer" to help coastal Louisiana communities better understand current day flood risk and how this risk will change in the future. In addition, the viewer provides information about State recommended restoration and protection projects that will help to create safer communities and a more sustainable coast.

The web-based, geospatial visualization tool integrates and displays the results from CPRA's 2012 Coastal Master Plan modeling effort which produced data about current and future changes in land loss, flood risk, and economic damages in coastal Louisiana. The viewer features interactive maps, including GIS data layers that can be turned on and off, and user friendly features that show how flood risk may impact communities. Key features include:

- Action oriented data: information display is designed to help identify at-risk populations (such as low income, minority, and elderly) and to show the critical areas for project implementation;
- Current and future conditions: data includes current day, near term, and long-term (50 years) time steps to better communicate land loss and flood risk in a changing environment;
- Dynamic interaction: various fields enable users to select different environmental scenarios, plan implementation scenarios, and flood event sizes (50, 100, 500-year flood event); a time slider displays land loss, flood depths, and damages over a 50 year planning horizon.

The data viewer supports communities and decision-makers by providing the state's best available future flood risk data to help develop locally appropriate resilience measures and hazard mitigation activities.

Sea Level Rise and Coastal Flooding Impacts Viewer in Louisiana

William Brooks [1], Doug Marcy [2], Marian Hanisko [1], and Todd Davison [2]

[1] The Baldwin Group at NOAA Office for Coastal Management, [2] NOAA Office for Coastal Management

Being able to visualize potential impacts from coastal flooding, land subsidence, and sea level rise is a powerful teaching and planning tool. The Sea Level Rise and Coastal Flooding Impacts Viewer brings this capability to coastal communities. The purpose of this viewer is to provide coastal managers and scientists with a preliminary look at coastal flooding and sea level rise impacts. The viewer is a screening-level tool that uses nationally consistent data sets and analyses. Data, maps, and map services provided can be used at several scales to help gauge trends and prioritize actions for different sea level

and flooding scenarios. The tool is presented in a Web mapping application format and can be accessed at coast.noaa.gov/ditgitalcoast/tools/slr. This project for Louisiana was made possible by the availability of multiple data sets, primarily elevation and levee data, and partnerships between NOAA, the Louisiana Coastal Protection and Restoration Authority, Louisiana Sea Grant, USGS, and others. This presentation will provide a description of the tool's features, as well as a discussion about mapping methods, data access, and similar tools and efforts. In particular, we will demonstrate assumptions and methods for mapping and displaying leveed areas.

Determining Localized Risk Perception and Impacts of Projected Sea Level Rise to Enhance Stakeholder Mitigation Planning through Visualization Tools

Tara Lambeth [1], Matthew Bethel [2], Wei Wu [3], Patrick Biber [3], Rebekah Jones [2], and Hailong Huang [3]
University of New Orleans-Center for Hazards Assessment, Response and Technology[1], Louisiana Sea Grant College Program[2], University of Southern Mississippi-Gulf Coast Research Laboratory[3]

Marshes are essential buffer zones between land and water in coastal zones, but they are disappearing rapidly, and those that remain are often in poor health. Coastal community leaders, government officials, and natural resource managers must be able to accurately assess and predict a given coastal landscape's sustainability and/or vulnerability, especially as this coastal habitat continues to undergo rapid and dramatic changes associated with natural and anthropogenic activities such as accelerated relative sea level rise (SLR).

The multi-disciplinary project team conducted Sea Grant sponsored research in Louisiana, with traditional ecosystem users, and Mississippi, with natural resource managers, in order to determine a method for producing localized vulnerability/sustainability maps for SLR for the two study sites, and determine how and whether the results of such an approach can provide more useful information for assessing localized impacts of SLR.

The goals of the project are to develop and refine SLR visualization tools for local implementation in areas experiencing subsidence and erosion, and discover the different ways stakeholder groups evaluate risk and plan mitigation strategies associated with projected sea level rise. The project team will integrate results from modeling subsidence, erosion, engineered restoration and coastal protection features, historical land loss, and future land projections under SLR that are complemented with traditional ecological knowledge (TEK) offered by the collaborating local ecosystem users for these assessments.

We are currently finalizing work for this research project, and intend to present the results in achieving the project objectives that includes: analyses of scientific field data collected related to marsh vegetation biomass characteristics, analyses of TEK data collected, and mapping products developed. The maps are then brought back to the stakeholders and used to benefit hazard mitigation and adaptation planning.

Monitoring Programs II

Programmatic Lessons Learned from the Coastwide Reference Monitoring System (CRMS)

Sarai Piazza [1], Craig Conzelmann [1], Leigh Anne Sharp [2], Dona Weifenbach [2], Ed Haywood [2], Bill Boshart [2], and Todd Folse [2]

[1] U.S. Geological Survey, [2] Coastal Protection and Restoration Authority of Louisiana

Establishing restoration project monitoring networks can be complex, expensive, and time consuming. The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) program funded the Coastwide Reference Monitoring System (CRMS) as a main component of restoration project assessment in 2003. Eleven years passed between programmatic conceptualization to implementation of full data collection at 391 CRMS sites. During the ten years that the network has been fully operational, many programmatic lessons have been learned that are outside of the scope of scientific restoration project evaluation. These lessons range from budgeting for infrastructure and landowner conversions to planning for and maintaining flexibility for advances in field data collection technology.

The CRMS program also maintains a website which is supported by a complex database. As with any long-term, data driven program, the computing technology backing the CRMS web application stack has evolved through time. Forethought in planning and development, related to technology choices, has enabled the program to easily change and grow while keeping pace with technology changes and not constraining future flexibility.

The CRMS program hopes to inform other programmatic monitoring efforts to help expedite the development process and use the programmatic lessons learned through CRMS to benefit the larger restoration monitoring and assessment community.

Leveraging the Gulf of Mexico Coastal Ocean Observing System (GCOOS) Build-out Plan (BOP) with Louisiana's System Wide Assessment and Monitoring Program (SWAMP): Synergies for the Good of Louisiana

Barbara Kirkpatrick [1], Stephanie Watson [2], and Christina Simoniello [1]

[1,3] Texas A&M University, [2] GCOOS Consultant

The Gulf of Mexico Coastal Ocean Observing System (GCOOS) Build-out Plan (BOP) and its implementation can be leveraged to supplement Louisiana's coastal restoration activities and SWAMP. The GCOOS BOP is a long-term, stakeholder-based vision of a comprehensive monitoring and observing system for the Gulf of Mexico ecosystem. In this presentation, we will provide an overview of the plan and its implementation, as well as discuss its potential as a leveraged resource for Louisiana's coastal restoration and the CPRA's SWAMP. The BOP was developed to meet multiple user requirements in the themes of healthy ecosystems, long-term change, public health, coastal hazards, and safe marine operations, with ~~some~~ several of these themes matching the priorities of coastal restoration and hurricane protection identified in Louisiana's Coastal Master Plan. The identified user requirements are based on contributions from more than 600 participants attending numerous workshops, existing plans, Requests for Information, the GCOOS Products and Services Advisory Committee, other stakeholders'

meetings, and 13 writing teams comprised of subject matter experts. The plan integrates 19 elements, including surface currents and waves, water quality monitoring, river discharge monitoring, data management and communications, and ecosystem modeling. Many of these elements are already being implemented and are providing data important for Louisiana's coastal restoration. The BOP and its implementation can be a leveraged resource for the collaborative implementation of the SWAMP, particularly with respect to identifying data needs, providing integrated near real-time data through the GCOOS Data Portal, and the use of empirically-tested standards for data, metadata, and data QA/QC.

Louisiana Coastal Protection and Restoration Authority's Coastal Information Management System (CIMS) - Overview

Charles Villarrubia [1], Craig Conzelmann [2], Edward Haywood [1], Christina Hunnicutt [2]

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Making informed decisions while managing Louisiana's coastal resources requires collecting, processing, and organizing tremendous amounts of data and information. With more than twenty years of monitoring data and several rounds of master plan modeling data available, the Coastal Protection and Restoration Authority (CPRA) tackled this substantial data management challenge through a cooperative agreement with U.S. Geological Survey (USGS) Wetland and Aquatic Research Center's Advanced Applications Team. The resulting developed software suite, the Coastal Information Management System (CIMS), provides tabular and geospatial database and document access to CPRA's suite of protection and restoration projects, geophysical data, computational modeling outputs, and coastal community resiliency information. CIMS provides a centralized online platform enabling data discovery/dissemination and assisting its day-to-day users employ data to inform their natural resource decision-making.

The three main components of the CIMS web application address time-series tabular data, spatial data and unstructured data such as documents or other binaries. The CIMS tabular or data download subsystem enables data flows from the field-based collection equipment into the enterprise database and then out to web connected users and restoration partner systems. The CIMS spatial or web mapping subsystem utilizes point, line, polygon and raster based earth overlays representing features ranging from real-world objects like project boundaries to scenario-based modeling outputs like flood risk. Finally, the CIMS libraries contain documents and photos representing various phases of project planning, development, and monitoring.

Although most users only see the public facing web interfaces, significant planning and development time investments ensure a solid data foundation largely driven by standardized data format and delivery guidelines. This structured approach to standards and conventions has resulted in many secondary benefits extending beyond native CIMS subsystems aiding other active data-intensive CPRA efforts and projects.

Wetland Carbon Storage

The Effect of River Diversion on Ecosystem-Scale Carbon Budgets from Delta Plain Marshes

Guerry Holm, Jr.[1], Brian Perez [1], Ken Krauss [2], David McWhorter [1], Richard Raynie [3], Charles Killebrew [3]

[1] CH2M, [2]U.S. Geological Survey, National Wetlands Research Center; [3] Louisiana Coastal Protection and Restoration Authority

Coastal marshes have high carbon sequestration potential with long-term burial rates on the order of ~200 g C/m^2/yr. We calculated net ecosystem exchange of carbon (CO_2 and CH_4) with semi-continuous measurements (eddy covariance) from a brackish marsh site (Pointe aux Chenes) and a freshwater marsh site influenced by a river diversion (Davis Pond) in the Delta Plain. Annual carbon budgets were constructed from the brackish site based on a single year of data, and from the freshwater river diversion site, based on two years of data collected under varying river inflows. The brackish marsh lost 148 g C/m^2/yr in the form of CH_4 and CO_2. Of this, 11 g C/m^2/yr was lost as CH_4 and the remaining 137 g C/m^2/yr was lost as CO_2. In contrast, the freshwater diversion had a net carbon uptake of 570 g C/m^2/yr. Of this, 47 g C/m^2/yr was lost as CH_4 and 617 g C/m^2/yr was taken up as CO_2. The results of this study demonstrate that the freshwater marsh, which has been receiving Mississippi River water for more than a decade, remains a healthy marsh and is maintaining a high carbon uptake capacity. In contrast, the brackish marsh, although chosen based on its initial healthy condition, suffered a loss of carbon during its rapid deterioration, thus illustrating a common condition of wetlands without restoration.

Carbon Inventories Across Sediment Delivery Gradients in the Atchafalaya and Terrebonne Basins

Annabeth McCall [1], Robert Twilley [1], Edward Castaneda [1], Azure Bevington [1], Marc Simard [2], Brady Couvillion [3]

[1]Louisiana State University, [2]NASA Jet Propulsion Laboratory, [3]USGS National Wetland Research Center

Coastal wetlands in Louisiana are experiencing phases of growth and decline. These phases follow the natural delta cycle coupled with manmade hydrological manipulations. It is known that wetland plant productivity and carbon sequestration are dependent on environmental conditions such as sediment input, soil type, nutrients, salinity, and elevation. Hydrological changes in Louisiana's coastal wetlands have led to changes in vegetation communities and carbon inventories associated with these vegetation types. Quantifying how the productivity of ecological systems has shifted over time will help us understand how carbon inventories have changed. Here, we examine the herbaceous production and carbon inventories across two coastal basins in Louisiana, studying these basins as experimental units of sediment delivery to wetlands. The Atchafalaya Basin, which contains the Atchafalaya River, drains 30% of the Mississippi River, giving rise to two growing deltas in the Atchafalaya Bay. The Terrebonne Basin, classified as an abandoned delta complex, currently receives very little sediment input. We hypothesize that under the optimal partitioning theory, root:shoot ratios will shift along soil development gradients from the sediment-rich Atchafalaya Basin to the sediment-poor Terrebonne Basin. As wetland vegetation has shifted within each basin, we expect that carbon inventories are increasing in the Atchafalaya Basin while decreasing in Terrebonne Basin.

Above-and belowground biomass was harvested in throughout both basins during peak river stage in May 2015 and during peak biomass during September 2015. Productivity rates and root:shoot ratios were calculated to determine carbon sequestration rates and growth models across sediment delivery gradients on a large basin scale. Using field data along with past reports of above and belowground productivity, we have calculated mean carbon sequestration rates per wetland type in each basin over time intervals from 1949 until present. This provides a spatial and quantitative look at how vegetation and carbon inventories have shifted throughout time.

Current and Historic Carbon Storage in Four Marsh Habitats in Coastal Louisiana

Leland Moss [1], Melissa Baustian [1], Camille Stagg [2], Carey Perry [3,4], Tim Carruthers[1], Mead Allison [1, 5]

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[2] United States Geological Survey, National Wetland Research Center, Lafayette, LA
[3] Gulf South Research Corporation, Baton Rouge, LA
[4]Coalition to Restore Coastal Louisiana, Baton Rouge, LA
[5]Tulane University, New Orleans, LA

Marsh types are characterized by the vegetation community and environmental characteristics (e.g., salinity, soil organic matter, soil chemistry, etc.) that influence how carbon is produced, decomposed, and ultimately stored in the soil. In coastal Louisiana, marsh habitats are commonly generalized as fresh, intermediate, brackish and saline. To assess the current and historic carbon storage, soil cores were collected to a depth of 100 cm with a McCaulley corer at 24 sites that represented the four marsh habitats in two Louisiana basins, Terrebonne and Barataria. Each core was analyzed at 2-cm depth intervals for % moisture, dry bulk density, organic matter, total carbon, and radionuclide (^{137}Cs and ^{210}Pb) geochronology. In addition to radionuclides, feldspar horizon core data at each Coastwide Reference Monitoring System (CRMS) site was used to compare accretion estimation methods. Initial results indicate that fresh marshes tend to have the highest soil carbon content, while saline marshes have the lowest. However, mean carbon densities among these marsh types were similar. Historical maps (1949 to present) of the spatial extent of the four marsh types (including the 24 sites) were used to determine if the marsh type and associated stored carbon may have changed over time. Fresh and saline marshes tended not to experience marsh type transitions over this period, whereas intermediate and brackish marshes had frequent transitions. Changing environmental conditions, such as salinity and flooding, due to sea level rise or restoration activities may change the relative spatial extent of these four marsh types and influence how these marshes produce and store carbon. This study helps to quantify and characterize carbon storage in four marsh habitats and therefore provide initial predictions of how carbon storage may change with transitions among marsh habitats because of global climate change or restoration activities.

The Future of Restoration

Results of the Luling, Louisiana Wetland Carbon Credit Pilot Project

Sarah Mack [1], Robert Lane [2], John Day [3], Steve Tullos [4]

[1]Tierra Resources LLC, [2] Louisiana State University, [3]Louisiana State University, [4]Entergy Corporation

Wetlands were first introduced to carbon markets in 2012 when the American Carbon Registry (ACR) certified the methodology, *Restoration of Degraded Deltaic Wetlands of the Mississippi Delta,* which was developed by Tierra Resources to transact wetland carbon credits derived from wetland restoration. The ACR methodology, *Restoration of Degraded Deltaic Wetlands of the Mississippi Delta,* provides a rigorous scientific framework for project development and aims to give offset credit for a wide range of restoration techniques including hydrologic management as well as reforestation with a variety of species. The methodology addresses each aspect of the project from establishing a baseline, monitoring of eligible carbon pools, and estimating carbon offsets that can be transacted as carbon credits.

The nation's first wetland carbon credit pilot project, located in St. Charles Parish approximately 19 miles from New Orleans, was launched in 2012. This was the first wetland offset pilot project in the nation to demonstrate a public private partnership that leverages carbon finance. The objective of this pilot project was to deliver a proof-of-concept carbon offset project at the wetlands near Luling, Louisiana, to address science gaps, "road test" the developed methodology, determine costs, benefits, and barriers to implementation, identify cost-saving measures, and potentially produce commercially viable offsets. The presentation will provide a detailed description of project results including monitoring efforts, carbon modeling, challenges and lessons learned. The results will inform managers and developers on how to develop wetland carbon credits that are compliance eligible, and scientifically defensible.

Saving Coastal Forests for Future Generations: Coastal Forest Conservation Initiative

Chris Allen [1], **Honora Buras[1]**, Micaela Coner [1], **Angela Thomas [1]**

[1]Coastal Protection and Restoration Authority of Louisiana (CPRA)

The Coastal Forest Conservation Initiative (CFCI) was developed and implemented by CPRA with funds from the 2005 Coastal Impact Assistance Program (CIAP) to provide incentives to willing landowners to conserve coastal forests through fee title or conservation servitude purchases. The goal of the program is to prevent conversion of coastal forests to non-forested uses, thus protecting increasingly scarce coastal forest habitats for their significant ecological values, storm damage reduction potential and other ecosystem services to communities, while allowing landowners to retain mineral rights and surface rights consistent with conservation goals.

CFCI, a pilot conservation program for Louisiana, sets the foundation for future conservation acquisitions. CPRA used input and assistance from many organizations to develop implementation guidelines, selection criteria, evaluation tools, and protocols that provide for rigorous oversight yet maintain flexibility for use under various funding programs.

During 2 application periods in 2010 and 2012, 39 landowners submitted applications representing over 74,000 acres of coastal forest. CPRA scientists and other experts from natural resource agencies and academia evaluated and ranked the applicants. CPRA's real estate specialists conducted negotiations and due diligence on the top ranked properties, acquiring 9 properties, totaling over 40,000 acres, across the coast. Over 32,000 acres were added to Wildlife Management Areas for public recreation. Conservation Management Plans were developed by The Nature Conservancy for each property to provide guidance for long term stewardship, preserving habitat conservation values in perpetuity. In this presentation we will provide information on each property acquired by the CFCI and highlight some of the lessons learned as we implemented the program.

The successful implementation of this program would not have been possible without sustained and strong support at many levels, demonstrating the importance of land conservation as one of the tools in the toolbox for coastal restoration, protection, and community resilience.

The Status and Future of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Program

Brad Inman, Mark Wingate

United States Army Corps of Engineers

The purpose of this presentation is to provide the status of the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Program. The CWPPRA Program celebrated its 25th year of existence in 2015. As of December 2015, the CWPPRA Program has constructed 101 projects and has another 21 projects in various phases of construction. Additionally, another 22 projects are in the Engineering and Design phase. The Program has funded $1.537 billion in project Construction, Monitoring, and Operations and Maintenance (O&M). If every project were constructed that is currently in the CWPPRA approved portfolio, including those currently under design, the program would expend a total of $2.267 billion.

The Program is managed by a Task Force consisting of five federal agencies which include U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service, Natural Resources Conservation Service, Environmental Protection Agency, National Marine Fisheries Service, and the state of Louisiana's Governor's Office of Coastal Activities. The Task Force is chaired by USACE.

The federal government provides 85 percent of Program funds from the Sport Fish Restoration and Boating Trust Fund, which generates funds through taxes on the sales of fishing equipment and gas for motor boats. The state of Louisiana is the designated the non-Federal local sponsor and provides the remaining 15 percent. Currently the program is authorized through 2019. Due to an early decision by the program to provide monitoring, operations, maintenance, and management for a 20-year period after construction of a project, the program may be forced to limit expenditures on new projects in order to keep funding in reserve to meet obligations as 2019 approaches.

The presentation will provide the status, opportunities and challenges, and lessons learned from the CWPPRA Program that could inform future coastal restoration projects.

Mid-Basin Sediment Diversions: Program Management

CPRA Approach to Implementing Diversions

Robert Routon [1], Maury Chatellier [1], Jerry Carroll [1], Bob Hayden [2]

[1] Louisiana Coastal Protection and Restoration Authority
[2] CH2M

CPRA has chosen to start with the development of an initial framework needed to create and support high-performing, integrated teams, and effectively manage multiple-firm and multi-disciplinary teams. The Program Manager will work carefully to determine the needed programmatic functions, critical success factors, and risks to successful delivery. The Program Management team will also work together to determine the appropriate long-term organization, governance, delivery plans, and processes to meet those challenges.

CPRA will develop contracting strategies and plans for the program including a complete suite of procurement, purchasing, subcontractor and vendor coordination, work package implementation, and other services necessary to move the projects through the desired delivery methods. During the program initiation phase, CPRA will evaluate the diversion projects for the most appropriate delivery method that addresses the project challenges and goals.

Given the complexity and unknowns of these diversion projects, Section 408 approval will present the greatest challenges because of the approval process needing to be coordinated within the New Orleans District, through Mississippi Valley Division, to USACE Headquarters, the approving authority. The initiation will focus on developing a USACE engagement strategy with CPRA, outlining the agreed-upon methods to secure timely and efficient USACE collaboration in both New Orleans and in Washington, D.C., as well as other state and federal agencies, and how to integrate the critical approval/permit milestones with the chosen delivery method for the diversion projects.

CPRA considers that having a master program schedule, controlling costs, minimizing the number of change orders, and time delays is critical to meeting a program's objectives. CPRA must not only have cost and schedule assurance, but also deliver on the reporting requirements to ensure that all stakeholders, especially those tied to funding and federal regulatory approval, receive timely information they will require on program status and performance.

Mid-Breton Diversion: Current Status and Path Forward

Glenn Ledet [1]

[1] Coastal Protection and Restoration Authority

The CPRA has designated a diversion into the mid-Breton Sound as one of the major Mississippi River sediment diversion projects listed in Louisiana's Comprehensive Master Plan for a Sustainable Coast (2012 Master Plan). The diversion is cited in the 2012 Master Plan as a 5,000 cfs diversion to build and maintain land. In 2010, the United States Army Corps of Engineers (USACE) – Mississippi Valley, New Orleans District generated an Integrated Feasibility Study and supplementary Environmental Impact

Statement (EIS) for the medium diversion at White Ditch, Plaquemines Parish, LA. The recommended plan from this study is a 35,000 cfs diversion in the vicinity of White Ditch at River Mile (RM) 59. This effort is now superseded by work conducted in the report entitled "Hydrodynamic and Sediment Transport Modeling using Flow-3D for Siting and Optimization of the LCA Medium Division at White Ditch Technical Report". CPRA authorized this additional work to optimize the inlet configuration for the diversion structure. In this study, the proposed location of the diversion structure has changed to a location near Bertrandville, LA at River Mile (RM) 68.6.

The CPRA also authorized an independent technical design review (ITR) of the previous work performed. The information presented in the ITR along with the Basis of Design from the USACE study and subsequent authorized work will serve as a current status of the work performed on the Mid-Breton Sediment Diversion Project. This presentation will highlight the current status of the design effort and will discuss the path forward regarding engineering and design, environmental, regulatory and program management activities.

Mid-Barataria Diversion: Current Status and Path Forward

Kodi Guillory [1]

[1] Coastal Protection and Restoration Authority

The Louisiana Comprehensive Master Plan for a Sustainable Coast (2012 State Master Plan) lays out CPRA's implementation plan for coastal protection and restoration. The 2012 State Master Plan concluded that sediment diversions are one of the critical elements to addressing the land loss crisis along Louisiana's coast by re-establishing sediment rich water connections between the Mississippi River and Louisiana's bays and estuaries. The Mid-Barataria Sediment Diversion Project (MBSD) is identified in the 2012 State Master Plan as a large-scale, long-term restoration feature recommended for re-establishing a direct connection between Barataria Basin and the Mississippi River.

CPRA has been working with federal, state, and local entities since 2001 to define the size, location, and benefits associated with a large diversion project in the vicinity of Myrtle Grove, Louisiana. Results of preliminary investigations determined that the optimum location for the diversion project is in Plaquemines Parish on the west bank of the Mississippi River in the vicinity of the town of Ironton, LA. The river intake is proposed at mile marker 60.7 Above Head of Passes; with the desired performance of conveying 75,000 cfs sediment laden water when the river stage is flowing in excess of 1,000,000 cfs. The MBSD would traverse the Mississippi River and Tributary Levee, Belle Chase Highway, New Orleans and Gulf Coast Railway, the Non-Federal Levee, low-lying agricultural land, and would terminate in the Barataria Basin. The diversion would allow variable flow rates to respond to seasonal, sediment and outfall area conditions, thus maximizing sediment transport for restoration potential.

In December 2012, CPRA began engineering and regulatory services for the MBSD project. Modeling, geotechnical data collection and evaluation, surveys, engineering design, permit development and submittal, and public outreach have all been underway. This discussion will focus on the current status and proposed path forward for this project.

Session Block VI, 1:30 – 3:00 p.m.

Fisheries Modeling

Spatial and Temporal Fisheries Analysis Using Hydrocoast Maps

Aimee Preau [1], John Lopez [1], Tom Soniat [2], Theryn Henkel [1], Patrick Smith [1]

[1]Lake Pontchartrain Basin Foundation, [2]University of New Orleans

Lake Pontchartrain Basin Foundation collects primary and secondary data throughout the Basin to compile its bi-weekly Hydrocoast maps. This sampled and modeled mapping data includes surface water salinity; discharge rates; aerial survey data of shrimp and oyster harvesting; as well numerous other biological, physical and chemical characteristics of the Basin. By applying GIS technology and spatial analyses to this data, the Foundation is investigating the relationships between fisheries and the changing physical parameters of the estuary. One initial investigation is looking at the spatial distribution of shrimping effort over time. Location and count of actively shrimping vessels throughout spring and fall inshore seasons are used to develop density maps of shrimping effort. By quantifying and mapping the highest densities of trawling activities, we hope to derive potential locations of more concentrated shrimp populations. Another investigation looks at temporal surface water salinity regimes within the Basin relevant to eastern oyster (*Crassostrea virginica*) propagation and harvesting. The Hydrocoast salinity regimes are examined spatially using Chatry's empirical optimal salinity for harvesting, as well as the salinity variables of an oyster Habitat Suitability Index model. By looking at the spatial and temporal relationships of Hydrocoast data in the context of observed and theoretical ideals, we are better able to understand the current and changing state of the oyster fishery and habitat. Results of these two initial studies show promise for gaining a deeper understanding of current fishery dynamics in the Basin and the coastal interactions that affect them, and have implications for fishery management and implementation of the Louisiana Coastal Master Plan.

Development of a Comprehensive Aquatic Systems Model (CASM) for the Mississippi River Delta Management Study Area (Part I)

Kate Shepard Watkins, Shaye Sable

Dynamic Solutions, LLC

Food web models were developed for Barataria Basin, Breton Sound, and Pontchartrain Basin to predict changes in species biomass in response to proposed river diversions. The food web for all three CASMs was made up of 34 taxa including phytoplankton, periphyton, zooplankton, benthic infauna, Caridean shrimp, brown and white shrimp, blue crab, oysters, bay anchovy, gulf menhaden, largemouth bass, red drum and spotted seatrout. Multiple life stages were simulated for many species. Bioenergetics-based equations were used to simulate daily biomass change for each consumer population. Daily temperature, salinity, chlorophyll, and marsh vegetation data from the Louisiana Master Plan models from 1995 to 2010 were used to drive the models allowing them to respond to fine-scale seasonal variations in environmental conditions. Phytoplankton and periphyton biomass were estimated from the chlorophyll data. Temperature was used to modify consumption. Salinity and structural habitat (i.e.,

marsh vegetation) were used to adjust daily growth according to population-specific habitat modifying functions. The CASM was run in 49 polygons to predict the distribution of each population across the model domain, and the results of each polygon were combined to produce biomass estimates for each of the three basins. Basin-wide biomass was calibrated to biomass estimates from Louisiana Department of Wildlife and Fisheries and National Oceanic and Atmospheric Association sampling programs. The CASM approach simulates changes in biomass due to bottom-up processes (hydrology, water quality affecting prey growth and distribution) and uses a daily time step, which is valuable for evaluating the effects of short term management actions (e.g. seasonal or pulsed operations the river diversions).

A Comprehensive Aquatic Systems Model (CASM) for Evaluating Coastal Restoration Projects in the Mississippi River Delta Management Study Area (Part II)

Shaye Sable and Kate Shepard Watkins

Dynamic Solutions, LLC

The comprehensive aquatic systems model (CASM) developed to represent the estuarine food web in Barataria Basin, Breton Sound, and Pontchartrain Basin was calibrated to daily species biomass data under existing conditions (1995-2010) and then used to evaluate the responses to proposed large-scale Mississippi River diversions for key species. We calibrated the model using a combination of the PEST software and ad hoc adjustments to match basin-wide biomass predictions to biomass data collected by Louisiana Department of Wildlife and Fisheries and the NOAA National Marine Fisheries Service. Plots of predicted seasonal biomass by polygon versus the mean seasonal temperature, salinity, primary production, proportion of marsh vegetation, consumption rate, and predation mortality were used to verify that spatial distribution patterns were realistic for each population and to understand the environmental and food web factors driving the distribution pattern. The DELFT-3D model was used to simulate restoration alternatives accounting for different river diversion locations and operational plans (intermediate versus high flow). Daily temperature, salinity, and Chl a generated at the DELFT nodes, and maps of marsh vegetation and open water generated by the LA-VEG module within DELFT at 1 km^2 resolution, were averaged for the 49 CASM polygons. The CASMs for each of the three basins were run over 5 to 50 years with the simulated environmental inputs for each alternative. The relative changes in key species biomasses (e.g., brown shrimp, blue crab, red drum, gulf menhaden) over time for the entire system and within the thee coastal basins were evaluated by comparing the predicted seasonal and annual biomass results from each diversion alternative to a future-without-project scenario with no river diversions. Species responses were primarily driven by primary production and bottom-up effects on the food web, although the factors driving biomass were more complex for the larger predatory estuarine species with varied diets and wide-ranging salinity and habitat preferences.

Linking Social and Economic Processes in River Diversions III

Socio-Economic Analysis of Four Proposed Sediment Diversions in the Lower Mississippi River

Mitch Andrus [1], David Batker [2]

[1] Royal Engineers & Consultants, LLC, [2] Earth Economics

The quantification of socio-economic effects associated with sediment diversions is vitally important to decision-making regarding these long-term projects and it is a task that is increasingly facilitated by the capabilities of numerical models and the understanding of diversions by the scientific community. This presentation reviews the development and implementation of a methodological framework for the socio-economic analysis of sediment diversions in the Lower Mississippi River. Within the framework, socio-economic literature, biophysical modeling outputs specific to proposed diversions, GIS datasets of physical infrastructure and population centers within the area of interest, input/output economic models, and land-cover based assessments of ecosystem service flows are used. This framework provides a robust and adaptive approach to identifying, quantifying, and monetizing the socio-economic effects of proposed sediment diversions over a 50-year time horizon. Economic and social indicators will be used to describe impacts for six categories including: 1) Commercial Fisheries; 2) Water Supply; 3) Navigation; 4) Recreation; 5) Storm Protection; and 6) Ecosystem Services.

The socio-economic analysis framework utilizes two quantitative methodologies: ecosystem service valuation and economic impact analysis. Where there are markets and transactions, the economic modeling software IMPLAN (IMpact analysis for PLANning) estimates monetary flows through the economy given existing economic relationships and expected changes in economic activity. Where there are no markets, as is the case for valuing wetlands as hurricane buffers, the Ecosystem Valuation Toolkit (EVT) developed by Earth Economics, is used to provide estimates of ecosystem service flows based on existing land cover categories. Both of these tools produce monetary or monetary-equivalent results. The results will then be used as drivers to discuss particular social implications which will be informed by pertinent cause and effect studies applicable to the impact categories and communities which will be most influenced by the proposed diversions.

Economic Evaluation of Coastal Land Lost in Louisiana

Stephen Barnes [1], Craig Bond [2], Nicholas Burger [2], Kate Anania [2], Aaron Strong [2], Sarah Weilant [2], and Stephanie Virgets [1]

[1]Louisiana State University, [2]RAND Corporation

Abstract: This research presents the findings from a joint project conducted by Louisiana State University and the RAND Corporation on the economic consequences of land loss to Louisiana and the rest of the nation, focusing on physical capital stock and economic activity at risk due to land loss in a future without action to protect and restore Louisiana's coast.

Coastal land loss directly affects some areas, but also increases storm damage to areas further inland, and this study considers both. Some land that currently holds valuable capital stock, such as homes and businesses, will be inundated over time and will diminish in value. In addition to assets directly

threatened by a shifting coastline, Louisiana is losing its valuable coastal wetlands, which provide a natural buffer between storm surges and inland areas. As Louisiana's shoreline migrates inward and the remaining landscape degrades, more developed areas further inland will face greater risk of damage due to the loss of storm protection services currently provided by that land.

The analysis in this report includes estimates of damage to physical capital stocks, including residential and non-residential structures and network infrastructure. We also estimate how land loss could affect economic activity, such as business operations or employment, and how these disruptions extend to commodity and trade flows linking coastal Louisiana to the rest of the world. Finally, land loss may have important effects on ecosystem services, including fisheries and recreation.

The report provides informed, practical baseline estimates of the economic effects associated with a changing coastline in Louisiana by calculating the direct and indirect costs of projected coast land loss in a future without action. It also provides a set of methods and data that can be used in future work to investigate the potential benefits of specific protection and restoration plans.

Building the Gulf: Recommendations for Ensuring Benefits for Communities in Restoration Economy

Jeffrey Buchanan [1], Mary Babic [1], Patrick Barnes [2], Andrew Blejwas [3], John Hosey [4]

[1]Oxfam America, [2]BFA Environmental, [3]The Nature Conservancy, [4]The Corps Network

As the Gulf Coast region begins an historic investment in repairing its coast, it faces a significant new opportunity: it can tap into the local workforce as it prepares the next generation of environmental stewards and restoration professionals. This report examines recent examples in the Gulf, best practices and challenges for integrating workforce development into ecosystem restoration highlighting opportunities to tackle the Gulf Coast's largest ecological challenges while building new ladders of economic opportunity for local workers.

Specifically, the report focuses on defining challenges and best practices for collaboration of actors involved in ecosystem restoration: federal, state and local agencies, along with private sector contractors, educational institutions, and workforce and community agencies. By developing partnerships, leveraging funding, and integrating initiatives, these actors can prepare local workers for new careers planning, constructing, and administering restoration projects. By tackling both environmental and economic objectives, stakeholders can build more resilient and prosperous communities. The report reviews recent state and federal level policies and the necessary partnerships and collaboration are needed to move these policies towards implementation.

The findings were developed at an expert convening in Gulfport, MS, to identify challenges and opportunities in integrating workforce development into future ecosystem restoration projects. The meeting pulled together experts from the above referenced sectors across all five Gulf Coast states to examine case studies of current ecosystem restoration training efforts, as well as hurdles in working together to build workforce development into future projects. In the end, this interdisciplinary group identified a set of best practices and key learnings.

The report includes analysis of labor needs including necessary skills and background of six recent representative ecosystem restoration projects across an array of resource restoration types and phases

including hydrological restoration, living shore construction, oyster reef construction and monitoring, and marsh creation construction and design.

Results from Recent Studies of Storm Surge Risk and Mitigation Options

Feasibility of Storm Surge Protection for Lake Pontchartrain

John Atkinson, PhD[1], Jordan Fischbach [2], Hugh Roberts [1], David Johnson [2,3]

[1] Arcadis, [2] RAND Corporation, [3] Purdue University

The State of Louisiana is interested in the feasibility of new flood protection structures on the East Land Bridge to prevent storm surge from entering Lake Pontchartrain. Reducing surge levels in the lake will add resiliency to the existing regional flood protection system. One of the challenges for this concept is to identify a structural configuration that not only reduces risk within the protected region, but does not induce additional risk outside the system.

To explore regional impacts, large scale hydrodynamic and wave modeling was performed for many barrier and gate configurations. Modeling results indicate that use of flood gates to close Chef Menteur and Rigolets may be an effective way to reduce flood risk to New Orleans and lake-adjacent Louisiana communities without inducing flooding along the Mississippi coastline. Simulations reveal that storm-induced flow through the two channels and into Lake Pontchartrain begins well in advance of the arrival of the primary surge. By hydraulically isolating Pontchartrain from the gulf, significant reduction in surge is possible even without levees along the land bridge itself. This presentation will provide an overview of the modeling approach, the regional impacts for the configurations, and an explanation of the surge dynamics within Lake Pontchartrain.

Integrating Storm Surge and Rainfall Flood Hazards in Upper Barataria

Hugh Roberts [1], Nancy Powell [1], Haihong Zhao [1], Shan Zou [1], Don Resio [2], David Johnson [3], Ryan Clark [4]

[1] Arcadis, [2] University of North Florida, [3] Purdue University, [4] The Water Institute of the Gulf

Flood hazards and risks are often determined based on coastal storm surge or rainfall runoff alone, founded on the assumption that one of the storm conditions is the dominant flood hazard for a given region. However, in regions like the Upper Barataria Basin in Southern Louisiana, flood hazards are ultimately dependent on the combined effects of surge from tropical events and rainfall throughout the watershed. The combined effects of surge and rainfall can cause flooding hours or days after the tropical storm has passed.

Upper Barataria Basin is affected by both tropical and extratropical events. Because of the topography of the area, surge propagation affects the drainage of storm related rainfall runoff. Frequent flooding in the region, coupled with flat terrain and limited outlets, results in flood hazards that are additionally complicated by the antecedent conditions that influence the onset and magnitude of the flood hazard.

As part of an analysis funded by the Coastal Protection and Restoration Authority, statistical joint probability methods have been modified from a surge-only approach to include an estimation of exceedance probabilities from rainfall-associated flooding events and antecedent conditions. HEC-HMS, HEC-RAS, and ADCIRC were applied to model rainfall and surge within the basin and provide peak stages

for the joint probability method. Flood hazards were preliminarily assessed using the Coastal Louisiana Risk Assessment model.

This presentation will cover storm climatology, tropical storm modeling, hydraulic modeling, and joint probability method development used to determine the flood frequency for the basin.

Current and Future Flood Risk in Greater New Orleans

David Johnson [1,2], Jordan Fischbach, Kenneth Kuhn [2]

[1] Purdue University, [2] RAND Corporation

Levee and floodwall failures during Hurricane Katrina exposed shortcomings in the infrastructure systems designed to protect greater New Orleans from storm surge flooding. Since the storm, over $15 billion has been spent upgrading the New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS). The Federal Emergency Management Agency (FEMA) has certified the upgraded HSDRRS as protecting New Orleans to *at least* the "100-year" level, but it did not assess the actual level of protection afforded by the upgrades or the residual risk to the city.

Future sea level rise, land subsidence, and changes to hurricane behavior all threaten to increase the risk of storm surge damage to New Orleans in the years to come. Using the Coastal Louisiana Risk Assessment model, we will present the latest available estimates of current and future risk to the greater New Orleans area within the upgraded protection system, highlighting areas and conditions under which significant risk may still exist.

Time Scales of Sediment Delivery for Land Building

Rapid Land Creation by a Major River Subdelta

Elizabeth Chamberlain [1], Z. Shen [2], B. Mauz [3], and T.E. Törnqvist [1]

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Deltas worldwide are experiencing alarming rates of land loss. Successful delta management hinges on knowing both the rates and patterns of land loss, and the capacities of these systems for land gain. Observational studies of the Wax Lake Delta (WLD) provide insight into growth patterns in an emergent system in the Mississippi Delta. However, the WLD record is limited simply by its short lifespan. Here, we use stratigraphic and geochronologic data from the ~10,000 km^2 Lafourche subdelta, Mississippi Delta, to characterize rates and processes of land creation by a major river-dominated, passive margin delta. Lafourche is excellently suited for these purposes because it is a large, mature subdelta with a geologic record that captures the varied processes that occur in the roughly 1 kyr lifecycle of a delta.

The pre-Lafourche coastline is constrained with borehole data; south of this boundary ~6,000 km^2 of new land formed between 1.6 and 0.7 ka as Lafourche prograded into a shallow bay. This produced a stratigraphic sequence with shelly bayfloor muds, overlain by laminated prodelta silts, then 2-3 m thick mouthbar sands, capped by mud-dominated overbank sediments that thin coastward and coarsen upward. OSL ages of the mouthbar sand reveal the history of Lafourche progradation. These show that Lafourche prograded at ~150 m/yr and created new land at >5 km^2/yr, average rates that sustained for centuries. Concurrently, Lafourche sequestered sediment inland through overbank deposition. For comparison, the incipient WLD has prograded at ~100 m/yr and created new land at <2 km^2/yr since sedimentation was initiated by dredging of the Wax Lake outlet in 1941. Our data indicate that a fully optimized Mississippi sediment conduit could significantly offset modern land loss. Progradation and land creation rates of Lafourche have valuable implications for coastal restoration through river diversions, and may give insight into future WLD growth.

Time-Scales of Land Construction Associated with Sediment Diversions in Fine-Grained Systems

Anjali Fernandes [1], Alex Kolker [2,3], Chris Esposito [3], Alex Ameen [3]

[1] University of Connecticut, [2] The Louisiana Universities Marine Consortium, [3] Tulane University

We use sediment cores, grain size and time-lapse bathymetry maps from Cubit's Gap and the West Bay Diversion on the lowermost Mississippi River to present a new model for land construction at diversions. In this model, sediment used for land-building is suspended sediment sourced from the upper fraction of the river's water column. We couple the record of deposition in Cubit's Gap, which opened in 1862, with the shorter record available from the West Bay Diversion, which was opened in 2003. Using flow hydraulics and channel geometries at these sites, and neglecting the effects of waves and tides, computed advection lengths of well-suspended sediment range from just under 1 km for 100µm sand to more than 8km for 44µm silt. This is in good agreement with grain-size patterns and deposition rates at

both sites, which display similar patterns of blanketing, fine-grained, sub-aqueous deposition.

Historic maps, used to constrain basin bathymetry between 1862 and 1870, show average aggradation rates of 16cm/yr within 4km of the outlet channel, in average water depths of 1.3m. At locations farther than 10km from the outlet, subaqueous aggradation rates were as high as 20cm/year; subaqueous locations less than 10km from the outlet show rates as high as 30cm/year. These rates are 5 – 10 times greater than present day deposition rates, and suggest that historical rates of land growth may not be replicable today. Bathymetry and grain-size data from sediment cores show that mud-rich riverine sediment was distributed as a blanketing deposit over a low-sloping subaqueous clinoform. Contrary to the traditional prograding delta model, blanketing deposition and net shallowing of the basin is dictated by the hydrodynamics of well-suspended sediment at the diversion outlet. This lengthens the time-scale associated with land emergence. Once the basin is sufficiently shallow, land-building can proceed more rapidly.

What Role Do Hurricanes Play in Sediment Delivery to Subsiding River Deltas?

James Smith [1], Samuel Bentley [1], Gregg Snedden [2], and Crawford White [1]

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The Mississippi River Delta (MRD) has undergone tremendous land loss over the past century due to natural and anthropogenic influences, a fate shared by many river deltas globally. A globally unprecedented effort to restore and sustain the remaining subaerial portions of the delta is now underway, an endeavor that is expected to cost $50-100B over the next 50 yr. Success of this effort requires a thorough understanding of natural and anthropogenic controls on sediment supply and delta geomorphology. In the MRD, hurricanes have been paradoxically identified as both substantial agents of widespread land loss, and vertical marsh sediment accretion. We present the first multi-decadal chronostratigraphic assessment of sediment supply for a major coastal basin of the MRD (Breton Sound) that assesses both fluvial and hurricane-induced contributions to sediment accumulation in deltaic wetlands. Our findings indicate that over multidecadal timescales, hurricane-induced sediment delivery may be an important contributor for deltaic wetland vertical accretion, but the contribution from hurricanes to long-term sediment accumulation is substantially less than sediment delivery supplied by existing and planned river-sediment diversions at present-day river-sediment loads.

Mobility as Adaptation: Historical Contexts for Coastal Management in Louisiana

Retreat from the Louisiana Coast: The Shifting Public Discussion and Policy Frameworks

Audrey Grismore [1]

[1]Louisiana State University

Coastal Louisiana has faced coastal disruptions since its re-settlement by European colonists, but now the problem has become more complex with the interlocking factors of climate change, tropical cyclones, and land-loss issues. The policy options communities and governments develop to deal with extreme events and climate change affect how a the residents copes with these impending disruptions. The deeply entrenched resistance to relocation is a relatively recent attitude in the region. A thorough review and content analysis of newpaper articles since the late nineteenth century reveal that relocation has long been an option considered by coastal residents and policy makers. During the 1980s and 1990s, relocation of threatened residents was much more prominent in public discussions about coastal land loss. As policy has shifted toward restoration, the relocation of people has shifted to the background of public discussions. While the 2012 Master Plan includes "voluntary acquisition" as a non-structural option, it provides no clear guidance or budget for pursing this possibility. The neglect of this option has profound implications for coastal residents.

Lifting the Anchor to Place: Changing Wetlands Management Regimes in Louisiana

Craig Colten [1]

[1]Louisiana State University

Residents of coastal Louisiana have traditionally have pursued a variety of livelihoods based on the region's natural resources. Public policies that influence how those livelihoods are pursued can impact profound the rootedness of coastal society and seldom incorporate public input. A historical-geographic analysis of public management policies of the coastal commons reveals a reliance on science-based management that consistently results in restrictions on the common resources of the region. Policy regimes in the early 1900s emphasized "wise use" through conservation and led to the creation of protected refuges to serve a limited segment of the population. The shift to restoration goals in recent years, again relies of science-based approaches, will alter wetland environments where residents pursue their livelihoods. Conservation policies, while restricting the commons, did allow commercial exploitation of wildlife to continue, albeit in a manner that demanded adaptation by resource gatherers. Reclamation projects permit commercial pursuits to continue as well, but demands still another round of adaptation by coastal residents, and like its predecessor, has allowed only limited local expertise to help frame the plans. The possibility that existing ecological relations will be disrupted again is prompting residents to loosen their anchors to the landscape where they live.

The Grounds for Displacement: Migration Possibilities and Complexities on Louisiana's Gulf Coast

Jessica Simms [1]

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Migration scholars are increasingly acknowledging that migration processes are seldom a result of a singular cause, and are instead products of multiple and interconnected political, social, spatial, and economic factors that affect individuals and communities unevenly. This research, builds on recent scholarship and addresses the complex questions about the mobility of Louisiana's coastal residents. In light of severe land loss, proposed water management projects, decreasing livelihood options and various other challenges, many coastal Louisiana residents are facing decisions about relocation. Social connections play a key role in constructing identities, forming and maintaining resilient practices, and constructing an attachment to and a sense of place. To expose these underlying factors, this paper combines and analyses primary and secondary materials with crucial informant interviews conducted from 2012 to the present. It begins with an analysis of the place and identity-based experiences of past and potentially upcoming displacements and uprootings for coastal Louisiana residents. This research teases out the spatial, temporal, and relational roles social networks at play in migratory decision-making as well as the possibilities of their mobilization in upcoming resettlements. This spatially grounded geographical understanding of the underlying decision-making processes of migration point out how the intersection of emotional, economic, social, and cultural factors play out in the lives and relocation decisions of residents in Terrebonne, Lafourche, and St. Bernard parishes.

Mapping and Monitoring Techniques

Mapping Hurricane Impacts Behind Non-Accredited Levees - Progressing LAMP in Coastal LA

Matt Shultz [1], Vikram Shrivastava [1], Siva Sangameswaran [1], and Ronald Wanhanen [2]

[1] Dewberry, [2] FEMA Region VI

Plaquemines Parish has four non-accredited levee systems south of the Hurricane and Storm Damage Risk Reduction System (HSDRRS). Approximately 14,000 people live behind these levees along with significant commercial interests (e.g. Port Venice, Philips 66 refinery). FEMA chose Plaquemines as one of the Levee Analysis and Mapping Procedure (LAMP) Pilots to test out the LAMP process, in an area subject to coastal flooding. FEMA Region VI worked with the Parish to constitute an encompassing Local Levee Partnership Team (LLPT) with representation from local and state government, USACE, academia, large and small businesses, and residents. The LLPT made steady progress and finalized a plan for implementing LAMP in May 2015. The LAMP Analysis is planned for completion in February 2016 and preliminary Flood Insurance Rate Maps with LAMP-derived mapping are scheduled to be issued in June 2016. While the LAMP mapping is not effective, the planned release of the preliminary maps in June 2016 is a major milestone. The communities and property owners will have credible information on flood risk behind these non-accredited levees.

The presentation will present the challenges and lessons learned that allowed the study to proceed while addressing concerns on the proposed analysis and impacts of the LAMP mapping. Given the unique situation of levees in coastal LA subject to coastal hazards, the presentation will discuss the coastal interpretations of LAMP procedures.

Integrated Surveying Techniques for Coastal Restoration Projects

Ricardo Johnson

John Chance Land Surveys, Inc.

Digital Terrain Modeling (DTM) is an integral part of coastal design projects. To achieve the best model possible in a coastal environment, various surveying methods should be utilized, including: Static GPS for establishment of control; Real-time Kinematic (RTK) Surveys for locating topographic features on land and within inundated areas, locating utilities, and ground truthing; Aerial LiDAR Mapping for digital ortho-imaging, locating surface features within inaccessible areas; Multi-beam Surveys for locating existing water bottom features. With all of these data collection methods, a seamless Digital Terrain Model (DTM) can be created complete with contours and planimetrics for the purpose of engineering and design. A sediment diversion project will be referenced.

Monitoring Louisiana Barrier Islands with Unmanned Aerial Systems

Gary LaFleur Jr.,[1] William Poche, Frank Yrle, and Balaji Ramachandran

[1]Nicholls State University Biological Sciences

Nicholls Geomatics program started investigating the adoption of emerging unmanned aerial systems (UAS) technology in the Post- Katrina era for monitoring and mapping the coast. Since its inception as a research endeavor in 2005, the UAS program has grown into a mature component of Geomatics and Biological Sciences program instruction and research. The ongoing research projects include characterization of Louisiana barrier islands, offshore platform inspection, precision-agriculture, and infrastructure monitoring. A UAS certification program is being designed to prepare students in UAS related careers. Here we present data on methods developed at our Nicholls Farm to launch and land the Trimble UX-5 wing, collect visible and near-infrared images, create image mosaics, build point cloud models and classify the images different cover types. We will also describe our work to implement these methods at Trinty Island, the largest component of the Isle Derniere Barrier Island Refuge, ten mile south of LUMCON. Using a crew of seven, we were able to establish radio base, deploy targets using Real Time Kinematic (RTK) GPS, and survey the island in a series of 35 minute UAS missions. By comparing visible imagery, near-infrared imagery, and ground truth surveys, we were able to resolve the difference between habitats dominated by plants including *Zanthoxylum americanum, Avicennia germinans, Phragmites australis,* and *Spartina patens,* as well as regions dominated by intertidal inhabitants such as *Crassostrea virginica,* and *Ocypode quadrata.* With software updates and wing designs improving monthly, we foresee these methods as providing a safe, efficient, yet fundamental tool to support monitoring and policy decisions for the Louisiana Coast of the future. This research effort is a public / private partnership between Nicholls State University and Navigation Electronics Inc. / Trimble Navigation Ltd.

Deltaic Soil Processes

Seasonal and Spatial Variation of Surface Water Nitrate Concentrations and Water Flow in Delta Islands of Wax Lake Delta, Louisiana

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Wax Lake Delta (WLD) is an active prograding delta forming new land at the mouth of the Atchafalaya River, a distributary of the Mississippi River (MR). This area is a unique ecosystem to study the nutrient biogeochemistry of coastal deltaic floodplains as ecosystems develop in response to large-scale river diversions. We quantified the seasonal and spatial variation of surface water hydrology and nitrate dynamics within delta islands receiving MR water. Fixed monitoring stations were established inside Mike (30) and Pintail (34) islands using a grid sampling approach in March 2013. Sampling was conducted monthly from March to August 2013 and 2014 to capture variability during peak spring-summer MR flood season. Mean water depths gradually increased from March (25 cm) to June (60 cm), and peaked at the end of May for both years. Shallow water depths were registered along the island edges, while deeper values were observed in the central and distal parts of islands characterized with the lowest elevation. Mean water temperatures ranged from 10ºC (March) to 31ºC (August) for both islands. Higher water velocities were registered in the central sections of islands and lower values in shallow vegetated areas. Surface nitrate was lower along the island edges and higher in the central and distal regions of delta lobes. Nitrate concentrations in distributary channels feeding water to island interiors varied from 60-180 µM. Surface nitrate in the central interior of islands remained around 100 µM (May-June), but decreased to <20 µM in hotspots along the island edges. Overall, low nitrate values were associated with shallow vegetated areas and higher water temperature and residence time. These results underline the significant nitrate removal capacity of these deltaic wetlands and the strong coupling with the MR flood-pulse events depending on surface water flow, vegetation, and soil elevation gradients across emergent delta lobes.

The Fate of Nitrate in Wetlands of Prograding Wax Lake Delta, an Emergent Coastal Deltaic Floodplain

Leanna Heffner [1], Edward Castañeda-Moya[1], Alex Christensen [1], and Robert Twilley [1]

[1] Louisiana State University

Classic models of nutrient biogeochemistry in developing alluvial floodplains are largely based upon riverine flood-pulse events. In these models describing the successional development of alluvial systems, soil nitrogen and carbon accumulate over time in mineral-dominated sediments, resulting in increased nutrient availability. The early-stage development of soil nitrogen (N) dynamics in prograding coastal deltaic floodplains is not yet well understood, but we hypothesize that N dynamics in these systems fit the model for emergent alluvial floodplains. Building upon previous work in Wax Lake Delta, Louisiana, an emergent coastal delta, we investigated how nitrogen biogeochemical processes change with successional development in soils as wetland net productivity augments organic matter content. Using ^{15}N tracers combined with a modified continuous flow-through method in intact cores, we compared winter versus spring rates of gross denitrification, dissimilatory nitrate reduction to

ammonium (DNRA), and inorganic nutrient fluxes in soils collected from older (>40 years) and younger sites (<10 years), representing a chronosequence in wetland development. We found significantly higher denitrification in sediments from the older site (181 µmol N_2 m^{-2} h^{-1}) than the younger site (92 µmol N_2 m^{-2} h^{-1}), likely due to the higher availability of soil labile organic carbon associated with vegetation. A higher percentage of nitrate uptake was accounted for by direct denitrification in the older site (58%) compared to the younger (22%). Denitrification rates were higher in the spring (191 µmol N_2 m^{-2} h^{-1}) relative to the winter (82 µmol N_2 m^{-2} h^{-1}). Preliminary results suggested that DNRA was 2x higher in the older site compared to the younger site, and accounted for a major portion of the remaining nitrate uptake measured during the study, depending on the season. These results demonstrate that nitrate uptake enhances as the delta ecosystem develops, influencing the fate of nitrate introduced via Mississippi River water.

Successional Patterns of Soil Nutrient Stoichiometry Observed Along a Chronosequence of Coastal Deltaic Floodplain Development.

Anika Aarons,[1] Robert Twilley [1], Azure Bevington,[1] Edward Castañeda-Moya[1]

[1]Department of Oceanography and Coastal Sciences, LSU School of the Coast and Environment

Coastal deltaic ecosystems are responsible for 40-50% of global ocean C burial and yet the soil biogeochemistry during early stages of delta development is understudied. The Walker and Syers (1976) conceptual model of nutrient biogeochemistry during ecosystem development predicts a shift from N limitation to P limitation as the system matures. Wax Lake Delta (WLD) is a newly emergent deltaic floodplain with subaerial emergence after 1972-1973 floods. An extensive soil survey in WLD demonstrated that the Walker and Syers (1976) model can be applied to a coastal delta chronosequence. In the older regions of the delta, the mean soil organic fraction lost on ignition (LOI %) is double (6.8 ± 0.4 %) that of the younger deltaic soils closer to the bay (3.4 ± 0.2 %). This corresponds to the decrease in soil pH between the older and younger soils (7.5 ± 0.1 and 6.8 ± 0.1, respectively) and the increase in bulk density (0.57 ± 0.03 and 0.87 ± 0.01 g cm^{-3}, respectively). There are also similar differences between older and younger soils in mean total C (2.19 ± 0.16 % and 0.93 ± 0.12 %, respectively) and N (0.18 ± 0.01 % and 0.06 ± 0.01 %, respectively). Preliminary results show that N to P ratios are higher in the older deltaic soils (6–19) than the younger soil (1-8) indicating a shift from N towards P limitation (>13) over time. In addition to age of land development, we found elevation to have a significant effect on these response variables. Delta morphology changes over time and variations in floodplain elevation result in differences in hydroperiod, vegetation community zonation and soil redox state thereby significantly affecting soil biogeochemistry. Further exploration of these patterns could have important implications for carbon burial in coastal land development and restoration projects.

History of Accelerated Land Loss, Oil and Gas Industry

Analysis of Continuous GPS Data for Assessing Deep and Shallow Subsidence Processes in Southeast Louisiana

Joshua Kent, PhD

Center for GeoInformatics, Louisiana State University

With wetland losses exceeding 60 km^2 per year, Louisiana's coastal zone faces an existential threat from the effects of natural and anthropogenic subsidence. Relative sea level rise has exacerbated coastal erosion across the region – increasing risks from flooding and storm surge. Research has found that late 20th century subsidence is comprised of multiple overlapping mechanisms resulting in spatially and temporally heterogeneous rates of vertical change. Identifying the processes that most influence these trends is essential for mitigating long-term consequences for Louisiana's coast. To this end, data analysis that combines continuous global positioning system (cGPS) observations with explanatory factors that include geologic, hydrologic, seismic, and land use practices is underway to infer the contributions from shallow and deep subsidence. As a proof of concept, thirty-months of 1-Hertz position data has been acquired for the two cGPS stations located in eastern Orleans Parish, Louisiana. To assess differential vertical motions, one station is attached to a concrete slab set in the Holocene surface; the other is attached to a 2-kilometer deep waste well that penetrates the lower Pliocene strata. A custom workflow has been devised to compile, prepare, and process the GPS data using precise point positioning software developed by the NASA Jet Propulsion Laboratory. Differential rates between the two CORS will be calculated. Results will be assessed relative to water gauge archives and geologic samples. Preliminary findings, techniques employed, and an assessment of the workflow effectiveness will be presented. The methods employed are expected to demonstrate efficacy of using techniques that integrate multiple, large datasets from disparate sources when identifying the principal characteristics of regional subsidence.

Natural Capital Asset Management (NCAM)™ for Oil and Gas Industry Sustainability and Optimization

Maureen Koetz, Esq. [1]

[1]Koetz and Duncan LLC

Coastal wetlands and marsh topography constitute compulsory infrastructure components of oil and gas industry operations in recovery, refining, and distribution processes by providing:

- Flood and storm control (absorption and storage)
- Subsurface supply and groundwater recharge
- Residual discharge processing (biological and chemical oxidation)
- Erosion control (sedimentation and filtering)
- Carbon sequestration

Currently, most commercial, industrial, and governmental enterprises do not identify required natural infrastructure components in their operational design basis. Nor does enterprise maintain full inventories of the natural infrastructure capacity held/used by the enterprise. The Gulf of Mexico contains approximately 15.4 million acres of natural wetland infrastructure assets to satisfy the operational process requirements listed above for $800 billion of oil and gas built assets: 19 acres for

every $100 million of built infrastructure. Natural infrastructure capacity also is not correlated to operational throughput or capability sought (e.g. barrels refined per day), further impairing effective maintenance and investment decision-making.

Wetlands infrastructure supply is shrinking, especially relative to demand from oil and gas operations. Natural Capital Asset Management (NCAM)™ *Inventory and Accounting* was developed in the Department of Defense to direct maintenance and investment to air, land, and water infrastructure supply shortages that were compromising operational capability. Similar capacity "encroachment" is occurring in the Gulf of Mexico where competing uses and insufficient recapitalization are diminishing or impairing vital operational oil and gas natural infrastructure components, including wetlands.

The presentation will 1) describe NCAM™ inventory, accounting, and correlation analysis procedures, and 2) discuss how these can be used by the oil and gas industry, insurers, and rate regulators to optimize operational recapitalization programming for natural infrastructure assets, thereby sustaining enterprise capability and the ecosystem while reducing operational risk and cost.

Using Oil and Gas Industry Data to Achieve Coastal Sustainability

Chris McLindon

New Orleans Geological Society

Oil and gas industry seismic data has been used by academic researchers to map the surface expression of faults across the south Louisiana coastal plain over the past two decades. The first academic study to use an industry 3-D seismic survey for this purpose resulted in the 2014 publication "Influence of growth faults on coastal fluvial systems: Examples from the late Miocene to Recent Mississippi River Delta" by Armstrong et al. This study mapped 28 faults in a 1375 km^2 3-D survey in Breton Sound and Barataria Bay and found that "Most of the seismically imaged faults appear to extend up to the modern land surface and some affect the modern delta morphology." This study did not make note of the fact one of the active surface fault traces mapped with the 3-D survey traversed the location of Magnolia site for the proposed Lower Barataria Diversion. The New Orleans Geological Society is actively promoting the use of oil and gas industry 3-D seismic data, advanced imaging technologies, and general geological knowledge base in academic research supporting the coastal restoration effort. The proper planning and design of restoration projects relative to the underlying geological structure of the wetlands would be the most effective way to insure long term sustainability of the projects.

Session Block VII, 3:30 – 5:00 p.m.

Avian Habitat Use, Distribution, and Restoration Scenarios

Modeling coastal bird distributions in response to restoration scenarios

Katrina Hucks, Paul Leberg

University of Louisiana at Lafayette

Coastal systems are facing many challenges including climate change, sea level rise, storm surge, and erosion, all of which contribute to land loss. In Louisiana, these problems and how to address them have led to the development of the Master Plan by the Coastal Protection and Restoration Authority. This plan currently uses Habitat Suitability Index (HSI) models to predict wildlife responses, however, these models were not originally intended for this purpose and it is unclear how they will function at large spatial scales. The goal of this project is to utilize a different modeling approach using maximum entropy software (Maxent) to predict how various bird distributions might change with coastal restoration and management practices. This approach is designed for predicting species presence and has been used to model wildlife occurrences at larger spatial scales than the HSI models. From 2015-2016, surveys will take place in southern Louisiana for Gadwall (*Anas strepera*), Mottled Duck (*A. fulvigula*), Green-winged Teal (*A. crecca*), Brown Pelican (*Pelecanus occidentalis*), and Roseate Spoonbill (*Platalea ajaja*). Localities and environmental data such as salinity, temperature, and wetland hydrology to will be collected to incorporate into the models. The results of this study will help us understand how coastal change and land loss are affecting distributions of avifauna in southern Louisiana.

Living on the Edge: an Assessment of Waterbird Habitat Use in Estuarine Wetlands of Barataria Basin, LA

Brett Patton [1], John Nyman [1]

[1]Louisiana State University, Baton Rouge, LA, USA

The wetlands of Louisiana are losing area at a rapid rate of 42.9 km^2 yr^{-1} and the trend is expected to continue; this combined with expected sea-level rise will likely cause large shifts in vegetation and salinity regimes that will affect the wildlife species reliant on these dynamic ecosystems. Waterbirds serve as key indicator species of ecosystem health in estuarine wetland habitats; therefore, these species are often the targets of wetland management goals in Louisiana. However, many proposed wetland restoration projects are focused primarily on social impacts with only a few specific waterbird species highlighted for management concern. Additionally, the majority of waterbird habitat use studies in Louisiana wetlands have been focused predominantly on waterfowl species and their abundance in fresh water habitats during migration. Therefore, our overall objective was to assess waterbirds across all waterbird taxa, and their habitat use in fresh and saline estuarine wetland habitats. Additionally, we examined their use at finer spatial scales to assess a possible preference toward marsh edge microhabitats when compared to open water and emergent vegetation. From July 2014 to December 2015, we analyzed waterbird species richness and density both spatially and temporally to assess habitat use within the parameters of water depth, emergent vegetation species richness and cover, and

submerged aquatic vegetation species richness and cover. Cursory data show more waterbird species diversity in fresh water communities and a probable preference toward the marsh edge. These data will be useful in attempts to simulate the effects of wetland loss and salinity changes on habitat quality for waterbirds in coastal Louisiana; thus, it will inform habitat restoration and management decisions for optimal waterbird use.

Loss of Quality of Habitat Leads to a Reduction in Nesting Success in Brown Pelicans

Kristin Wakeland [1], Brock Geary [2], Scott Walter [2], Jordan Karubian [2], and Paul Leberg [1]

[1]University of Louisiana at Lafayette, [2]Tulane University

Barrier islands are of great importance to the reproductive success of Brown Pelicans (*Pelecanus occidentalis*) in coastal Louisiana. Unfortunately, those habitats are continuously threatened by hurricanes, land loss, and environmental contamination. It is known that barrier islands in Louisiana suffer greatly from land loss as a result of sea level rise and subsidence which impacts the nesting success of Brown Pelicans. However, loss of quantity of habitat does not always mean loss of quality of habitat. To understand how habitat quality impacts nest success of Brown Pelicans, we monitored pelican nests on 4 barrier islands in the Terrebonne and Barataria Bays of southeastern Louisiana. Islands were classified as natural or natural restored. Habitat characteristic parameters were collected such as percent vegetation cover and percent water cover. In addition, nest characteristics were collected including nest height, nest material, and nest elevation above sea level. Nests were monitored from March 2015 until June 2015 when chicks either fledged or the nest failed. We found higher rates of nest success on natural restored islands where nest height and elevation were greater, percent water cover was less, and the primary nest material was black mangrove. One natural unrestored island had complete nest failure due to a high water event. Restoration of barrier islands used by pelicans for breeding colonies should be a primary management priority to ensure the survival of Brown Pelicans in coastal Louisiana.

Changing Course: Navigating the Future of the Lower Mississippi River

Changing Course - The Moffatt & Nichol Team Solution- The Giving Delta -A "Systems Approach" to a consolidated and sustainable Lower Mississippi River Delta.

Jonathan Hird, PE

Moffatt and Nicol

In response to the Changing Course Design Competition a bold, innovative "systems approach" to link the specific needs of the region's ecosystem, economy and community is proposed. "The Giving Delta" plan empowers the Mississippi River's seasonal natural flood pulse to maximized sediment capture in order to build and maintain wetlands, mitigate the effects of climate change and subsidence, and to slow the inevitable marine transgression of the Delta. Sediment capture is optimized by a series of sediment retention strategies and passive sediment diversion structures, as well as establishing a new deep draft navigation channel connected to the Barataria Bay shoreline littoral zone 40 miles north of the current channel.

This paradigm shift from "flood control" to "controlled floods", connects the River's natural flood pulse to the coastal landscape. Using hydraulic residence time in the basin as a design and operational criteria for these controlled and passive structures, balances estuarine recovery and system response tolerance in order to determine the magnitude of the peak flows possible without intolerable salinity suppression in the receiving basins. Seasonal salinity gradients can be established that enable the diversion program to operate in harmony with and promote regional fisheries. On an annual basis, fisheries, communities and ecosystems will adapt to seasonally changing conditions.

This plan is not designed to completely rebuild the wetlands that have been lost over the last century. Instead, the design encourages wetland adaptation to accelerated sea level rise in the coastal basins. With this plan, the basin ecologies would "self-organize" in parallel to the human settlement's natural ability to adapt and change to this long-term vision, as a new, consolidated and sustainable Delta emerges. By establishing a framework of implementation over 100 years, incremental adaptation minimizes individual uncertainty and costs within each human generation.

The New MISI-ZIIBI Living Delta: An ECO 3D Approach to a Self-Organizing Sustainable Delta

John Hoal, PhD

Acknowledging that the Mississippi River Delta will continue to evolve over the next 100 years, the new MISI-ZIIBI LIVING DELTA for the 22nd century – *a healthy, productive and resilient delta* - relies on a synergistic and leveraged combination of delta building, the working delta, and delta living. This new Delta will be more sustainable and smaller in area, but have faster vertical accretion rates than earlier deltas, which keeps pace with current and future rates of global sea-level rise. The vision for the new Delta will be achieved through ECO 3D [dredge + dump, dredge-siphon, divert] – in which the bounded Mississippi River will be fragmented into a network of constructed distributaries, using sediment diversions, in order to feed the wetlands with the necessary sediment for delta building. Although the

diversions will be constructed and managed, the delta formation in the receiving basins is self-organizing and naturally formed.

In addition, we propose to shorten the Mississippi River and construct a new navigation entry point further upstream with a new distributary node near West Point à la Hache. The realigned and shortened river provides more efficient methods to use the sediment loads and increase safety and navigation reliability, and lower flood levels along the Mississippi River in this area. Ensuring that the navigation and marine economy continues to expand the river will be dredged to 50ft deep, the existing ports and Port Fourchon expanded, existing navigable inland water bodies maintained, and a new port constructed in the new Bird's Foot.

We propose retreat from the southern rim of the existing Delta in order to assure long-term sustainability of the regions with the highest population density and economic productivity. The concept of DELTA LIVING is about embracing the ideology and cultural aspect of communities by enabling a means to continue to live with the Delta in new ways, and accommodating a regional growth strategy of safe, strong, and distinctive communities. Overall, the MISI-ZIIBI LIVING DELTA uses constructed and natural ecological landscapes to provide for both the safe and sustainable inhabitance of the Delta region while encouraging a vibrant, growing and sustainable economy that thrives in light of unpredictable and long-term changes.

Changing Course Design Competition: the Baird Team Solution – a Delta for All

Rob Nairn, Ph.D., P.Eng. [1]

[1]Baird & Associates

The Changing Course Design competition was initiated to evaluate options for re-positioning the mouth of the Mississippi River and/or modifying the management of the Lower Mississippi River to support the 2017 Master Plan for the Louisiana coast. This paper will present the findings of one of the selected competitors: the Baird Team and their "Delta for All" approach.

A key to success in the future management of the lower Mississippi River is the development of an integrated and holistic approach to management that recognizes the need to harness the full land/wetland building and restorative potential of the river at the same time as improving flood protection and navigation.

Fundamentally the Baird solution recognized the underlying geomorphic challenges of the Delta: it receives three to four times less sediment from the Mississippi River than it did historically and sea level is rising two to three times faster than it did historically and is predicted to rise much faster in the future. The result will be a smaller delta in the future. Our approach seeks to harness as close to 100% of the land building potential of the river to make the smaller future delta as large as possible. This compares to the 2012 State Master Plan which would harness approximately 50% of the land-building potential. Our approach also recognizes that the further inland new distributary mouths and associated sub-deltas are located, the greater the delta building potential.

Our approach builds with the river by creating and managing new river distributaries that are opened and closed every 50 years or so to build new sub-deltas within a defined sustainable delta footprint. By placing the last outlet somewhere in the vicinity of English Turn the lower Mississippi River would

become a tidal channel. These two simple concepts of harnessing 100% of the river and placing the last outlet near English Turn result in immediate and significant benefits for flood protection and navigation. Through the elements of our approach the level of flood protection for New Orleans and surrounding areas would be increased from a 1/100 year to approximately 1/1000 year level. By making the lower river a tidal channel, costly future maintenance dredging costs for a 50 ft navigation channel would be mostly eliminated and expansion of navigation and shipping facilities would be possible.

Storms and Waves in the Coastal Landscape

A Comparison of Modeled and Observed Wind Waves in Terrebonne Bay, LA.

Thomas Everett [1], Qin J. Chen [1,2,3], Kyle Parker [1] , Arash Karimpour [1]

[1] Department of Civil and Environmental Engineering, [2] Center for Computation and Technology, [3]Coastal Studies Institute, [4]Louisiana Sea Grant, Louisiana State University

The coastal wetlands in Louisiana are an important resource that sustains many economies and ecosystems. Subsidence, sea level rise, saltwater intrusion, storms, sediment depletion etc. have placed great strain on coastal ecosystems. Chronic wetland losses have converted vegetated lands into open waters and increased wind fetch. Locally generated wind waves acting on the marsh edge therefore contribute considerably to wetland loss. A numerical model that can accurately describe the wave climate along Louisiana's coast is a valuable tool that can be used for shore protection, environmental conservation, and resource management.

Terrebonne Bay was chosen for this research because it has experienced one of the largest wetland loss rates among Louisiana estuaries. A continuous wave measurement in upper Terrebonne Bay was obtained over the course of a year. The Delft 3D flow and SWAN wave models are coupled to hindcast/forecast the wave climate in the estuary. Since a fine resolution mesh is employed in the model to resolve the topographic features along the shoreline, bathymetry corrections to the existing data sets must be implemented. Using nearshore depth observations in estuaries, a new shoreface and mudflat equilibrium profile is proposed and incorporated into the model. The coupled Delft3D flow and SWAN wave models are validated against in situ measurements from the wave gauges. The long term wave power is calculated at different locations in Terrebonne Bay using the modeling results. An effective wave power value that causes marsh edge erosion is sought after. The SWAN model results are then compared to the results of a parametric wave generation model. Improvements of wave hindcast using the parametric wave model in long term wave analyses for shoreline retreat prediction will be presented.

Numerical and Experimental Study of Coastal Wave over Levee Structures

Yuyi Pei, **Dr. Ning Zhang,[1]** Dr. Dimitrios Dermisis

[1]McNeese State University, Department of Chemical, Civil and Mechanical Engineering

Louisiana coast experiences significant erosion due to wave actions. The loss of beaches in some coastal areas in Louisiana is severe. There are wetlands and marshes located in the coastal areas. Wetland loss is a major threat to the coast areas. 3D numerical simulations of wave-levee interactions were conducted, and the results were analyzed to determine the flow characteristics and surface shear distributions. The simulation setup is exactly the same as an experiment conducted in a wave tank facility. The velocity histories on different locations near the test levee surface were compared, and the agreement is very good, therefore the simulation is validated. A test levee system was also constructed on a test Gulf beach site, approximately 4.6 miles west of Holly Beach in Cameron Parish, Louisiana. Long term observation of erosion was conducted, and survey data showing the change of the test levee were produced. From the observations, the loss of this portion of Gulf beach is significant during the 2-

year research period. Real-time images were recorded to show this significant change in topography. The losses of the levee materials during the entire project period were quantified based on the survey data. The history of the loss was plotted. It indicates some major storm event contributed to significant losses and erosion of the test structure. It can be seen from the results that the real-time erosion pattern on the test site agrees reasonably with the surface shear patterns from the simulations. In the numerical simulation, commercial package ANSYS-FLUENT was used. A free-surface flow model is adopted with open channel wave boundary conditions. A grid-independence study was performed to determine to appropriate grid resolution to be used in the simulation. Parallel computing was conducted due to the expensive cost of this 3D simulation with relatively fine grid resolutions.

Hurricane Storm Response Rapid Prediction Using Surrogate Models

Jay Ratcliff [1]

[1]US Army Engineer and Development Center

Surrogate or “meta” models have a wide range of applications and are increasingly being developed and trained for tropical storm surge and wave responses. USACE Engineer Research & Development Center (ERDC) has developed surrogate models for the rapid prediction of hurricane responses along the Gulf of Mexico and north Atlantic coastlines. Surrogate models are implemented using artificial networks and machine learning algorithms and methods including Gaussian process emulators. Training is based upon high fidelity numerical modeling (ADCIRC and STWAVE) of over hundreds synthetic tropical storms developed from a joint probability model. Models have been validated for water levels and waves. This is the first surrogate system to predict and forecast time series results. CHS-CHRP software and data system was developed to deliver surrogate model predictions in an operational real time environment. Hurricane parameters are read from NOAA 6 hour update web service and used to predict waves and storm surge water levels in minutes. This technology is being deployed where very rapid predictions of hurricane storm surge is required for USACE emergency managers to make critical decisions, structure closures, other emergency responses, as well as risk assessment analyses.

Increasing Sediment Retention

Lower Mississippi River Water and Sediment Budget in Support of the Moffatt & Nichol Changing Course Design Competition Plan

T. Stokka Brown Jr., MS, PE[1], Ioannis Georgiou [2]

[1] Moffatt and Nichol, Baton Rouge, LA, [2] University of New Orleans, New Orleans, LA

The historic operation of the Mississippi River Tributaries (MRT) system to manage the "design" flood is characterized as flood control with the intent of containing the Mississippi River flood waters within the MRT system and route floodwaters to the Gulf of Mexico. Under this operation, we are missing an opportunity to divert sediment laden and nutrient rich flood waters into the estuarine complex. One goal of the Moffatt & Nichol Changing Course Team was to change the mindset from restricting the River for flood control to allowing controlled floods into the estuarine system mimicking natural river pulses that enhance seasonal salinity gradients.

Diversions north of Belle Chasse will be active diversions controlled manually via gates. Diversions south of Belle Chasse will be passive diversions through multi-height spillways. The timing and amount of flow through the multi-height spillways will be controlled by the crest elevation and width of the spillway notches. Using field data and rating curves adapted from the Mississippi River Delta Hydro Study, average annual flow and sediment volumes through the proposed structures and existing outlets were calculated and operational sediment and water budgets under varying flow rates along the River were developed. These operational budgets were developed for the existing River alignment as well as proposed New Cut River alignment. The location and average flow rates of the gated structures and the location and geometry of the multi-height spillways were determined and sized to maximize delta building opportunities while achieving target hydraulic residence times in the receiving basins and maintaining minimum flow rates in the River.

As a result of this Plan, 80% of the previously lost sediment resources are routed through coastal wetland and estuaries adding an estimated 10 million cubic yards and 13 million cubic yards per year of new sediment into the Barataria and Pontchartrain/Breton Sound Basins respectively.

An Innovative River Diversion Concept for Accelerated Land Building

Fredrik Huthoff [1], Hermjan Barneveld [1], Geerten Horn [1] and Carolien Wegman [1]

[1] HKV Consultants, Lelystad, The Netherlands

An innovative river diversion concept is proposed to speed up land building in deltaic zones through natural confined sediment trapping zones. As opposed to natural coastal delta formation the proposed concept builds on the observed infilling of lakes in lacustrine deltaic zones. In the investigated concept a by-pass channel is created within a confined diversion region that ultimately reconnects with the river further downstream. The flow velocities in the by-pass are low, enabling most of the sediment to settle down. At the reconnection point, sediment-poor water flows back into the river, thereby maintaining sediment transport capacity and navigable depth in the main river channel. The ridges that confine the by-pass may be natural or man-made and constrict the flow to the targeted land-building area at low

and medium river stages. The confining ridges will be over-topped during river floods, leaving most sediment behind in the targeted confined area.

Preliminary hybrid 1D2D hydrodynamic flow simulations demonstrate that the concept may work and has potential for speeding up targeted land-building. Particular attractive characteristics of the by-pass diversions are that they may be activated during medium and low flow conditions in the river without compromising navigation conditions and that the confining ridges can be designed to direct and control overflows during floods. As a feasibility study, two locations in the lower Mississippi delta are explored and opportunities and challenges for combinations of land building, diversion-control, river navigation, ecological impacts, flood risk and hurricane safety are investigated and discussed.

Efficient Retention of Mud for Land Building on the Mississippi Delta Plain

Christopher Esposito [1], Zhixiong Shen [2], Anjali Fernandes [3], Elizabeth Chamberlain [1], and Torbjörn Törnqvist [1]

[1]Tulane University, [2] Coastal Carolina University, [3]University of Connecticut

River deltas are uniquely vulnerable to sea level rise, presenting an existential threat to some of the densest human populations and most valuable economic infrastructure on Earth. Delta management strategies include plans to disperse sediments to the delta plain, where they can be used to increase land elevation and prevent submergence. Sediment Retention Efficiency (SRE) of delta plains is thus a critical parameter, but is difficult to measure, and poorly constrained in the literature.

We examine the texture and SRE of a relict crevasse splay in a vegetated inland location on the Mississippi River Delta where accretion rates exceeded the current local rate of relative sea-level rise. We use 132 cores to develop a 3D model of the splay deposit to assess the mass fraction that is composed of sand-sized grains. We then analyze sediment transport data in the Lower Mississippi River and find that the composition of the sediments carried in the top few meters is very similar to that of the splay, suggesting that the sediments extracted by the crevasse from the river were stored without any significant winnowing of the fine fraction. This is the mark of a very efficient sediment trap, and an important result from the perspective of delta management. We perform a similar analysis using 23 cores in a modern crevasse splay, Cubit's Gap, which has been discharging into an open bay in the Birdsfoot since the mid 1800's. The Cubit's Gap deposit is shown to be sandier than the riverborne sediment load, indicating a loss of fine material.

Our results show that mud alone can be used to rapidly and efficiently build land, and that diverting sediments to inland delta locations would be a more effective use of limited sediment resources than diversions close to the coast.

Louisiana's Strategic Adaptations for Future Environments (LA SAFE)

LA SAFE: Resettlement as a Resilience Strategy

Shirley Laska

Lowlander Center

Louisiana SAFE acknowledges resettlement is both a controversial and difficult typology within which to experience and measure success. However, it is a logical component to any comprehensive policy framework for a future Louisiana. If the State is to adopt and adhere to the idea of maximizing undervalued and underdeveloped space while preserving space with high value and moderate vulnerability, we must also acknowledge not all territory can be maximized or preserved; rather, some will be lost. Moreover, if we are to envision such a reality, we must also commit to resettlement techniques mindful of cultural, social and economic bonds.

Up to 86 percent of at-risk families stand to benefit from Coastal Master Plan structural interventions; however, those outside of that number, specifically those residing in sparsely populated rural communities, remain vulnerable in their current locales. Native American communities in southern Lafourche and Terrebonne parishes are particularly at-risk.

Put plainly, Louisiana must improve upon our nation's track record in both relocation and resettlement initiatives. Without a proactive approach, relocation will take place ad hoc, as illustrated by documented population movements following Hurricane Katrina. Whether a household uses insurance proceeds to move following a disaster event, or accepts a voluntary fair market value buyout, there is no investment in keeping communities together, nor is there a mechanism to maintain social and cultural bonds developed within our state's most vulnerable populations.

Louisiana SAFE envisions a systems-based approach to community-led planning and group migration. It is a small-scale, targeted strategy for culturally-sensitive at-risk communities and special needs groups, including the disabled, the elderly, disaffected minority groups and very low income populations. It is intended to capture a community's remaining – and often rapidly dwindling – value and transfer it to an environment in which it has the opportunity to grow and ultimately thrive.

LA SAFE: Retrofitting as a Resilience Strategy

Patrick Forbes[1]

[1]State of Louisiana Office of Community Development

Louisiana cannot and will not initiate a comprehensive retreat from the coast; it simply offers too much economic and cultural value to our state and nation which, if lost, would degrade our American way of life, not just Louisiana's. It is out of necessity that we maintain communities in close proximity to vital economic activities, adapting these communities so they can continue to prosper in rapidly changing and deteriorating environmental conditions.

The 2012 Coastal Master Plan highlights a few specific examples of this scenario. Hackberry, in Cameron Parish, lies adjacent to salt domes housing one of the nation's four strategic petroleum reserves, with capacity to hold more than 228 million barrels of crude. Meanwhile, the nearby Chenier Plain wetlands are deteriorating, heightening flood risk in Hackberry. Lafitte, a strategically-important fishing community in the Barataria Basin, is currently experiencing significant land loss and, with no action, may experience up to 12-feet of flooding in a 50-year storm event by 2061. LA Highway 1, a thoroughfare connecting Port Fourchon to inland areas and cross-country transportation corridors, regularly experiences closures during high tides and has remained underwater for days following previous storm events. In short, Louisiana constantly balances its economic and cultural interests with clear and present risks. It is an arrangement requiring thoughtful, strategic interventions to maintain a vital connection between residential corridors – the human element – and hubs of commerce and industry.

The 2012 Coastal Master Plan articulates CPRA's strategy involving restoration projects, structural protections and nonstructural protections. LA SAFE dovetails with and augments this framework by envisioning a medium-scaled, town and neighborhood-level approach designed to preserve community development footprints in proximity to moderately-vulnerable, high-value economic and cultural assets, and where possible, expand upon that existing value.

LA SAFE: Reshaping as a Resilience Strategy

Angela Lawson[1]

[1]State of Louisiana Office of Community Development

Typically, population movements are dictated by one of two macro forces. Populations are drawn to a locale on the promise of an increased quality of life, usually in the form of economic opportunity, outward social mobility, or a combination of both. Conversely, populations flee locales for inverse reasons. Economic opportunities dry up, or are relatively less abundant than in other destinations. Catastrophic events, including acute events like natural disaster or loss of a major employer or chronic deteriorating conditions such as land loss and sea level rise have a similar effect on migration patterns. In short, people are drawn to locations that are both safe and bountiful, while they are drawn away from locations plagued by risk and barrenness.

Louisiana has experienced significant population shifts from both types of catastrophic events, acute and chronic deterioration. For example, in Plaquemines Parish, an area heavily impacted by Hurricane Katrina in 2005, total population declined 14 percent, from 26,757 to 23,042, between 2000 and 2010. However, Belle Chasse – Plaquemines' largest municipality and an area within the U.S. Army Corps of Engineers-designed Hurricane and Storm Risk Reduction System (HSDRRS) – grew 28 percent, from 9,848 to 12,679, over the same period. In a general sense, areas heavily impacted by Katrina declined in population, like St. Bernard (-46 percent), Orleans (-29 percent) and Jefferson (-5 percent), while higher-ground "receiver" parishes gained population, like Ascension (40 percent), Livingston (39 percent), St. Tammany (22 percent), St. Charles (10 percent), East Baton Rouge (7 percent), St. John the Baptist (7 percent) and St. James (4 percent).

Mindful of event and risk-influenced migrations, Louisiana must Reshape underdeveloped, high-ground corridors in anticipation of future population and economic growth. LA SAFE envisions a larger-scale strategy geared toward parish-level planning and engagement designed to incentivize smart, structured and contextual development.

Mining Data for Effective Management

Status and Trends in Coastal Louisiana as Indicated by the Coastwide Reference Monitoring System (CRMS)

Leigh Anne Sharp [1], Katrina Hucks [2]

[1]Coastal Protection and Restoration Authority, [2]University of Louisiana at Lafayette

The Coastwide Reference Monitoring System has been collecting monitoring data for Louisiana's coastal restoration effort since 2006. At this time, we can evaluate trends in multiple factors related to vegetation, hydrology, elevation change, and land change. Trends in critical factors will be presented spatially and data will be interpreted relative to dominant processes in coastal basins. Current findings show that areas of the Mermentau Basin are losing surface elevation more rapidly than the Barataria and Terrebonne basins. The Teche/Vermilion Basin has the highest marsh elevation on the coast. Most of the 392 CRMS sites lost land between 2005 and 2012. Trends in salinity and flooding are variable across the coast but localized areas of increasing salinity and flooding are apparent in each coastal basin. These, and other findings derived from CRMS data will be presented.

Quantifying Coastal Louisiana Wetland Resilience Using Large-Scale Regional Monitoring Data

Krista L. Jankowski,[1] Torbjörn E. Törnqvist, Anjali Fernandes

[1]Department of Earth and Environmental Sciences, Tulane University, 6823 St. Charles Avenue, New Orleans, Louisiana 70118-5698, USA

Coastal wetlands are critical for both ecosystem services and coastal protection from storm surge, and their response to accelerated sea-level rise is a key issue in long-range coastal management. In coastal Louisiana, the question is whether wetlands are able to prevail while facing some of the world's highest rates of relative sea-level rise (RSLR). Here we analyze a regional dataset of unprecedented size, derived from 239 rod surface elevation table-marker horizon (RSET-MH) stations established within the framework of the Coastwide Reference Monitoring System, to determine present-day vertical accretion (VA) rates as well as the shallow subsidence (SS) component of overall RSLR (SS + deep subsidence + sea-level rise) observed at the wetland (mostly marsh) surface. Comparison of VA rates to overall RSLR rates provides insight into potential wetland resiliency as wetlands must gain surface elevation at or above the rate of RSLR in order to survive. Our results show great variability in VA rates from site to site, emphasizing the importance of a large data set to elucidate coastwide conditions. We find that 45% of Mississippi Delta sites are experiencing an elevation deficit compared to local RSLR rates. Conditions in the Chenier Plain are even worse, with 73% of sites falling short. Considering the expectation of continued acceleration of global sea-level rise, the longer term future of Louisiana's marshes is therefore bleak.

Using CRMS Monitoring Data to Develop a Predictive Model of Marsh Transition to Open Water

Donald Schoolmaster Jr.,[1] Leigh Anne Sharp,[2] Camille Stagg [1]

[1]US Geological Survey, Wetland and Aquatic Research Center

[2]Coastal Protection and Restoration Authority

According to estimates, Louisiana's three million acres of wetlands are being lost at the rate about 43 square kilometers annually. However, the risk of wetland loss is not spread evenly along the coast, and is changing through time as the result of natural processes, human activities and restoration interventions. In order to prioritize and direct resources effectively toward slowing or reversing the trend in wetland loss, it is essential to have assessment tools that reflect and synthesize the effects of multiple processes.

Using the Coastwide Reference Monitoring System (CRMS) data from 273 sites from 2008-2014, we built a predictive, statistical model to estimate the risk of marsh transition from vegetated to open water. The goal of this model is to predict the probability of wetland loss as a function of vegetation attributes, spatial, and hydrologic predictors. The models use predictors from year t, to estimate the probability the vegetation will transition to open water in year t+1.

We found that transition events from marsh to water were highly correlated at the site level. The most parsimonious model was found to include year, vegetation cover, site-level variation in vegetation cover, mean tidal amplitude, annual average of hourly salinity and percentage of land in the surrounding square kilometer. The resulting model predicts transition to open water very well (in-sample AUC=0.95, CV-AUC=0.88). The model finds that larger values of vegetation cover, site-level variation in vegetation cover, mean tidal amplitude and larger percentage of surrounding square kilometer comprising land are associated with lower risk of marsh loss. On the other hand, larger values of annual average of hourly salinity are associated with higher risk of marsh loss.

This model is a potentially useful assessment tool because 1) it is a predictive model, and thus useful for directing resources, 2) early tests have shown it to be highly accurate and 3) it outputs the probability of near-future marsh loss, which is a metric that is easily understood and communicated to stakeholders.

Soil Processes

Sustained Impacts on Louisiana Salt Marsh Soil Greenhouse Gas Fluxes Following the Deepwater Horizon Oil Spill

Brian Roberts [1]

[1] Louisiana Universities Marine Consortium (LUMCON)

We quantified the effects of the Deepwater Horizon oil spill on greenhouse gas (GHG) fluxes from oiled and unoiled Louisiana marsh soils. Temporal patterns were assessed along transects of increasing distance from marsh edges at 4 sites (2 unoiled, 2 oiled) in Terrebonne Bay (TB) over the 2012-2015growing seasons. GHG fluxes showed significant seasonal and inter-annual (both in magnitude and seasonal patterns) variability. Oiled sites consistently had lower carbon dioxide (CO_2) and nitrous oxide (N_2O) and higher methane (CH_4) fluxes 2 – 5 years post-exposure. CO_2 was the major driver of soil radiative balance at all sites, but CH_4 accounted for 33-60% of forcing in oiled compared to only 3-5% in unoiled soils. CO_2 & N_2O fluxes were correlated with soil properties (CO_2 in unoiled marshes only), but CH_4 fluxes were not. CO_2 fluxes increased with distance from marsh edge (stronger patterns in unoiled sites), CH_4 fluxes showed different patterns in oiled (decreased) and unoiled (increased) sites, and N_2O did not show a consistent pattern. Laboratory incubations of Barataria Bay (BB) soils associated with *Spartina alterniflora* and *Avicennia germinans* showed CO_2 production was greater in unoiled marshes and comparable between vegetation types; CH_4 production was greater in oiled marshes and *Avicennia* soils; N_2O was higher in unoiled marshes and *Avicennia* soils. TB and BB marsh soils incubated at different salinities (5, 15, 25, 35 ppt) showed CO_2 production increased and CH_4 decreased with salinity; CH4 production was higher in TB and unoiled soils; CO_2 production increased as the magnitude of salinity manipulation increased and the slope of the CO_2 response to increased salinity was positively related to soil C, N and water content. These results have important implications for wetland carbon models and how fluxes may respond to both episodic (e.g., oil spills) and climate-related (e.g., altered salinity and vegetation) stressors.

Biogeochemical Processes in Oiled and Unoiled Louisiana Salt Marshes: a Multiyear Analysis

Ariella Chelsky [1]*, John Marton [1,2], Anne Bernhard [3], Anne Giblin [4], Samantha Setta [1], Brian Roberts [1]

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Louisiana salt marshes are important sites for carbon and nitrogen cycling because they can mitigate fluxes of nutrients and carbon to the Gulf of Mexico where a large hypoxic zone develops annually. The aim of this study was to investigate spatial and temporal patterns of biogeochemical processes in Louisiana coastal wetlands during peak growing season, and to investigate whether the 2010 Deepwater Horizon oil spill resulted in persistent changes to rates and the microbial communities responsible for these processes. We measured nitrification potential and sediment characteristics at two pairs of oiled/unoiled marshes in each of three regions across the Louisiana coast in July from 2012 to 2015, with plots along a gradient from the salt marsh edge to the interior. Nitrification potentials across the

coast (overall mean of 901 ± 115 nmol gdw^{-1} d^{-1} from 2012-2014) were high compared to other published rates for salt marshes. Rates were highly variable with an overall range of 4 orders of magnitude across the three years, and within each region interannual means varied by factors of ~2-5. Neither nitrification potential nor ammonia oxidizer abundances exhibited consistent differences in response to oiling history. However, nitrification did display consistent spatial patterns within each region that corresponded to changes in relative elevation and inundation, which influence patterns of soil properties and microbial communities. In 2015, we also measured greenhouse gas (CO_2, N_2O and CH_4) production and denitrification enzyme activity rates in addition to nitrification potential across the region to investigate spatial relationships between these processes. This study highlights the importance of using long-term data across regions to assess environmental impacts, as biogeochemical process rates can have high spatial and temporal variability. Results of this study will serve to inform policy change as well as better management of these systems in the long term.

Interactive Effects of Variable Hydrologic Regimes and Atmospheric [CO_2] on *Spartina alterniflora* Salt Marsh in Coastal Louisiana

Scott Jones [1,*], Camille Stagg [2], Ken Krauss [2], Mark Hester [1,3]

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[2]Wetland and Aquatic Research Center, U.S. Geological Survey, Lafayette, LA
[3]Institute for Coastal and Water Research, University of Louisiana at Lafayette, Lafayette, LA

Coastal salt marshes provide key ecosystem services. Global climate changes such as sea-level rise and altered atmospheric composition of gases are influencing the provision of ecosystem services by changing dynamic processes in Louisiana's coastal marshes. Due in part to high rates of geologic subsidence, Louisiana marshes are subject to high rates of relative sea-level rise. Restoration methods that decrease inundation stress and increase elevation, such as sediment-slurry amendment, have the potential to increase the longevity of subsiding marsh platforms by restoring ecological equivalence and restarting positive surficial processes. It is not well known, however, if increasing marsh platform elevation effectively minimizes the stress response of restored marshes to high rates of relative sea-level rise, nor how concomitant increases in atmospheric [CO_2] may potentially interact and alter plant stress response.

To address these knowledge gaps, we quantified the effects of atmospheric and hydrologic stressors on above- and belowground plant production, soil surface elevation change, net ecosystem exchange of carbon, and soil structure and function in elevated and ambient CO_2 greenhouses; we used mesocosms of *Spartina alterniflora*, the dominant salt marsh macrophyte in coastal Louisiana. We exposed the mesocosms to two levels of atmospheric [CO_2] (ambient and elevated), three hydrologic regimes (diurnal tide, flood stress and drought stress), and three marsh platform elevations (to represent sediment-addition, healthy, and drowning marshes). These data will allow us to better understand how specific climate change scenarios in combination with human restoration efforts affect salt marsh response to hydrogeomorphologic changes, and how multiple stressor interactions modulate these responses. Multiple stressors and their interactions are not often studied in rigorous greenhouse settings, making this work especially valuable for elucidating complicated responses to global change. Our work also gives land managers insight into the future of salt marsh resiliency and support of ecosystem services along coastal Louisiana.

Coastal Projects: From Feasibility to Implementation

Overview of the Southwest Coastal Louisiana Feasibility Study

Jennifer Mouton [1], Andrew MacInnes [2]

[1] Coastal Protection & Restoration Authority of Louisiana, [2] U.S. Army Corps of Engineers, Mississippi Valley Division, New Orleans District

The people, economy, environment, and cultural heritage of coastal areas in Southwest Louisiana are at risk from damages caused by hurricane and storm surge flooding. Southwest coastal Louisiana's topography, and low elevation, proximity to the Gulf of Mexico, subsiding lands, and rising seas, are all contributing factors which cause coastal flooding, shoreline erosion, saltwater intrusion, and loss of wetland and Chenier habitats. Congress authorized the investigation of alternatives to provide hurricane protection and storm damage reduction, and significantly restore environmental conditions. The Southwest Coastal (SWC) study area encompasses 4,700 square miles in Calcasieu, Cameron, and Vermilion Parishes in southwest Louisiana.

The National Economic Development (NED) plan (hurricane storm damage risk reduction measures) evaluated various levee alignments as well as stand-alone nonstructural plans. The National Ecosystem Restoration (NER) plan consisted of multiple restoration methods including marsh creation, shoreline protection, and hydrologic and salinity control. Costs and benefits for the proposed measures were estimated, ineffective measures were screened out, and a final plan was selected.

The NED Recommended Plan (RP) consists of a nonstructural plan for the flood proofing of eligible structures in the 25-year floodplain by various methods including the elevation of eligible residential structures, dry flood proofing of eligible non-residential commercial structures, and the construction of localized storm surge risk reduction measures of less than six feet in height around eligible industrial complexes and warehouses. The project is primarily voluntary in nature; however, certain structures will be subject to acquisition.

The NER RP consists of a total of 49 ecosystem restoration features being recommended for construction, in addition to the recommendation for long-range studies of the Calcasieu Ship Channel salinity control structure and Cameron-Creole Spillway structure. The RP includes nine marsh restoration measures, five shoreline protection measures, and a Chenier reforestation program.

Opportunities and Challenges of Advancing LCA Projects Using In-kind Cross-Crediting Provisions

Gary Hawkins [1]

[1]U.S. Army Corps of Engineers, New Orleans District

The purpose of this presentation is to provide the U.S. Army Corps of Engineers (USACE) perspective of advancing LCA projects to construction using cross-crediting, as authorized in Water Resources Reform and Development Act of 2014 (WRRDA 2014). Section 1019 of WRRDA 2014 amends section 7007 of the Water Resources Development Act of 2007 (WRDA 2007) to authorize credit, in accordance with section 221 of the Flood Control Act of 1970, for the cost of in-kind contributions for a study or project

authorized in Title VII of WRDA 2007 (including LCA Projects) that is carried out by a non-federal interest. Section 1019 of WRRDA 2014 also amends section 7007 to allow for the transfer of "excess credit" for a study or project to be applied toward the non-federal cost share of any other study or project carried out under Title VII.

The advancement of the LCA Projects, which consists of 15 large, coastal Louisiana restoration projects, can be a significant step in meeting USACE and the State of Louisiana's shared commitment to combating coastal land loss in Louisiana. The State of Louisiana has initiated construction of certain LCA projects in advance of USACE receipt of Federal funding, and has identified other LCA projects that it would be willing to use excess credit to cost share in the construction with USACE. Five Memoranda of Understanding (MOU) have been executed to preserve the State's eligibility to receive in-kind credit and USACE and the State conducted extensive coordination on the development of a mutually agreeable process to enable the State to receive in-kind credit to the maximum extent possible.

The presentation will provide the status, opportunities and challenges of implementing cross-crediting provisions, and USACE's perspective on the issues and concerns that have arisen, resolutions sought, and lessons learned.

A Resilient Future for an American Icon: Reducing Storm Surge Risk in the "Big Easy"

Dan Grandal,[1] PE, CFM, LEED AP

[1]Stantec

When a city like New Orleans faces a risk the size of a Category 5 hurricane, the solution needs to be just as formidable. Enter the Permanent Canal Closures and Pumps (PCCP) project. Scheduled for completion in 2017, the PCCP project includes closure structures and pump stations constructed at the mouths of the London Avenue, Orleans Avenue, and 17th Street canals. With a capacity of 24,300 CFS, this is one of the largest combined pumping facilities in the world.

Designed to serve the community now and in the future, the massive drainage pumping stations and flood gates play a key role in the multi-billion-dollar Greater New Orleans Hurricane and Storm Damage Risk Reduction System. The PCCP project replaces the Interim Closure Structures constructed immediately following Hurricane Katrina.

The United States Army Corps of Engineers awarded this $615 Million design-build project in 2013 to PCCP Constructors JV. Stantec is the lead design engineer and architect providing civil, geotechnical, structural, mechanical, project management, and construction support. This presentation provides an overview of the project (including adaptability for possible future conditions) and discusses the many of the challenges faced by the design team and construction progress.

Friday, June 3rd

Session Block VIII, 9:00 – 10:30 a.m.

Legal and Financial Approaches

Legal Aspects of Coastal Change

Kelly Haggar

Riparian, Inc.

Coastal change is unlikely to require new law but properly dealing with its effects and planning our response to them will require more than just a good understanding of present law. Statutes rest on fundamental - but often unstated - societal assumptions favoring some outcomes and denying others. For example, Western societies presume land should remain in commerce and always be productive.

Virtually all of the major cases and controversies concerning water and/or coastal issues arising around the nation in recent years - - property damage and land loss during hurricanes due to exploration and production (E & P) canals, increased expenses to levee boards from a subset of those same E & P canals[*], diversions affecting oyster beds, beach front lot owners objecting to beach restoration projects, Anthropogenic climate change causing increasing hurricane damage - - were all resolved by applying existing law. Many of those laws are not just based upon Roman laws going back over 2,000 years; some are almost word-for-word copies of them.

Unfortunately, much of the general public either does not understand the basic principles of land use and tort or perhaps simply wishes for different outcomes despite existing (and well-settled) laws. Worse, there does not seem to be sufficient appreciation of the underlying geological factors driving some of the changes in and along our coasts, marshes, and swamps.

Law as an institution has never attempted to "control nature" per se but it most assuredly attempts to specify and control who gains and who loses - and why - when a river changes course, when new land forms at the beach, and when a dispute breaks out as to "what is a beach?" and "who owns it?"

A general overview of the major cases and an explanation of why they turned out as they did will better enable coastal planners to find - and stay within - more realistic limits of what can and cannot be accomplished within the framework of our existing laws. Moreover, if American society does determine a new direction in coastal programs is needed, a fuller understanding of current law will likely allow better choices to be consciously made. However, since law can only help illuminate the choices and assign the risks to various parties, ultimately geology - not law - is the key to future decisions about our coastlines.

[*] The general presumption is that the 5th Circuit will issue its opinion on the SELFPA-East's suit against the 80-odd oil companies before Christmas. Further, if it affirms the dismissal by the trial court, the case is highly likely to end. Only if the 5th reverses and the case does not promptly settle will its outcome be unknown by June of 2016. As for the state court suit, at this writing, only one of the two

parish plaintiffs remains. However, updating a pending case is not a problem between March and June of 2016. For that matter, I have no objection to omitting these two cases as long as either is pending and undecided. All the other cases researched have reached finality; two pre-date the Civil War.

Status and Challenges of Wetlands in Carbon Markets

Sarah Mack [1], Robert Lane [2], John Day [2]

[1]Tierra Resources LLC, [2] Louisiana State University

In the last decade, considerable global, national, regional and state-level governmental participation in the stabilization of atmospheric greenhouse gases has facilitated significant growth in emissions trading markets. Wetland restoration techniques have proven to be effective climate change mitigation strategies that promote enhanced carbon sequestration via increased vegetative productivity and carbon burial, as well as avoided carbon release when wetlands are lost. A carbon market that facilitates financial investment into wetland restoration can potentially create offsets that provide a wealth of co-benefits such as storm surge reduction, fish and wildlife habitat, recreation, job creation, and economic development that are vital to the sustainability of coastal Louisiana.

To ensure quality and credit validity, protocols and methodologies must provide a transparent accounting methodology for the development, certification, and monitoring of carbon offset projects, and be approved through a transparent process that provides opportunities for stakeholder engagement and scientific review. In 2012, the first wetland restoration methodology "Restoration of Degraded Deltaic Wetlands of the Mississippi Delta" was certified by the American Carbon Registry introducing wetlands to carbon markets. Since that time other wetland methodologies have been certified in national and international markets. However, to date no carbon offsets have been transacted.

This presentation will provide an update on regulatory and voluntary emissions trading markets with an emphasis on wetland carbon offset development. Louisiana's wetlands will be discussed within the broader context of the opportunities and challenges that wetlands face within current carbon markets.

Enhancing Financing Mechanisms for Louisiana Coastal Restoration

Scott Nadler [1]

[1]US Business Council for Sustainable Development

Exciting new technologies are emerging to support coastal restoration and protection, but financial resources and mechanisms are lagging far behind. "Financing the Future II", a November 2015 publication of the Tulane Institute on Water Resources Law and Policy, estimates a $70 billion funding deficit for implementation of Louisiana's 2012 Coastal Master Plan. This sobering analysis reaffirms the importance of finding additional financial resources to enhance and leverage existing funds, with a focus on green and green/gray (hybrid) infrastructure to reverse coastal wetland loss. This presentation will discuss progress achieved in the 'boots on the ground' project initiated by the Louisiana Water Synergy Project in summer 2015. This project is focused on ways to make green and hybrid projects more "bankable" by identifying, quantifying, and monetizing benefits and co-benefits of these projects and communicating these results to public and private beneficiaries as well as to investors seeking to

broaden their social benefit investment portfolios. Co-benefits include community flood protection, habitat creation, carbon sequestration, avoided property loss and business interruption, protection or creation of economic drivers for the region including the energy industry, navigation, fisheries, recreation, and preservation of the aesthetics and culture of the region.

Project strategies include 1) development of a credible local investment model using Louisiana project examples; 2) documenting the logic trail for how this methodology was developed/adapted; and 3) exploring adapted and innovative financing mechanisms; and 4) engaging financial resources ready to move to the next stage and begin piloting actual infrastructure investments.

2017 Coastal Master Plan I

The 2017 Coastal Master Plan Decision Framework

Mandy Green [1], Karim Belhadjali [1], and Melanie Saucier [1]

[1] Coastal Protection and Restoration Authority

The Coastal Protection and Restoration Authority is charged with coordinating restoration and protection investments through the development and implementation of Louisiana's Comprehensive Master Plan for a Sustainable Coast (Plan). The first Plan was submitted to the Louisiana Legislature in 2007 and is mandated to be updated every five years. The plan's objectives are to reduce economic losses from flooding, promote sustainability by harnessing natural processes, provide habitats for commercial and recreational activities, sustain cultural heritage and promote a viable working coast. Two goals drive decision making about the appropriate suite of restoration and protection projects to include in the Plan: restore and maintain Louisiana's wetlands and provide flood protection (structural and nonstructural) for coastal Louisiana's citizens. As part of the decision making process, a wide range of additional metrics (e.g., cost-effectiveness, sustainability) are used to evaluate the complex, competing needs of communities, industries, navigation and fisheries.

CPRA accepted proposals for new restoration and protection projects to be considered as part of the 2017 Coastal Master Plan. Individual protection and restoration projects are ranked by how well they performed across the set of decision drivers and metrics, and high performing projects are then assembled into alternatives constrained by available funding and river resources. The planning process is grounded not only on extensive scientific analysis but also on interdisciplinary collaboration between scientists, engineers, planners, community advocates, and coastal stakeholders which creates the long-term dialogue needed for complex environmental planning decisions. It is through this collaboration that recommended alternatives are reviewed and modified to develop the final Plan.

Coastal Ecosystem Integrated Compartment Model (ICM): Modeling Framework

Ehab Meselhe[1], Eric White [1], Denise Reed [1], T. Stokka Brown [2], Brady Couvillion [3], Zhifei Dong [4], Mandy Green [5], Scott Duke-Sylvester [6], Alex McCorquodale [7], Mallory Rodrigue [8], Jenni Schindler [8], Gordon Thomson [4], Z. Jonathan Wang [2]

[1]The Water Institute of the Gulf, [2]Moffatt & Nichol, [3]U.S. Geological Survey – National Wetlands Research Center, [4]CB&I, [5]Coastal Protection and Restoration Authority, [6]University of Louisiana at Lafayette, [7]University of New Orleans, [8]Fenstermaker

The Integrated Compartment Model (ICM) was developed as part of the 2017 Coastal Master Plan modeling effort. It is a comprehensive and numerical hydrodynamic model coupled to various geophysical process models. Simplifying assumptions related to some of the flow dynamics are applied to increase the computational efficiency of the model. The model can be used to provide insights about coastal ecosystems and evaluate restoration strategies. It builds on existing tools where possible and incorporates newly developed tools where necessary. It can perform decadal simulations (~ 50 years) across the entire Louisiana coast. It includes several improvements over the approach used to support the 2012 Coastal Master Plan, such as: additional processes in the hydrology, vegetation, wetland and

barrier island morphology subroutines, increased spatial resolution, and integration of previously disparate models into a single modeling framework. The ICM includes habitat suitability indices (HSIs) to predict broad spatial patterns of habitat change, and it provides an additional integration to a dynamic fish and shellfish community model which quantitatively predicts potential changes in important fishery resources. It can be used to estimate the individual and cumulative effects of restoration and protection projects on the landscape, including a general estimate of water levels associated with flooding. The ICM is also used to examine possible impacts of climate change and future environmental scenarios (e.g., precipitation, eustatic sea level rise, subsidence, etc.) on the landscape and on the effectiveness of restoration projects.

Integrated Compartment Model (ICM) Application: Scenarios, Uncertainties and Project Evaluations

Eric White [1], Ehab Meselhe[1], T. Stokka Brown [2], Brady Couvillion [3], Zhifei Dong [4], Mandy Green [5], Scott Duke-Sylvester [6], Alex McCorquodale [7], Mallory Rodrigue [8], Jenni Schindler [8], Gordon Thomson [4], Jenneke Visser [6], Z. Jonathan Wang [2], Emad Habib [6], Denise Reed [1]

[1]The Water Institute of the Gulf, [2]Moffatt & Nichol, [3]U.S. Geological Survey – National Wetlands Research Center, [4]CB&I, [5]Coastal Protection and Restoration Authority, [6]University of Louisiana at Lafayette, [7]University of New Orleans, [8]Fenstermaker

The Integrated Compartment Model (ICM) is a comprehensive and computationally efficient numerical model that can be used to provide insights about coastal ecosystems and evaluate restoration strategies. Due to uncertainties in future environmental conditions and climate change, particularly over a 50-year planning horizon, a range of plausible future scenarios was identified to assess effects of changing conditions (e.g., precipitation, evapotranspiration, eustatic sea level rise, subsidence, and tropical storm intensity and frequency) on the landscape and on the effectiveness of coastal restoration strategies. A range of plausible outcomes yields more robust understanding of the system and informed decision making. Because the ICM is a newly developed tool used to evaluate project effects for Louisiana's 2017 Coastal Master Plan, it was subject to thorough calibration, validation, and uncertainty analyses to assess model performance. The uncertainty analysis provides insight into the confidence associated with both internal and terminal ICM outcomes, including parameters such as land area, vegetation coverage, and habitat suitability. It is conducted by applying manual perturbations to key calibrated parameters to yield a range of outcomes. The perturbation magnitudes are informed by model validation results and the range of outcomes from these perturbations represent the uncertainty in the validated ICM; model uncertainties are identified and documented. The ICM is primarily used to evaluate projects and groups of projects, including sediment diversions, marsh creation, hydrologic restoration, among others, for a variety of future scenarios over 50 years. Example results will be provided to illustrate how various project types are evaluated in support of the 2017 Coastal Master Plan.

Structural Risk Reduction I

Improvements in Design of Coastal and Hydraulic Structures Subjected to Hurricane and Extreme Storm Events

Malay Ghose Hajra

The University of New Orleans

Coastal property development, global climate change, sea level rise, geologic subsidence, loss of barrier islands, increasing number and intensity of coastal storms and other factors have resulted in water quality degradation, wetlands loss, reduced storm and surge protection, ground settlement, and other challenges in coastal areas throughout the world. These natural and human hazards are putting more people and property at risk exposing significant infrastructure to open water conditions and making the areas situated nearby less suitable for human as well as various wildlife and fish species. On August 29, 2005, Hurricane Katrina made landfall at Buras, Louisiana in Plaquemines Parish about one hour south of New Orleans. Katrina was moving with Category 5 strength less than twelve hours prior to landfall. The storm generated a 28-foot storm surge and 55-foot waves. Approximately 80% of New Orleans was flooded to depths exceeding 15 feet in many areas. Surge and waves caused 50 major levee breaches in the regional Hurricane and Storm Damage Risk Reduction System (HSDRRS). Thirty-four of the city's 71 pumping stations were damaged, and 169 of the system's 350 miles of protective structures were compromised. Also contributing to the flooding was heavy rainfall: 14 inches in a 24-hour period. More than 1,500 lives were lost. According to the Federal Emergency Management Agency, Katrina is the costliest disaster ever to occur in the United States.

Since hurricane Katrina, design and analysis of foundations to support Hurricane and Storm Damage Risk Reduction Systems (HSDRRS) in the Mississippi River Valley division have undergone major revisions to account for uncertainties and incorporate higher design standards. Design and construction of conventional inland foundations vary significantly from foundations built to support coastal structures. In addition to supporting structural loading, foundations in coastal areas must withstand flood forces, high winds, scour, soil erosion, any seismic activity, and impact forces from floating debris. Based on recommendations from international experts, scientific organizations, government agencies and the private sector who studied causes of system failure during Katrina, new design and construction guidelines have been created to construct T-walls, I-walls, heavily loaded pump stations, sector gates, and other coastal infrastructures. This presentation will summarize the effects of hurricane Katrina on coastal foundations, incorporate lessons learned from this major storm event, and discuss new design methodologies and guidelines recommended and implemented for foundations to support coastal structures. A comparison of old and new design methodologies will be presented using data from a real-world project in New Orleans.

Risk Assessment of Hurricane Storm Damage Risk Reduction System (HSDRRS) Closure Structures

Robert Turner [1], David Moore [2]

[1]Southeast Louisiana Flood Protection Authority – East, [2]Tetra Tech, Inc.

The Southeast Louisiana Flood Protection Authority – East is charged with the responsibility of operating and maintaining the newly constructed Hurricane Storm Damage Risk Reduction System (HSDRRS) to protect the Greater New Orleans area from hurricane and tropical storm induced flooding. This system consists of 350 miles of levee/floodwalls, 78 pump stations, outfall canals and pump stations, and major closures structures that protect against storm surge. Recognizing this immense responsibility, SLFPA-E is in the process of developing a risk-based management and maintenance program, similar to that developed by the Dutch, that will result in the identification of risk and hazards associated with operation of major HSDRRS closure structures including: Lake Borgne Surge Barrier and Gates, Seabrook Complex and Gates, Bayou St. John Sector Gate, Bayou Bienvenue Sector Gate, Bayou Dupre Sector Gate, and the Caernarvon Sector Gate. This program will identify the possible risk of failure or breakdown of structural, mechanical, or electrical systems and allow the development of risk reduction measures that will increase the probability of successful operation of the structures when called upon. These risk reduction measures will be incorporated into enhanced operation and maintenance procedures that will cover areas ranging from staffing and communication procedures to storage of replacement parts and the quick repair of an inoperable piece of equipment. In summary, this program will allow SLFPA-E to most effectively utilize their resources to mitigate potential problems that could arise during the course of operation.

To develop this program, SLFPA-E convened a set of risk elicitation workshops with its partners. During the workshops, three different risk analysis methods will be utilized to identify and address possible risks of failure including a Hazard and Operability Study (HAZOP), a Failure Modes and Effects Analysis (FMEA), and a Fault Tree Analysis (FTA) for critical mechanical components. These three methods will be integrated to increasingly define the risk of failure beginning with the identification and qualitative ranking of risks in the HAZOP to a quantitative evaluation of risk through the development of fault trees. This process is graphically shown in Figure 1 *(deleted from Abstract).*

In order to maximize the value of this process, all stakeholders that have a role in the operation, maintenance, and decision making regarding the complex structures were invited to attend the first risk elicitation workshop. Input from a broad range of stakeholders with a diverse background was key to preparing a baseline risk assessment and ultimately improving the overall operation and maintenance of the HSDRRS under the jurisdiction of SLFPA-E.

CPRA Levee Safety

Billy Wall, P.E.[1], Rickey Brouillette, P.E.[2], and Sarah Moss, P.E.[3]

[1]Engineering Supervisor, Coastal Protection and Restoration Authority
[2]Engineering Manager, Coastal Protection and Restoration Authority
[3]Engineering Supervisor, Coastal Protection and Restoration Authority

A successful levee safety program is comprised of several facets working together smoothly. For CPRA, this requires, among other things, consistent coordination with levee system stakeholders, involvement in ongoing levee system design or construction, continual management of completed works, an efficient emergency management program, and public outreach for data collection and sharing through CIMS.

HSDRRS is a federal project within the greater New Orleans area consisting of gates, levees, and floodwalls, as well as pump stations and outfall canals. As the non-federal sponsor for this project (along with local authorities and levee districts), CPRA is an active participant in the design, construction,

inspection and maintenance of the features within this system. These responsibilities are also carried over into CPRA projects and non-state projects such as federal-only projects, parish projects, and levee district projects.

Management of completed works requires a rigorous inspection program consisting of quarterly, annual, and periodic inspections as well as semi-annual reporting as required by Code of Federal Regulations Title 33 and necessary to remain eligible for federal assistance under the Rehabilitation Program (Public Law 84-99). Successful system management also requires coordination with local authorities and levee districts to ensure operations and maintenance information remain current, any necessary permits are issued, and problems with project features are promptly reported and resolved.

Emergency management encompasses both storm events and riverine (high water) events. Responsibilities associated with hurricane events include participation in Levee Information Management System (LIMS), monitoring closure criteria, Louisiana Governor's Office of Homeland Security & Emergency Preparedness (GOHSEP) activities, and recording and reporting damage assessments. Riverine event responsibilities include participation in levee system inspections and assisting with any issues that arise along the system during the event.

CIMS allows for the collection and distribution of levee safety data for Coastal Louisiana levee systems through a geographical information system.

Uncontrolled River Diversions

USFWS Delta NWR Sediment Diversion with Terraces Case Study

James Harris [1]

[1]USFWS, Southeast Louisiana NWR Complex

This presentation covers the first successful use of a small sediment diversion coupled with terraces to create new wetlands on Delta National Wildlife Refuge (NWR) near Venice, Louisiana. Project was funded by Chevron Pipe Line Company (CPL), Texas Petroleum Investment Company (TCIP), Friends of Louisiana Wildlife Refuges, National Fish and Wildlife Foundation, and the US Fish and Wildlife Service (FWS). Following site selection and design by Refuge personnel, a 100 ft. wide by 800 ft long by 6 ft. deep sediment diversion was constructed within the Refuge off of Octave Pass. Coupled with this diversion, a total of 6,200 linear ft. of 3 ft high by 50 ft. wide terraces were constructed within the receiving pond. Small scale sediment diversions have proven to be an effective restoration tool within the Mississippi River birds-foot delta. Combining such diversions with a system of terraces represents a new approach to deltaic splay development in this area. This combination of sediment delivery and the use of terraces to slow and redirect water flow and velocity has successfully created healthy wetland habitat for a variety of plants and wildlife. The combination of a sediment diversion and terraces represents an effective tool for wetland restoration in Southeastern Louisiana and has resulted in the establishment and growth of emergent marsh and associated shallow water habitats in a relatively short time frame.

Backwater Hydrodynamics in Complex Channel Networks

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A fundamental characteristic of many river deltas is that they branch into distributary networks as they approach their receiving basin. Recent studies show that the pattern of sediment transport in the lower reaches of the trunk channel is controlled by interaction with the downstream water level, and that channel geometry plays a critical role in modulating the relationship. However these studies have typically concentrated on regional scales, and not investigated the terminal distributary channels which are subject to flow losses along their length, and which have an additional upstream water level boundary constraint set by the trunk channel.

We present observations showing that in many cases large and small distributary channels emanating from the same crevasse have similar water surface slopes and trends in flow properties, indicating that channel geometry is not as dominant a control in terminal distributary channels as it is in the trunk channel. We consider the hypothesis that big and small terminal distributary channels act similarly because the down-channel pressure gradient overwhelms inter-channel variations in bed friction over the observed distributary length, and that these channels are subject to a geomorphic control driven by

flow losses that is not present in engineered modern trunk channels. We then adapt existing models of backwater flow to account for the fixed upstream boundary condition and flow losses. Our results have implications for the management of coastal river systems and for our understanding of channel bifurcation stability.

Morphodynamics of the Initial Erosional Phase of the West Bay River Sediment Diversion

Brendan Yuill*[1], Ashok Khadka [1], João Pereira [1], Mead Allison [1,2], Ehab Meselhe [1]

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The objective of this study is to investigate “initial phase” at the West Bay sediment diversion (Louisiana, USA) using coupled field observations and numerical modeling. The West Bay diversion was cut into a lower Mississippi River levee to mimic the function of a crevasse-splay, i.e., to divert river water and sediment to an adjacent receiving basin for land-building purposes. Bathymetric measurements show that the diversion channel experienced significant natural morphologic evolution during the initial decade (2004-2014) and, similar to a natural crevasse-splay, was predominately erosional after its construction. Hydrodynamic and sediment transport modeling suggests that this evolution initially increased the discharge of flow and sediment through the crevasse as the channel became wider and deeper and altered its orientation relative to the main river flow direction. After 5 years, the model results predict that further evolution led to monotonically reduced diversion discharges. During this time, natural and engineered sediment deposition in the receiving-basin decreased predicted basin-flow velocities and promoted a backwater effect that reduced the sediment transport capacity of the diversion channel. Observations during the final 2 years show that much of the initial erosion around the diversion had abated indicating that diversion morphology may have stabilized. A modeling sensitivity analysis confirmed that the observed changes to channel geometry and orientation likely promoted flows of water and sediment through the diversion while increases in basin-bed elevation would have had a contrary effect. The morphodynamic evolution of the West Bay diversion documented in this study presents a model indicative of the erosional phase of crevasse-splay evolution in a deltaic distributary fluvial network. Study results offer an analogue on how an engineered river sediment diversion constructed for coastal restoration may function during its first years of operation and suggest that the desired land-building processes may take time to become established.

Community Response to Federal Policy

Proactive Risk Management: FEMA's Mitigation Support for Climate Resiliency

E. Kenney [1]

[1]CDM Smith

Hazard Mitigation Assistance (HMA) provided by the Federal Emergency Management Agency (FEMA) is focused on funding projects that support risk reduction due to natural and man-made disasters. In response to *The President's Climate Action Plan*, Executive Order 13653 (*Preparing the United States for the Impacts of Climate Change)*, and FEMA's Climate Change Adaptation Policy (2011-OPPA-01), FEMA is taking steps to ensure its programs account for the impacts of climate change and include planning for mitigation actions in support of climate resilient infrastructure and communities. In particular, HMA may be expanded to meet the goals of long-term climate resilience, as funding could support cost-effective project grants that incorporate flood risk reduction and drought mitigation. These methods include the use of green infrastructure, accounting for environmental benefits of mitigation projects and other eligible hazard mitigation activities that reduce disaster losses and protect life and property from further disaster damages. FEMA recommends communities consider the impacts of climate change in their mitigation actions and is evaluating ways to encourage the use of green infrastructure in HMA projects.

To explore how climate resilient infrastructure may be incorporated into eligible HMA grants, CDM Smith supported FEMA to research climate resilient project options and identify actions that mitigate the impacts from climate change weather extremes. The research included an evaluation and analysis of various eligibility, technical, economic-financial, implementation, and environmental considerations. FEMA has identified several mitigation actions that provide risk reduction benefits for flood and drought, and lend themselves to implementation using green infrastructure and supporting increased resilience to the impacts of climate change.

FEMA and CDM Smith are committed to building stronger, more resilient communities by supporting eligible climate resilient projects. Mitigating the impacts of climate change in risk reduction activities increases resilience and reduces damage from natural hazards and, therefore, reduced costs to rebuild communities post-disaster. FEMA encourages all communities consider climate change in their hazard mitigation planning and projects. FEMA has identified a few activities in particular that provide benefits for risk reduction and climate change adaptation. This presentation will provide a summary of the methodology and major findings from the research and evaluation resulting in these activities to support communities with implementation of climate resilient infrastructure in eligible HMA projects. As part of this effort, FEMA will continue to evaluate ways to integrate climate change adaptation into programs, policies, and operations to strengthen the nation's resilience by considering and planning for future risk.

Communities on the Coastal Fringe: A Case Study of the Impact of Flood Reduction Alternatives on the FEMA Flood Insurance Rate Map

Dax Douet [1], Jeanne Hornsby [1], Bliss Kelley [1], Robert Miller [1], Justin Shaw [2]

[1]C.H. Fenstermaker and Associates L.L.C., [2]R&M Consultants

Coastal restoration and protection efforts typically focus on areas within the immediate coastal zone most likely to be impacted by a given project. In low-lying areas such as south Louisiana, comprehensive protection plans including storm surge barriers or levee systems have the potential to alter the FEMA Flood Insurance Rate Map by providing surge protection at the risk of impeding rainfall runoff from upland watersheds. Hydraulic modeling programs such as HEC-RAS are commonly used to delineate the 100-year floodplain for inland areas and can also be adapted to evaluate a wide variety of floodplain scenarios coupled with local drainage improvement activities.

This study illustrates the effort required to evaluate the impact of various drainage improvement activities on the 100-year FEMA floodplain map in a tidally-influenced watershed located just outside of the coastal zone in central Iberia Parish, LA. Tete Bayou and Pharr Canal are located in Iberia Parish with the upper portions of Tete Bayou within the City of New Iberia. Tete Bayou is approximately 10.2 miles in length commencing just southeast of Dauterive Hospital and terminating into Lake Fausse Pointe. The study area has historically exhibited drainage problems and C.H. Fenstermaker and Associates, LLC (Fenstermaker) was contracted by the Iberia Parish Government and the City of New Iberia to develop a comprehensive drainage assessment of the outfall system. Existing models of Tete Bayou and Pharr Canal were revised to incorporate recently collected high water marks and completed drainage improvement activities, which include channel clearing, culvert replacements, and dredging of Pharr Canal. HEC-RAS version 4.1.0 was used to analyze flood stages for various storm events and examine drainage improvement scenarios for Tete Bayou and Pharr Canal. The HEC-RAS stream network was digitized using high-resolution aerial photography, LiDAR data, and topographic survey data. The stormwater runoff flow hydrographs developed in HEC-HMS were used as upstream boundary conditions for the HEC-RAS model, while static tailwater elevations established by the United States Geological Survey (USGS) and the USACE were used at the mouth of Tete Bayou and Pharr Canal. Due to the limited amount of available discharge, precipitation, and peak water surface measurements within the channels, the hydraulic models used in this study were calibrated against limited 100-year Base Flood Elevations (BFE) published in the FEMA Flood Insurance Rate Maps (FIRM) and existing high-water marks within the parish.

Before the analysis, only 6,000 feet of the upstream-most section of Tete Bayou had been studied by FEMA, which left the rest of the floodplain unstudied and determined using approximate methodologies. As a result of this stud, the floodplain was re-delineated using detailed methods and base flood elevations were established for a much larger portion of the watershed terminating at Lake Fausse Pointe. This extension of the FEMA model brings us one step closer to establishing the important link between coastal restoration and protection activities and urban drainage improvement activities occurring on the fringe of the advancing coastal zone. The extended modeling results were used as the technical basis of a Physical Map Revision (PMR) application by Iberia Parish to FEMA, and the PMR is currently undergoing FEMA's review process.

NOAA All-Hazards Risk/Threat Assessment for the Gulf of Mexico

Zachary Nixon [1], Michael Bauman [1], Jacqueline Michel [1], Adam Davis [2], and Charlie Henry [3]

[1] Research Planning, Inc., [2] National Oceanic and Atmospheric Administration, Office of Response and Restoration, Emergency Response Division, [3] National Oceanic and Atmospheric Administration, Office of Response and Restoration, Disaster Response Center

Critical elements to preparedness planning are clearly defining and characterizing threats and risks. This project evaluates plausible risks to the coastal regions that boarder the Gulf of Mexico within the scope of the NOAA's National Ocean Service and Disaster Response Center's mission priority for coastal preparedness, response, recovery, and resiliency to All-Hazards. Risk was evaluated for 78 coastal parishes and counties in the five states bordering the Gulf of Mexico using a fully quantitative framework. We began by explicitly estimating annual hazard occurrence rates for 32 different hazard types using a common methodology. Evaluated hazards included tropical and convective storm winds, tornadoes, lightning, riverine, coastal, and flash flooding, earthquake, landslides, volcanoes and tsunamis, harmful algal blooms, as well as anthropogenic hazards such as oil and chemical spills, and radiological and biological releases from pipelines, waterways, railroads, roadways, and facilities. We generated these hazard rates using actuarial and spatial analyses from publicly available climactic and pollution databases, as well as literature. We then computed metrics quantifying human population, human-built infrastructure, and environmental assets (i.e., sensitive species and wetlands). We computed the vulnerability of each asset to each hazard type by multiplying the frequencies with which past hazards have occurred across three severity classes (minor, moderate, and major) by the relative measure of impact these events had in terms of injuries and fatalities, economic cost, and areal extent. These three concepts, hazard rate, relative asset amounts, and hazard-and-asset specific vulnerability, were combined to generate parish/county specific numeric risk indices suitable for mapping and further analysis. We also used these results to estimate compound hazards (e.g. the risk of oil spills from vessels due to tropical storm winds). Final methodology and results are publicly available on the internet for stakeholder review and incorporation into NOAA's Environmental Response Management Application (ERMA).

Natural Coastal Infrastructure I

Living Shoreline Demonstration Project – Recent Experience on Design and Construction

Josh Carter [1], Arpit Agarwal [2], Dean Goodin [3], and Tye Fitzgerald [4]

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A set of 8 artificial oyster reef products were proposed for use in an erosion control project in coastal Louisiana. A successful living shoreline project will reduce the shoreline erosion and provide ecosystem benefits. Performance characteristics of available living shoreline products are limited due to the experimental nature of the products. The goal of the project is to establish a living shoreline that will help prevent erosion along the coastal fringe marsh of Bayou La Loutre in St. Bernard Parish, Louisiana by using the living shoreline products to attenuate the wave energy that reaches the shore, while stimulating oyster growth and thereby increase the biodiversity in the immediate vicinity of the project site. The project is also intended to provide the Louisiana Coastal Protection and Restoration Authority (CPRA) experience and data on living shoreline products and their performance in order to design more effective living shoreline projects in the future. This presentation discusses the project design and experience from construction using unique artificial oyster reef projects.

Design focused on using the artificial oyster reef products must reduce wave energy transmitted past the designed structure to levels below the marsh erosion tolerance limit to successfully control shoreline erosion. However, known performance characteristics of available living shoreline products are generally limited due to the experimental nature of the products. Therefore, the ability of each product to reduce wave energy transmitted past the designed structure was evaluated along with the hydraulic loading on the structures using 2D-V and 3D computational fluid dynamics modeling tools. Construction utilized precast concrete units and innovative installation procedures. A review is provided on lessons learned applicable to more efficient design, project layout to improve constructability, as well as a variety of installation procedures.

Nature-Based Coastal Infrastructure: Implementing Low-Crested Artificial Oyster Reef Breakwaters into Restoration Practice

Kari Servold [1], Cheryl Ulrich [1], Bret Webb [2], and Scott Douglass [3]

[1] Dewberry, [2]University of South Alabama, and [3]South Coast Engineers

The northern Gulf of Mexico is home to numerous coastal restoration and shoreline protection projects exploring and incorporating nature-based coastal infrastructure (oyster reefs, marshes, etc.) over more common, traditionally engineered infrastructure solutions (seawalls, bulkheads, revetments, etc.). One way nature-based costal infrastructure is currently being incorporated into restoration practices and projects is through the use of nearshore, low-crested, artificial, oyster reef breakwater structures. Artificial oyster reef breakwater structures attempt to serve dual purposes of affording shoreline

protection by attenuating wave energy and providing habitat and ecosystem values that exceed that of "hard" armored shoreline stabilization solutions.

However, nearshore, low-crested, artificial, oyster reef breakwater structures are not well understood coastal infrastructure technologies. Designs (placement, material composition, and geometric properties, etc.) vary greatly. Additionally, coasts and shorelines are very unique systems with ranging and variable features, composition, and nearshore hydrodynamics, even when compared to nearby or adjacent sites. As a result of these differing and fluctuating characteristics the functionalities and capabilities of nearshore, low-crested, artificial, oyster reef breakwater structures are largely unknown. This presents a considerable challenge to the widespread implementation of these nature-based coastal infrastructure technologies in coastal restoration practice.

This presentation will consider and review factors hindering the widespread adoption of nearshore, low-crested, artificial, oyster reef breakwater structures in engineered coastal restoration projects. Discussion will emphasize research and engineering techniques that should be implemented into restoration practices which are adopting nearshore, low-crested, artificial, oyster reef breakwaters. Additionally, discussion will highlight remaining needs and shortcomings that are limiting the widespread use of nearshore, low-crested, artificial, oyster reef breakwater structures in coastal restoration practice.

The Current and Future State of Living Shoreline Design

Erin Rooney [1], Daniel Heilman [1]

[1] HDR

Although living shorelines have become increasingly common as a method of shoreline protection, current coastal engineering theory and practice lags in the development of accepted and/or standardized design criteria that address functional performance. While the definition of living shorelines varies, the general intent is to protect the shoreline with a method or system that provides or enhances natural habitat. These methods typically seek to avoid traditional hard structures such as seawalls and revetments that may displace natural habitat. Common living shoreline designs include planting vegetation nearshore and/or building a low-crested (i.e., submerged or semi-submerged) structure such as a low-crested breakwater or oyster reef.

Some agencies and organizations including NOAA, the Nature Conservancy, and various state agencies have issued general guidance on the design of living shorelines, but there is still an absence of industry standards to design these projects to meet specific shoreline protection criteria. Current industry-standard numerical models often have limitations calculating wave transmission over and through low-crested breakwaters. Additionally, many empirical wave transmission equations were not intended for use on some non-rock options including oyster reefs and other proprietary designed systems.
In addition to overcoming limitations calculating wave transmission, practicing engineers must find a balance between reducing shoreline recession (by reducing wave energy) and providing smaller or fewer hard structures. Depending on the amount of wave energy at the project site, low-crested hard structures may not adequately reduce the wave transmission resulting in continued shoreline recession. As the implementation of living shorelines continues to increase, more industry discussion should occur to better determine best practices and engineering guidance. The intent of this presentation is to

present the current state of living shoreline design standards and open an industry discussion on how to advance the theory and practice.

Best Practices in Non-Structural Flood Protection: Learning from History and Coastal Communities

Nonstructural Adaptation for Vulnerable Communities in the Gulf Coast

Robert Verchick [1], Carmen Gonzalez [2,] Alice Kaswan [3], Yee Huang [4], Shawn Bowen [1], and Nowal Jamhour [1]

[1]Loyola University—New Orleans School of Law, [2] Seattle University School of Law,' [3]University of San Francisco School of Law, [4]Center for Progressive Reform

Adapting to the impacts of climate change can take many forms, such as structural measures like levees and dams, as well as nonstructural measures such as property buyouts, elevation, and pre-disaster planning. Historical policies have favored structural measures, but federal agencies and state and local governments are increasingly turning to nonstructural measures and strategies. These strategies support mechanisms for adaptation that are flexible, that operate on a range of levels from the individual homeowner to entire communities, and that provide protection or additional protection in vulnerable areas. Some nonstructural adaptation strategies offer permanent, long-term protection against natural hazards; others significantly reduce the risk to people and property over the medium- to long-term risks outside of areas protected by hard infrastructure.

In Louisiana, the 2012 Coastal Master Plan emphasizes the importance of nonstructural programs and identifies options for reducing flood risk through better design and residential elevations, as well as a limited number of voluntary acquisition measures. However, unless these programs and funding opportunities are designed to reach socially vulnerable communities, these communities will face great challenges to reducing their risks.

Nonstructural adaptation strategies include identifying areas of risk, pre-disaster planning and risk mitigation, developing post-disaster recovery strategies, implementing floodplain regulations and obtaining flood insurance, implementing land use regulations, and educating the public about the risk from natural hazards as well as flood-proofing homes through elevation and relocating homeowners to less vulnerable locations.

This talk will examine selected case studies of nonstructural adaptation strategies implemented in response to flood-related disasters in Mississippi and Louisiana, in Cedar Rapids, Iowa, and along the East Coast. It will summarize lessons learned and best practices for implementing selected strategies in vulnerable communities. The goal is to inform the policy and advocacy discussion about how best to help vulnerable communities adapt to climate change impacts.

A View from the Ground: Nonstructural Flood Protection and Every Day Life

Pamela Jenkins [1]

[1] University of New Orleans

In recent years, cascading storms and the Deepwater Horizon oil spill created ongoing conditions of vulnerability for Louisiana's coastal communities. These events (hurricanes and oil spills) brought the spotlight to an area that had over the years experienced acute and chronic weather events.

This presentation will present a new study documenting and presenting the views of community people in the parishes most at risk – views that have rarely been captured anywhere else, including their views on current policy proposals. With nonstructural issues identified as a major focus of the 2017 iteration of the Louisiana Coastal Master Plan, there is an opportunity to further delineate these issues and recommend policy changes over the next two years. The three parishes (Terrebonne, Lafourche, and Plaquemines) are at the epicenter of coastal land loss and other critical changes in the environment. How residents understand and respond to the challenges of sea level rise and climate change will provide possible strategies and recommendations for local and state policy choices.

The research developed case studies involving residents in three Louisiana coastal parishes utilizing a series of semi-structured interviews with key stakeholders, including a number of current and former grantees of Oxfam America, and a number of additional local government, tribal, business, nonprofit and other leaders. There were 17 interviews, including people from all of the organizations and their contacts. Some of those interviewed live in raised homes. All of those interviewed are lifelong residents of the area. They represent Cajun, African-American, Native American and other Anglo residents. The report also includes notes from observations of two community meetings in Plaquemines parishes.

Nonstructural Flood Protection: Recommendations from Coastal Communities Coalition

Rev. Tyronne Edwards [1]

[1] Zion Travelers Cooperative Center

This presentation will include a summary of policy recommendations and discussion of upcoming campaign activities by member of the Coastal Community Coalition and allies to support inclusive and robust nonstructural flood protection efforts in response to recent research and continuing challenges. This will include a presentation on recommendations surrounding state and federal financing options, improving community engagement and education, promoting quality elevations and partnerships with industry and developing neighborhood based approaches to the most challenging nonstructural issues.

Additionally, the presentation will discuss upcoming educational efforts to highlight the importance of nonstructural flood protection efforts within the 2017 Coastal Master Plan and beyond to key decision-makers by members of the Coastal Community Coalition.

Storm Surge Forecasting and Resilient Communities

Hurricane Storm Surge Forecasting Along the Northern Gulf of Mexico

Matthew Bilskie [1], Scott Hagen [1,2], and Stephen Medeiros [3]

[1] Civil and Environmental Engineering, LSU, [2]Center for Computation & Technology, LSU, [3]Civil, Environmental & Construction Engineering, University of Central Florida

In the past decade numerous hurricanes have attacked the US Gulf Coast and caused pronounced social, economic, and ecological loss. Recent advancements in data monitoring and collection, computing technology, and first-hand experience have led to the development of more accurate and efficient physics-based storm surge models. These high-resolution, research grade models are now being used in scientific studies of relative sea level rise and climate change. In this work, novel terrain analysis techniques are employed to develop intelligent, stable, and semi-automated mesh de-refinement methods to optimize the research grade tide and surge models for use in a forecasting framework. A vertical feature extraction based protocol is applied to optimize flood plain descriptions of Louisiana, Mississippi, Alabama, and the Florida Panhandle coast, while retaining water surface elevation results to within 10% of the research grade model. At the same time, surface characteristics of bottom roughness, wind reduction due to vegetative structures and canopy, are being enhanced through lidar-based techniques. The resulting forecast model for the northern Gulf of Mexico (NGOM) region will be applied to the ADCIRC Storm Surge Guidance System to provide real-time hazard guidance with emphasis on accurate estimation of the timing and magnitude of peak water levels. Before deployment, the model is subjected to a rigorous validation of historical storms with focus on accurate computation of high water marks and inundation extent. A major product of this work will be robust, high-fidelity, and computationally efficient tide and storm surge models for the NGOM coast for the accurate and timely simulation of tides, surges and related processes, all of which can lead to enhanced coastal resilience.

CERA – An INTERACTIVE ADCIRC STORM SURGE and WAVE VISUALIZATION FRAMEWORK

Carola Kaiser [1], Robert Twilley [1,2]

[1] Louisiana State University, [2] Louisiana Sea Grant College Program

One of the key components of a successful tide and surge model is the delivery of the forecasting results to the end-user in a fast and easy-to-understand way. Emergency managers, weather forecasters, and GIS specialists seek visualizations and geographic data to evaluate the impact of an impending or active tropical storm or to visualize the tide, wind-wave, and extra-tropical surge conditions.

The interactive website CERA (Coastal Emergency Risks Assessment, see http://coastalemergency.org) has proved to be a successful and efficient tool for the presentation of ADCIRC model results. CERA has been designed to be an intuitive-to-understand tool for the scientific community, emergency managers, and decision makers. The CERA web application uses a general language, non-ambiguous terms, and an intuitive interface to serve those requirements. On the other hand, CERA also provides in-depth information for experienced users such as modelers, meteorologists, or oceanographers. The CERA website is the user-facing endpoint of a fully automated, stable, reliable, and robust workflow implementing an effective post-processing system which generates the data visualization directly from

ADCIRC. Additionally, the CERA visualization system overlays the simulation results with consolidated real-time data which is automatically collected from various agencies.

This presentation will show the existing CERA technology with examples from several storm runs (Katrina 2005, Irene 2011, Isaac 2012). We will demonstrate the importance of accurate input data like the bathymetry and elevation from the ADCIRC meshes and the improvements that have been made over the past years. We will provide examples to define additional information that proved to be useful for emergency managers during active storms. We will also explain how the Advanced Surge Guidance System (ASGS) can be effectively used in operational mode to provide forecasting results in real-time.

Session Block IX, 11:00 – 12:30 p.m.

Developing Partnerships for Resilience

Regional Resiliency

Robin Barnes [1]

[1]GNO Inc.

In the aftermath of extreme and unprecedented weather related disasters across the country, the U.S. Department of Housing and Urban Development (HUD) created the National Disaster Resilience Competition (NDRC) in 2015 to provide up to $1 billion in funding for 67 states and communities to build more resilient systems for future protection. As one of the top contenders for NRDC funding, four Louisiana entities have progressed through the two phases of this competition and now have robust applications centered around water management and coastal restoration in consideration for these funds. These four applicants include: the state of Louisiana, Orleans Parish, Jefferson Parish and St. Tammany Parish.

As the economic development agency for the ten parish Greater New Orleans region, building and advocating for resiliency is undoubtedly a critical element of Greater New Orleans, Inc. (GNO, Inc.'s) work—it is only through embracing proactive stances on water management, flood protection and corollary systems that the industries and workforce of the region can grow and prosper with confidence. Under this premise, GNO, Inc. worked closely with the four Louisiana applicants—the state, Orleans, Jefferson and St. Tammany Parishes—to provide a consistent regional resiliency narrative throughout all four applications.

This panel will explore how the four applications worked together to integrate mutual themes of resiliency throughout the four proposals, create best practices in regional coordination, and continue to develop pathways for ongoing coordination for resiliency in Southeast Louisiana. Additionally, this panel will include an overview of the winning applications and a funding/project status from each. As HUD will be making final award determinations by March of 2016, awardees will have a clear understanding of their work plans by the State of the Coast Conference, providing panel participants with an idea of resilient initiatives to come.

Developing Resilience and Protection Strategies for Coastal Decision-Makers

Traci Birch [1] and Jeff Carney [1]

[1] Louisiana State University, Coastal Sustainability Studio

Coastal Louisiana is vulnerable to both sudden and long-term hazard impacts that put homes, businesses, communities, and infrastructure at risk. In response, the State developed the *Comprehensive Master Plan for a Sustainable Coast* which calls for a range of protection and restoration measures to reduce flood risk and strengthen coastal systems. While the plan has robust recommendations for ecosystem restoration, there is an identified need for detailed frameworks and implementation

strategies that enhance community resilience (CPRA 2015). This presentation focuses on efforts by the Louisiana State University (LSU) Coastal Sustainability Studio (CSS) to fill this gap by creating development decision support materials and outreach tools for local governments in support of the Master Plan's recommendations. LSU CSS is a trans-disciplinary organization that focuses on research, design, and outreach that raises awareness of the dynamic Louisiana environment and the need for community resilience and ecosystem restoration.

This project builds upon the Louisiana Resiliency Assistance Program (LRAP), a CSS program that supports community resilience through education and communication of regional and national best practices. In particular, the work focuses on increasing coordination between land-use planning, hazard mitigation planning, and implementation of the Master Plan; and creating platforms for collaboration and community resilience action. This presentation will highlight 2 aspects of the project: 1) the production of infographics and graphic case studies for use by planners and citizens that illustrate development, planning, implementation, and monitoring of local resilience projects; and 2) an intensive workshop that brought elected officials and design professionals together to conceptualize resilient responses to specific community development issues. We will discuss internal successes and challenges in producing simple communication tools that convey complex processes, external challenges such as stakeholder fatigue and toolkit overload, and how these efforts dovetail with other planning and outreach efforts.

Resilience Actions for Small and Medium Coastal Louisiana Businesses in Light of Environmental Changes

[1] Alessandra Jerolleman, PhD, MPA, CFM

[1]Lowlander Center

In 2011 Entergy Corporation sponsored a detailed study that examined the likely infrastructure damage that the Gulf of Mexico communities would experience from future storms and environmental changes including in light of expected population and infrastructure growth. Following the release of the report, a series of meetings were held coast wide to bring community leaders together to talk about the future and the ways in which the region might come together to address these risks. Currently a new effort is being undertaken to share the same report with other community stakeholders in Louisiana who were not initially participants for additional benefit to the coast's resilience. This effort is focused upon small/middle sized businesses who are frequently not at the forefront of consideration when community resilience is considered. This paper will report on the first 6-month phase of reaching out to small/medium size businesses and the non profit, for profit and government agencies who work with them to learn about the businesses' awareness of the coastal storm risk, their concerns, resilience resource needs as identified by the businesses and their partner stakeholders and to create an actionable resilience plan with them that will be addressed in the second part of the project. The organization that is implementing the project with Entergy is the Lowlander Center.

2017 Coastal Master Plan II

2017 Coastal Master Plan Storm Surge and Wave Modeling Improvements and Preliminary Analysis

Hugh Roberts [1], Zach Cobell [1]

[1] Arcadis

In support of Louisiana's 2017 Coastal Master Plan, storm surge and wave models have been developed to evaluate coastal flood hazards along Louisiana's coast for a range of possible near- and long-term project implementation and environmental and risk scenarios. Model outputs define flood hazards for various possible hurricanes and tropical storms and are used to inform the Coastal Louisiana Risk Assessment (CLARA) model to evaluate flood risk throughout the coastal zone. This presentation will provide an overview of the ADvanced CIRCulation (ADCIRC) and Simulating Waves Nearshore (SWAN) models, model improvements since the 2012 Coastal Master Plan, and model results available for the ongoing development of the 2017 Coastal Master Plan. The model overview includes a description of the linkages with both CLARA and the Integrated Compartment Model (ICM), both of which are discussed in more detail as part of the session. The ICM is an integrated landscape and ecosystem model, which in this context is used to define storm surge and wave model elevations and frictional parameters based on projected land and vegetation type changes.

An Updated Coastal Louisiana Risk Assessment (CLARA) Model to Estimate Flood Depths, Damage, and Risk Reduction Project Benefits

Jordan Fischbach [1], David Johnson [2], and Kenneth Kuhn [1]

[1] RAND Corporation, [2] Purdue University

The Coastal Louisiana Risk Assessment (CLARA) model is a quantitative simulation model of coastal flood risk developed by researchers at the RAND Corporation and Purdue University. CLARA was originally developed to support long-term, scenario-based analysis and coastal master planning in Louisiana. The modeling team recently made a series of augments and improvements to better support the development of Louisiana's 2017 Coastal Master Plan. This oral presentation provides an overview of the CLARA flood depth and damage risk assessment approach. It also describes key improvements made to create CLARA v2.0, including:

1. expanding the model domain to account for a growing floodplain;
2. creating a high resolution spatial unit designed to inform local planning in coastal communities;
3. updating and improving the inventory of coastal assets at risk;
4. developing new scenarios of levee fragility to capture the range of uncertainty; and
5. incorporating parametric uncertainty into estimates of flood depths and damage.

This session will describe the model structure and methods, and will present initial simulation results from the analysis supporting Louisiana's 2017 Coastal Master Plan. Results will include updated descriptions of flood depth and damage in plausible future without action scenarios, as well as example risk reduction project benefits—expressed in terms of a reduction in expected annual damage—for

selected areas of the coast. Plausible damage reduction benefits from high-performing nonstructural risk reduction projects, such as home elevations, will also be discussed.

Using Model Outputs to Inform the Development of the Master Plan

Denise Reed [1], Eric White [1], Mandy Green [2], Karim Belhadjali [2], Melanie Saucier [2], Ehab Meselhe[1], David Groves [3]

[1]The Water Institute of the Gulf, [2]Coastal Protection and Restoration Authority, [3]RAND

The development of Louisiana's 2017 Coastal Master Plan uses outputs from coastal systems models and combines them in ways that help evaluate individual projects and groups of projects against the plan objectives. The modeling results are used in concert with project costs and assumptions about the availability of key resources, such as sediment, to identify the projects that best meet the State's need for a sustainable coastal landscape and communities that are resilient in the face of storm surge flooding. Model outputs are compared to the Future Without Action (FWOA) and restoration project effects are estimated using the models at 5-year intervals during the 50-year planning horizon. For protection projects, expected annual damages are estimated and compared to FWOA. The net amount of land maintained or created by a project is used as the key decision driver. 'Sustainability' is assessed by examining the trajectory of the land change curve at the end of the planning period, e.g., is the project continuing to result in a net increase in land area or are its effects diminishing over time. This is especially important considering the effects of eustatic sea-level rise are greater in later planning decades. In addition to direct model outputs - such as relative biomass of key fishery species, suitability of habitat for select wildlife, and the flooding of historic properties - several additional 'metrics' are calculated enabling decision-makers to examine trade-offs among both ecosystem and socio-economic outcomes. For example, patterns of land loss/gain and sedimentation and velocity patterns in channels are combined to assess the degree of support a project provides for the navigation industry. Salinities in areas where rice and sugar cane, for example, are currently important crops and the extent of asset damages in agricultural communities are combined to estimate future support for agricultural communities of coastal Louisiana. The final development of the 2017 Coastal Master Plan will include extensive stakeholder engagement as well as analysis of model results, but the models play a crucial role in providing an 'even playing field' for the evaluation of hundreds of restoration and protection options and ultimately guide billions of dollars of coastal investments.

Structural Risk Reduction II

Using Engineering Logic in a Non-Traditional Format for Evaluating Shear Strength Gain

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Traditional geotechnical investigations gather existing information such as geological background and available soil data to develop a subsurface exploration prior to performing geotechnical analyses.

This proposed technique utilizes existing soil data and geotechnical analyses prior to selecting a subsurface investigation program. Engineering analyses and logic may be applied to the existing information such that the subsurface investigation only targets areas where additional data is necessary. This methodology was implemented on Hurricane and Storm Damage Risk Reduction System (HSDRRS) Levee Lifts Prior to Armoring project.

Construction of HSDRRS provided a detailed geologic and geotechnical baseline. The Levee Lift Prior to Armoring Project was evaluated using this detailed baseline data not considering shear strength gain. Since levees are designed by a “weak” soil reach section, engineering logic considering “weak” and “strong” sections was used to screen the need for further investigation (namely, whether consideration of shear strength gain was necessary for the proposed section). Pending the engineering slope stability analyses, the engineering logic would result in one of three outcomes: 1) the proposed section met slope stability requirements with previous shear strengths from the detailed baseline, 2) further field investigation was necessary at the “weak” section, or 3) further field investigation was necessary at both the “weak” and “strong” sections. Once locations were determined by soils reach, shear strength gain was evaluated by Piezocone Testing (CPT) at the screened location. The direct tip resistance gain following consolidation settlement was determined comparing new CPTs to the original CPTs. The new shear strength information was then applied to the slope stability models to confirm the proposed levee lift sections.

In lieu of traditional soil borings/CPTs to investigate and then analyze, this method used detailed engineering and logic to select the subsurface investigation, which led directly to only exploring necessary areas.

Geotechnical Design Adaptations

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Sea level rise, climate change and other phenomena have demonstrated the necessity for adaptations to our design methodologies and life-cycle oversight of critical hazard mitigation infrastructure (CHMI) systems along coastal Louisiana. Foundation soils require site-specific characterization because of the potential impact to CHMI systems. CHMI systems require the foundation soils to provide resistance against large lateral forces (e.g., floodgate closure structures and floodwalls resisting storm surges). We, as engineers, commonly design CHMI foundations using geotechnical data in conjunction with the conventional "safety factor" approach. The safety factor approach is the engineer's all-encompassing correction for the various unknowns that exist within the foundation soils. However, this design approach may be improved upon for structures supported by soils that weaken under repeated loading (e.g., soils subjected to large disturbances during cycles of storm surge loading and unloading). Resiliency is the best measurement of how well a CHMI system will perform throughout the design life-cycle when the system is subject to evolving challenges. The resiliency of a system is performance-based and requires our understanding of the foundation soils over time, not just at the time of the original exploration. Significant advances have been made in geotechnical instrumentation monitoring with the ability to obtain "real-time" measurements of soil response during and after loading events which allows for improved understanding at a particular site and calibration of a predictive model. The use of real-time field measurements in conjunction with state-of-the-art soil-structure-interaction (SSI) predictive modeling provides a platform for making necessary adaptations to the CHMI system throughout its design life.

In this paper we propose adaptations to conventional design procedures in order to integrate the concept of resilience into the geotechnical engineering designs of coastal infrastructure. We present a case-study as an example for necessary actions before and after implementation of a CHMI system.

Louisiana Flood Protection Design Guidelines

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The Louisiana Flood Protection Design Guidelines (LFPDG) were developed by CPRA to support the 2012 Coastal Master Plan. As part of CPRA's mandate, the Authority has oversight over all matters relating to the study, planning, engineering, design, construction, extension, improvement, repair, and regulation of integrated coastal protection projects and programs, including hurricane protection, flood control, and storm damage reduction, and is authorized to develop guidelines for cost-sharing agreements with public and private entities participating in approved integrated coastal protection projects.

Hurricanes Katrina and Rita caused tremendous loss of life and destruction of property when they struck Coastal Louisiana in 2005. As a result, The Hurricane and Storm Damage Risk Reduction System Design Guidelines (HSDRRSDG) were published in 2007 (updated June 14, 2012) by the U.S. Army Corps of Engineers (USACE). HSDRRSDG has been the main design and construction resource for Coastal Louisiana flood protection projects. Major projects in the region have been designed and constructed using HSDRRSDG to reduce flood risk from a 100-year flood event. The LFPDG have been drafted to accommodate CPRA and State of Louisiana Projects based on lessons learned and experience gained from Louisiana projects by various non-federal sponsors and engineering consultants. Looking forward,

CPRA anticipates receiving significant funding to continue establishing and enhancing flood protection systems across the Louisiana Coastal Zone. Where practical, CPRA prefers to have local levee and flood entities oversee and perform the work. The LFPDG will serve as the minimum standard consistent with sound engineering practices for those engaged in designing or constructing flood protection projects and systems where state funding is utilized.

CPRA will continue to improve and update these guidelines as new information is discovered and as design techniques evolve.

Louisiana Coastal Area Mississippi River Hydrodynamic Study

LCA Mississippi Hydrodynamic Study Data Collection: Discharge Controls on Sediment Dynamics in the Lower Mississippi River

Mead Allison [1,2], Thad Pratt [3], and **Brian Vosburg** [4]

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Field data collection in the lower Mississippi River between Vicksburg and Head of Passes was conducted in 2012-2015 in support of model development to examine proposed sediment diversions for (1) capture efficiency at various locations, and (2) their impact on river morphology. This presentation will focus on two longitudinal surveys at low discharge in September-October 2012 and high discharge in May 2013, as well as studies of salt wedge dynamics conducted in 2012-2015. In the low discharge longitudinal survey where stations were occupied following the velocity of a single water mass, depth and cross-sectionally averaged suspended sediment concentrations declined from 302 to 7 mg/l (19.2 to 0.2 x 10^4 tons/d) downriver. Unit stream power and Rouse parameter calculations show that this decline, and a concomitant decline in suspended grain size, was a function of declining water column velocities in this inertially driven reach. In the high discharge study, stream power loss associated with the Old River Control diversion of water to the Atchafalaya was responsible for a 35% loss in suspended sediment from 90 x 10^4 tons/d. Below Old River, sediment loads increase slightly despite a reduction in stream power during this more slope-driven discharge, possibly because of the progressive downstream fining of the bottom sediment (bar sand) source. Studies of the salt wedge section of the river channel, including placement of bottom instrumentation below the wedge for months and installation of a monitoring station immediately above Head of Passes, show that wedge position and thickness is primarily controlled by river discharge, but is significantly impacted by meteorological and astronomical tides. Salt wedge processes also influence the timing and magnitude of nitrate supplied to the continental shelf. In situ camera studies indicate the importance of flocculation on the seasonal bottom storage of riverine particulates versus their advection offshore.

River Morphology Modeling

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A significant component of the LCA Mississippi River Hydrodynamic Study involved the development and utilization of a variety of modeling tools to understand river morphology and hydrology. Modeling included both one dimensional and multi-dimensional modeling focused in the river channel to determine effects of a future without action scenario and various restoration project scenarios. The Study used an ensemble model approach and although each model is similar in some aspects, each was utilized for a specific purpose. An one-dimensional model (HEC-6T) with a domain from Vicksburg, Mississippi to the Gulf of Mexico was utilized for long term (up to 50 years) simulations. A regional two dimensional model (ADH/SEDLIB) with a domain from The Old River Control Structure to the Gulf was utilized to investigate two dimensional behavior for short term simulations. A regional Delft 3-D model

with a domain from the Bonnet Carre Spillway to the Head of Passes was utilized to investigate three-dimensional behavior for short term simulations. Finally, several site specific Delft 3D models were developed to understand local sediment dynamics. Key findings of each of the modeling type will be discussed.

Lowermost Mississippi River Management: Technical Investigation Program

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The Lowermost Mississippi River Management Program (LMRMP) is included in the Gulf Coast Ecosystem Restoration Council's Approved Initial Funded Priorities List, with funding provided by the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf coast States (RESTORE) Act. Phase 1 of the LMRMP is the Technical Investigation Program (TIP), a partnership between the CPRA and USACE which will continue to refine our understanding of Mississippi River physical processes to improve navigation, reduce flood risk, and maximize river-based restoration benefits. It will further develop the science needed to adequately inform decision makers on future lowermost Mississippi River management issues.

The TIP will perform a full and objective assessment of the current management scheme for the Lowermost Mississippi River, including both the benefits and unintended adverse impacts to the surrounding coastal environments. It will evaluate alternatives to the current management scheme which would meet the aforementioned goal, as well as maintaining the current management scheme, within a range of predicted futures based on climate change, sea level rise and subsidence. This program will not include updating existing or developing new environmental compliance documentation associated with Mississippi river management activities.

The program includes five technical elements: 1) Extended applications of the Mississippi River Hydrodynamic Modeling Tools; 2) Subsidence Investigations; 3) The Impacts of Coastal Features on Storm Surge; 4) Genesis, Stability and Fate of Subaqueous Lateral Bars; and 5) Dredged Material Management. Research teams from CPRA, the Water Institute of the Gulf (WI), the USACE Engineering and Research Development Center (ERDC) and the USACE Mississippi Valley Division (MVD) and New Orleans District (MVN) are collaborating to develop and execute detailed Scopes of Work for these elements. A program management element executed by CPRA and MVN will organize and lead the technology transfer and stakeholder/public engagement components of the program.

Responses to a Risky Landscape

Native American Monumentality and Cultural Resilience in Coastal Louisiana: Case Studies from the Ellesly Mound

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Resilience is the ability of complex systems to adapt to change in the wake of disturbance. In deltaic systems, resilience is complicated by disturbances on many timescales, from seasonal river flooding to episodic severe storm inundation. Here, we use a multidisciplinary approach, combining established geologic and archaeological methods to assess the resilience of pre-historic native people of coastal Louisiana. LIDAR, borehole data, and optically stimulated luminescence (OSL) ages are used to reconstruct natural land evolution and anthropogenic monument building at Ellesly Mound, an earthen monument located along Bayou Lafourche, a Mississippi Delta distributary. These data show that Ellesly Mound is situated above naturally-deposited crevasse sediments underlain by organic-rich facies indicating a relatively low-lying vegetated environment, and then a succession of emergent delta facies. This suggests prehistoric native communities waited until land was suitably stabilized and elevated by natural delta processes before constructing major earthen monuments, implying that prehistoric Gulf Coast societies evaluated landforms before developing infrastructure, like earthen and shell monuments, on them. We observe this as a sign of resilience, given that many of the monumental sites remain occupied for hundreds of years. Further, the Ellesly site features a complex history of occupation, with the land being repurposed as a plantation, farmland, and ultimately supporting modern community infrastructure (a hardware store that supplies mainly fishermen). The reoccupation of the Ellesly site spans cultures and generations, and underscores the well-known fact that high-elevation land in the delta is both valuable and somewhat rare. This observation has implications for modern society; in particular, the challenges of persisting in acoastal region that is rapidly subsiding and eroding into the Gulf of Mexico. We hope to raise awareness of the spatial limits of our usable coastal land, while also adding awareness about valuable archaeological sites that are also being lost to coastal inundation.

Assessing Trends Since the 1950's Till Present in Development of Coastal Infrastructure, Ecosystem Function and Indices of Societal Wellbeing in Coastal Louisiana

Scott Hemmerling, Tim Carruthers

The Water Institute of the Gulf

Louisiana's coastal zone is a highly productive, dynamic ecosystem with a long history of supporting equally dynamic and resilient human communities. Over the last half century, the development of the oil and gas industry in coastal Louisiana has had profound impacts on both coastal communities and coastal ecosystems. At the same time, the region has been a hotspot of environmental change. High subsidence rates and associated relative sea level rise, major hurricanes, and coastal land loss make coastal Louisiana an ideal location to gain unique insights into the sustainability of the oil and gas industry and trends in coastal infrastructure, community economic and social wellbeing, and ecosystem function. This presentation will discuss current research at the Water Institute of the Gulf that examines

the historical and contemporary linkages between oil and gas development, coastal communities, and the suitability of coastal ecosystems to provide valuable ecosystem services, including commercial and recreational fishing, hunting, and subsistence food provision. Drawing on methodologies from the natural and social sciences, this research combines data on the evolution of the oil and gas industry and its infrastructures, demographic analysis, and ecological transformations in coastal Louisiana to identify trends in these various social, infrastructural, and ecological entities in order to foster recommendations on how to plan for the sustainability and resilience of social and ecological systems in the Gulf Coast. While it's unique social, economic, and environmental circumstances make coastal Louisiana an ideal location to examine trends in coastal infrastructure, societal wellbeing and ecosystem function, the approach used here can be more broadly applied to other coastal areas that have experienced (or are anticipated to experience) industrial growth and development.

Inhabiting Risk: A Dual Framework for Insurable Alternatives in a Changing Environment

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Flood and wind damages to coastal communities result in increased costs of natural disasters at the local, state, and national scale. Development, by its nature, often accelerates risk as cities encroach on coasts; as coastal regions become more densely populated and expansive, collective risk of a developed area increases as well. Additionally, the tendency to maintain unsustainable building practice is exacerbated by established insurance procedures that have not evolved with societal knowledge and information. Therefore, this Dual Framework addresses issues facing the future of the National Flood Insurance Program and proposes an integration of risk data with incentivized individual and community design responses.

Developments to the information regarding hydrologic and meteorological conditions, land use distribution, and structural protection measures are continually evolving. However, in locations where urbanization trends, risk mitigation strategies, and coastal barriers are continually transforming, other factors must also be considered. Urban development patterns, population trends, emergency response, wetland ecologies, and coastal monitoring systems are also relevant.

For proportions of coastal communities that are experiencing population growth, incentivized design options begin to consider the shared risks of the wider populace. Cities with continual gain in demographics require stabilization of protection systems; individual property owners within these municipalities are offered the option to contribute to these reserves as an alternative to continually raising an individual structure. On site sewage and stormwater management practices are encouraged to reduce pressure on nearby drainage and pumping infrastructures. Design strategies that incorporate continual existing and potential future habitat migration are rewarded with reduced premiums to homebuyers. Design actions that reduce subsidence and maintain wetland ecosystems are especially encouraged. Following repeated flood events, unoccupied portions of neighborhoods and cities can be transformed through shared costs of the benefiting populace. Continually updated and technologically credible risk information is integrated with individual and community design responses to provide a Dual Framework Strategy contributing to an evolution in the National Flood Insurance Program.

Natural Coastal Infrastructure II

Implementation of EcoSystems Artificial Reef at Shark Island, Vermilion Bay

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Several of the shoreline areas experiencing coastal erosion in Louisiana have site conditions, primarily poor soil conditions, that preclude the use of traditional rock aggregate installations to protect against erosion. To address this issue, NRCS sponsored the The Non-Rock Alternatives to Shoreline Protection Demonstration Project (LA-16) at Shark Island in Vermilion Bay to explore alternative coastal protection technologies. The presentation describes the installation and performance of one of the alternatives tested: the *EcoSystems* Artificial Reef.

The *EcoSystems* solution consists of 500 linear feet of pile-mounted concrete disk units that form a barrier to wave energies that have contributed to shoreline erosion. The system addresses the lack of sturdy soils by mounting artificial concrete reef units on hollow fiberglass piles; thus, the reef does not rely on any bearing capacity from the soft soils. Since the system includes fiberglass piles and reinforcement, which eliminates corrosion that could occur with steel reinforcement, and piles of sufficient length to minimize settlement, maintenance requirements are expected to be minimal.

The crest of the structure was designed to correspond with the elevation of the 90th percentile wave height at each site. With this structure height, it is anticipated that for the design wave height the transmitted wave height through the structure will be 20-25% of the design wave height. The spacing between columns of units allows for smaller marine wildlife to move freely through the shoreline protection wall.
The presentation will discuss challenges during construction. The primary challenges have been accounting for continuous shoreline retreat and uncertainty regarding subsurface soil conditions.
The project includes monitoring the installation's performance. The primary monitoring parameter is planform land area behind the structure.
The presentation will include monitoring results and recommendations for future coastal protection installations.

Evaluating the Effectiveness of Wetland Restoration on a Densely Vegetated Sand Berm Through RTK GPS and Terrestrial LiDAR Survey

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The state of Louisiana has been suffering from severe wetland loss that accounts for around eighty percent of the nation. Wetland restorations are effective and widely used engineering approach to prevent future land loss. However, due to lack of scientific guidance based on quantitative assessment and insufficient knowledge about coastal land and hydrodynamics, many wetland restoration projects

are often experimental with different construction materials and may result in non-sustainable protection and expensive site nourishment. Field based assessment of wetland restoration projects usually involves measurements of sediment changes through labor intensive GPS survey or sparse cross section elevation profiles based on GPS, total station, or leveling instrument.

This research presents a 3-D evaluation method for wetland restoration based on fine scale morphological modeling of a densely vegetated sand berm through RTK GPS and terrestrial LiDAR survey. The sand berm was reconstructed in July 2014 with near ocean side covered half in sand bags and half in newly invented EcoShield mat. Based on the surveys in July 2014 and October 2015, this research will present fine scale 3-D morphological models of the sand berm and analysis of sediment erosion and accretion to evaluate the effectiveness of wetland restoration and the performance of both materials. The derived results can be used to detect areas with severe sediment erosion and indication of driven forces such as storm surge, rainfall, bank failure, subsidence, and landslide. In practical coastal wetland restoration, the findings will enhance knowledge of land dynamics and driven forces and provide engineering support of material preference, locations for sediment nourishment, existing issues occurred at the site, lessons learned in the projects, and government decision making.

Successes and Failures During 7 Years of Assessing Three Types of Bio-Engineered Oyster Reefs Used in Shoreline Erosion Control

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We assessed three types of bio-engineered structures over a 7-year period, Gabion Mats, A-Jacks, and ReefBlks. Oysters initially recruited to all three structure types with relatively good oyster populations by 2-years post construction. However, by 4-years post construction there was significant loss of oyster shell substrate (>50%) in some ReefBlks and a corresponding loss in reef development. Between the period of 4-7 years post construction there was wholesale reef failure of all ReefBlks due to shell loss (> 75%), while A-Jacks had good but skewed oyster population densities with 2.5 times greater oyster abundance on the leeward sides as opposed to windward (bay-facing) sides. During the same 4-7 year period, Gabion Mats showed a definitive correlation of denser oyster populations with tidal inundation time. Successful development of oyster reef was ranked as Gabion Mats (#1), A-Jacks (#2), and ReefBlks (#3-failed). Shoreline erosion abatement had the three bio-engineered structures ranked in the same order as for oyster reef development.

This is the longest running study of a living shoreline project in Louisiana. We develop a set of “Lessons Learned” from this CWPPRA/CPRA project to help as more living shoreline projects are being proposed and built. We describe the success and failures we observed by discussing how wind fetch (across an open bay) was a major influence, and how spatial and temporal oyster recruitment had an influence. We also discuss how oyster population size frequency distributions differed based on the physical setting of each bio-engineered structure, and how salinity and its associated bio-fouling organisms influenced the oyster shell budget within the ReefBlks. Hooked mussels, a major reef-fouling organism, is discussed as to how it could be detrimental to oyster long-term survival and reef development. Finally, we discuss the importance of proper structure alignment along the shoreline and the influence of depth placement of structures on the potential for success or failure of oyster reef development.

Coastal Infrastructure Risk Reduction Projects

Houma Navigation Complex (HNC)

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The HNC Lock Complex Project is a large-scale, long-term protection and restoration feature recommended for implementation in Louisiana's Comprehensive Master Plan for a Sustainable Coast (2012 State Master Plan) approved by the Louisiana State Legislature in May 2012. This complex was included in the Morganza to Gulf of Mexico project by the U.S. Army Corps of Engineers (USACE), whose Post Authorization Change (PAC) Report identifies that the complex will provide both environmental and storm surge protection benefits. This complex is also a key component of the Increase Atchafalaya Flow to Eastern Terrebonne project proposed to divert freshwater into the adjacent marshes in Terrebonne Basin. The HNC Lock Complex Project will consist of a lock, a floodgate, adjacent floodwalls, and other project features that will be constructed to a 1 percent annual exceedance probability elevation for a 100-year design life and will adhere to the HSDRRS design guidelines.

The surrounding marsh is suffering from land loss and salt water intrusion due to hydrologic alteration, sediment deprivation, subsidence, and storm surge impacts. The objective of the project is to construct a structure that will maintain and improve existing storm surge protection, prevent saltwater intrusion, and distribute freshwater within the Terrebonne Basin, all while maintaining navigation capabilities for the surrounding industry.

The Terrebonne Levee and Conservation District (TLCD) partnered with CPRA and procured an engineering consultant (CB&I) to begin permitting, planning, and design phase for the HNC Lock Complex. As part of the planning and design phases, the engineers will evaluate innovative approaches to the design and construction in an effort to reduce costs, shorten the construction duration, and minimize disruption to the navigation industry.

Feasibility and Design for the Increase Atchafalaya Flow to Terrebonne Diversion Project

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Freshwater and sediment in the Atchafalaya River, in southern Louisiana, are currently confined to the leveed river until released well south of Morgan City into the Atchafalaya Bay. Confinement of the river, in combination with high rates of subsidence and rising seas, has resulted in salt water intrusion and marsh degradation. The Increase Atchafalaya Flow to Terrebonne Project was proposed to utilize freshwater and sediment from the Atchafalaya River to build, sustain and maintain wetlands in the sediment-starved deltaic basin to the east of the river's levee. A key component of the project is a

15,000 cfs freshwater diversion intended to hydrologically influence 500,000 acres of wetlands, and slow the current wetland loss being experienced in the basin.

Moffatt & Nichol developed a Wetland Morphology Module (WMM) for the comparison of project alternatives. This WMM is used to model the long-term effects of each alternative on salinity propagation throughout the Terrebonne wetlands, as indicated by changes in vegetation, land cover and open water. The WMM is dynamically coupled with a 2D hydrodynamic model and is used to evaluate the evolution of marsh types over time (50 year) under the stressors of hydro-period and salinity on a high-resolution scale. In short; the WMM determines whether wetlands will survive, collapse or switch from one wetland type to another. Modeling to date predicts the project will remediate and offset increased saltwater intrusion and high subsidence rates which have significantly contributed to wetland loss in this Louisiana basin.

The 2D hydrodynamic model has been further refined and was subsequently used to inform the design of the diversion project. By the start of 2016 the feasibility phase for the project will be completed and the engineering and design phase will have begun.

Design and Construction of the Mississippi River Reintroduction into Bayou Lafourche Project

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The Mississippi River Reintroduction into Bayou Lafourche Project (BLP) is located in Ascension, Assumption, and Lafourche Parishes and consists of several phases. The primary goal of the BLP is to ensure safe drinking water for over 300,000 people living in Terrebonne, Lafourche, Assumption, and Ascension Parishes. The secondary benefit is the reduction of salinity in the Barataria Basin. These goals will be accomplished by dredging Bayou Lafourche to a grade and template sufficient to increase the channel capacity to 1,000 cubic feet per second. This projected flow rate currently exceeds the capacity of the existing pump station in Donaldsonville, LA, which is the sole source of fresh water to the bayou from the Mississippi River.

Design and construction are being administered by the Bayou Lafourche Freshwater District in cooperation with CPRA. The first phase of the project, completed in 2011, dredged 6.2 miles along the head of Bayou Lafourche. The second phase of the project is under construction and will dredge an additional 11 miles of the bayou. The third phase, currently in design, will replace the UPRR railroad crossing in Donaldsonville. Future phases in planning include additional dredging, a new salt water control structure, and construction of a new pump station.

The designs of the different phases include several collections of survey and geotechnical data, historic investigations, hydraulic modeling, highway and railroad bridge analyses, and ultimately an alternatives analysis in support of the construction template and methodology. Due to potential conflicts with private land ownership, a legal opinion was obtained from the Louisiana Attorney General and utilized to optimize the design of the channel capacity improvements. Construction of the first and second

phases includes construction of access ramps and bank protection, removal of vegetation and debris, demolition of private improvements, and dredging and disposal of bayou sediment.

Educational Innovations for Coastal Restoration in Louisiana

Louisiana Discovery, Integration and Application Program (LaDIA): Focus on Science Communication to Innovate Outreach of University Research to Coastal Communities

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Louisiana Sea Grant's Louisiana Discovery, Integration, and Application Program (LaDIA) expands the impact of research on coastal issues. The program supports scholars who want to share their discoveries with diverse audiences and apply their work to real world problems. By encouraging interdisciplinary efforts among research disciplines and strong links with coastal communities, the LaDIA Program connects the dots between science, communication, and coastal residents. In essence, the program provides a two-way conduit between university research results and community needs. Louisiana Sea Grant offers one-year fellowships to highly talented tenure-track faculty from institutions of higher education in Louisiana. Training received as part of the program helps support innovative solutions to the coastal challenges facing the Mississippi River Delta and coastal systems worldwide. The program welcomes faculty representing a range of academic disciplines—from environmental science and engineering, to design disciplines, to sociology, geography, and law. Led by national leaders in the fields of science communication and outreach, the LaDIA Fellows Program Retreats broaden fellows' knowledge of coastal concerns, hone fellows' communication skills, and expand their ability to address coastal challenges. Louisiana Sea Grant marine extension agents attending the retreats also provide perspective on how coastal issues affect communities. Networking with local leaders and site visits to coastal areas enhance fellows' understanding of the unique challenges involved. Through all of these activities, fellows gain access to state of the art research tools and networks. In 2015, LaDIA Fellows Program supported training for ten fellows from national experts in science communication and outreach, including COMPASS, and the Integration and Application Network-University of Maryland. A review of these skills and training capabilities will be presented with experience in how to prepare faculty to apply research results to coastal issues.

Unlocking the Educational Value of Louisiana Coastal Restoration: Development of Web-Based Active-Learning Modules for Undergraduate Education

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Water and coastal resources managers in Louisiana and the Gulf South region are expected to deal with intricate problems rooted within natural ecosystems with a multitude of interrelated processes. An appreciation of the natural variability of hydrologic processes, their impacts on the ecosystem, and the complex interaction between engineered projects and natural stressors, are mostly lacking in today's engineering and science curricula. The use of Coastal Louisiana as prime example of a coupled natural and human managed ecosystem as an educational vehicle provides a wealth of real-world problems and unique learning settings that the educational community needs to tap into.

This study describes the development of a set of web-based learning modules situated in the Chenier Plain in southwest Louisiana. The modules leverage the wealth of field data and model simulations generated as part of recent coastal restoration studies in the region. A set of six learning modules are described: (1) The Chenier Plain Ecosystem, (2) Regional water and salt budget in coastal ecosystems, (3) Feasibility and design analyses for a freshwater introduction restoration project, (4) Alternative analysis for a salinity control project within navigation constraints, (5) Hydrologic impacts on vegetation in coastal environments, and (6) Tradeoff assessment in using bioengineered oyster reef for coastal restoration. In each of these modules, students navigate through a highly engaging set of activities with data and modeling-based exercises. Students setup and develop hydrological models using a variety of modeling tools and techniques that are used in research and engineering practices. The modules include user support in the form of feedback and self-assessment mechanisms that are integrated within the online modules. The study also presents assessment results on the effectiveness of the modules from students' perspective and shares experiences in developing and implementing such modules and challenges encountered due to curricular and institutional constraints.

Watch the Delta Grow: Combining Scientific Research and Outreach Efforts Focused on the Wax Lake Delta to Create Science-Based Educational Programs

Leanna Heffner [1], Arash Karimpour [1], Qin J. Chen [1], and Robert Twilley [1]

[1] Louisiana State University

Deltas are among the most ecologically-rich, productive systems on the planet. They are also among the most heavily exploited systems and are deeply impacted by human activities. Though a majority of Louisiana residents live in or near the Mississippi River Delta, most are unaware of the dynamics of deltas and the implications of how we manage the delta and its resources. As the state grapples with the land loss crisis, the issues surrounding coastal restoration strategies and, in particular, sediment diversions as means to build wetlands, have been rife with controversy and misinformation.
Watch the Delta Grow is an initiative by Louisiana Sea Grant to create a public outreach program to increase awareness and understanding of delta dynamics, with a particular focus on the Wax Lake Delta, an emergent coastal delta fed by the Atchafalaya River. The initiative leverages current research funded by the National Science Foundation as a basis for building educational programs and outreach efforts. Preliminary efforts are focused on creating 1) an open-access website that features delta dynamics, and 2) classroom teaching modules for grades 4-8. The website, intended for a wide audience, provides an overview of the history, geology, hydrology, and ecology of Wax Lake Delta, as well as the insights the delta provides regarding the potential for sediment diversions to build land in coastal Louisiana. The website employs various levels of information, with basic material presented along with opportunities to "dig deeper". The website also serves as an interface to access scientific data collected from the Delta Observatory – a series of monitoring stations set up in Wax Lake Delta that provide real-time data on environmental conditions to researchers. The classroom modules build off the website, using specific features for students to interact with various modes of media to learn about the Wax Lake Delta, and to use the Observatory data sets to simultaneously build skills in analyzing and interpreting scientific data.

Session Block X, 2:00 – 3:30 p.m.

2017 Coastal Master Plan III

Decision Support for the 2017 Coastal Master Plan

David Groves [1]

[1] RAND Corporation

CPRA is using a decision support framework and tool to support the development of Louisiana's 2017 Coastal Master Plan. The CPRA Planning Tool combines information about hundreds of restoration and risk reduction projects with model estimates of current and future coastal conditions, with and without projects in place, to help CPRA compare projects and formulate the 2017 Coastal Master Plan. Specifically, the Planning Tool calculates the cost-effectiveness of each project across different scenarios using standardized restoration and risk metrics. It then presents interactive visualizations to help CPRA and coastal stakeholders compare projects based on their costs and effects on the coast. The Planning Tool also includes an optimization algorithm that estimates the best set of projects to implement over a 50-year time horizon that are consistent with specified funding amounts, sediment availability, and other user-specified constraints. Through iteration, CPRA will use the Planning Tool to formulate different alternatives based on different planning constraints and then compare the projects included and the aggregate effects on the coast, supported by the Planning Tool's interactive visualizations. In the end, this process will help CPRA and its stakeholders define the projects to include in the 2017 Coastal Master Plan.

This presentation will describe the CPRA Planning Tool and its use supporting the 2017 Coastal Master Plan. It will also provide a live demonstration of some of its key capabilities.

Alternative Formulation for the 2017 Coastal Master Plan

Karim Belhadjali [1], Mandy Green [1], Melanie Saucier [1], David Groves [2], Denise Reed [3]

[1] Coastal Protection and Restoration Authority, [2] RAND Corporation, The Water Institute of the Gulf

The first phase of the alternative formulation process will focus on identifying straightforward alternatives (i.e., groups of restoration and protection projects) that maximize Expected Annual Damage (EAD) reduction and land building under different environmental, risk, and funding scenarios. These alternatives will be evaluated by the systems models, and the results will be returned to the Planning Tool for comparison. Key items that will be addressed during this phase of alternative formulation include determining under which environmental, risk and funding scenarios landscape sustainability can be improved over fifty years, determining how much 50-year risk can be reduced under the same scenarios, and identifying projects that are selected regardless of the scenario. Performance of these alternatives with respect to land, EAD, and select other metrics (e.g., habitat, sustainability, etc.) will be compared to support discussions about which future outcomes are the most desirable (e.g., land building compared to sustainability or to habitat). In the second phase, alternative formulation will include additional performance constraints to achieve better outcomes with respect to the metrics

identified in the first phase. Key items that will be addressed during this phase include determining whether performance can be improved for select metrics without sacrificing land building and EAD reduction outcomes. The draft master plan will be defined based on these alternatives. The final phase of alternative formulation focuses on refining the draft master plan to formulate the final master plan. In this phase, projects may be specified to be included or excluded (hand-crafted elements) based on local knowledge, project synergies, project incompatibilities, etc. Deliberation with master plan advisory groups and coastal stakeholders throughout alternative formulation is a key element of the master plan framework and ensures that the draft and final master plans are the result of an iterative, transparent process.

Outreach and Engagement for Louisiana's Comprehensive Master Plan for a Sustainable Coast

Nick Speyrer [1], Melanie Saucier [2], Karim Belhadjali [2], Ashley Claro [2], Andrea Galinski [2], Jenny Kurz [2], Alyson Gaharan [1]

[1] Emergent Method, [2]Coastal Protection and Restoration Authority

Public support of, and participation in, the planning process is essential to effective coastal protection and restoration in Louisiana. Successful community outreach and engagement is based on the clear communication of information to a wide range of audiences from citizens to industry groups, academics, and nongovernmental organizations. While planning efforts are based on highly sophisticated technical analysis, they will not be achievable if the public is not a part of the plan development process and afforded a deeper understanding of the scientific analysis.

Louisiana's Coastal Master Plan is an example of a large-scale planning process that is founded on the practice of building long-term relationships and partnerships with coastal stakeholders. Stakeholders and community members are engaged throughout the process, have access to science and technical information as the analysis unfolds, and are provided a forum to discuss and debate the many complex stakeholder interests. These partnerships include a coastal stakeholder advisory group (Framework Development Team) as well as focus groups that represent coastal Louisiana’s communities, landowners, and commercial activities. The stakeholder outreach and engagement approach for the Plan is based upon the following four principles: scope, timing, fair hearing and access. Stakeholders and citizens are given opportunities to learn about and comment on the tools and processes that assist in creating the Plan and not just the finished plan itself.

While it is impossible for every stakeholder or citizen preference to be included, the master plan team is committed to ensuring that each idea will be considered and questions will be answered promptly. Additionally, the team is offering a variety of ways for stakeholders and citizens to learn about and participate in the master planning process, including small groups, web offerings, direct communication with local and state government, and public meetings.

Alluvial Borrow Pits

The Effects of Turbulence on Borrow Pit Infilling In Rivers

Brendan Yuill [1], Yushi Wang [1], Ehab Meselhe[1], Mead Allison [1,2]

[1] The Water Institute of the Gulf, [2] Tulane University

Little is known about how and to what extent suspended sediment contributes to borrow pit infilling in large, sandy low-slope rivers. While it is generally assumed that the increase in flow depth within the borrow pit leads to flow deceleration and promotes settling of sediment within the flow column, the manner in which this produces permanent sediment deposition within the borrow pit is not well constrained. A simple model of sediment deposition may be calculated from the reduced sediment transport capacity in the borrow pit, the horizontal flow velocities within the pit, and the distribution of sediment settling velocities. However, this model neglects the effect of turbulence generated by the topographic heterogeneity of the borrow pit morphology which may produce vertical velocities fluctuations that counter settling of sediment in flow. This turbulence would have the net effect of lengthening the spatial extent of sediment deposition along the bed which, depending on the length scale of the borrow pit and the downstream flow velocity, could reduce the amount of sediment deposition retained in the borrow pit able to contribute to infilling. In this study, we employ numerical modeling to investigate the relationship between turbulence and borrow pit sediment dynamics under a range of flow conditions. Relatively high resolution fields of predicted flow velocity and sediment transport are resolved along a longitudinal depth profile of a channel with a simple borrow pit imposed on the bed using the Delft3D and CFD modeling. We show how borrow pit geometry generates coherent turbulent structures that cause suspended sediment dynamics to deviate from that predicted by traditional morphodynamic tools such as the Rouse profile model. Study results provide insight on how to better predict borrow pit infilling after sand mining and how to direct dredging to create borrow pits that trap an optimal amount of suspended sediment.

Establishing Refill Rate Estimates for Borrow Sites within the Atchafalaya River through Morphodynamic Modeling

Dinesh Manian [1], Maarten Kluijver [1], and Rafael Canizares [1]

[1]Moffatt & Nichol, 529 Fifth Avenue 14th Floor, New York, NY 10017

The general objective of the Atchafalaya Long Distance Sediment Pipeline (ALDSP) study is to find suitable material for marsh restoration within the Terrebonne Marshes, hydraulically dredge the material and transport it by means of a pipeline to the marshes in need. To identify appropriate sediment resources within the Lower Atchafalaya River, a preliminary study was performed to determine and prioritize the location and size of candidate borrow sites. Subsequently, the performance of the selected borrow sites as a renewable resource for wetland restoration material was then examined. This presentation will focus on the performance analysis and assessment of refill rates for borrow-sites through numerical modeling.

As part of this analysis, a morphological model of the Lower Atchafalaya River inclusive of the selected borrow sites was developed and calibrated. The analysis of the infill rates would be based on multiple

realizations of potential future river discharge scenarios. However, the computational time required to perform 10-year morphological simulations of multiple river discharge scenarios was prohibitive for the project's schedule, and an alternative statistical method was introduced. A small number of 1-year simulations was performed to find correlations between the annual volume of infill, and other flow and sediment load characteristics for that year. A strong correlation was found between the annual sediment infill volume for the borrow site and the annual sand load. A series of constant discharge simulations were then performed to correlate the river discharge to suspended sand load. Using the resulting correlations estimates of the annual infill volume were obtained based on multiple realizations of the historical river discharge. The estimates for the mean annual infill volume and associated standard deviation were used to assess the project feasibility and project duration in relation to the total sediment demand for potential marsh restoration projects.

Evaluation of Sediment Extraction Options in Alluvial Rivers Used as a Resource for Land-Building

Ahmed Gaweesh [1]; Alex McCorquodale [1];Ehab Meselhe [2]; Joao Pereira [2]

[1] University of New Orleans, [2]The Water Institute

Coastal Louisiana is experiencing one of the highest rates of land-loss in the world, in the order of 40 km^2/yr. The Louisiana 2012 State Master Plan identified two viable mechanisms to build land: sediment diversions and dedicated dredging. A legitimate concern with the introduction of either sediment extraction option is to starve the system causing supply limitation which can negatively impact the sustainability of the Bird's-Foot Delta. The objective of this study is to investigate the change in dynamics of the river caused either by the introduction of sediment diversions or mechanical dredging. A three-dimensional morphodynamic model was parameterized and validated using historical and recent field observations in order to investigate the different sediment extraction alternatives. A 200 km reach of the river was modeled. A number of Diversion scenarios were tested in comparison to current and future conditions without diversions. The water discharge varied between 20% and 60% extraction of the maximum River flow. Dredge case scenarios were designed to remove same amount of sediment extracted from the river as in the diversion scenarios. The water discharge reaching the Bird's Foot Delta resulting from the diversion scenarios was reduced by 13% to 30%, while the sediment loads were reduced approximately by 40% to 60% for the moderate and large diversion options. In the case of dredging, an average of 3 to 5 years is required to fill in the dredge pits. The recovery period and the accompanied local and regional morphodynamic changes for either alternatives are analyzed and discussed.

Marsh Creation

Louisiana Coastal Area Beneficial Use of Dredged Material Implementation

Darrel Broussard [1], Daimia Jackson [1]

[1]USACE, New Orleans District

This presentation focuses on completed and proposed projects in the Mississippi River Delta funded thru the Louisiana Coastal Area Beneficial Use of Dredged Material (LCA BUDMAT) program. LCA BUDMAT was authorized at $100M for the beneficial use of dredged material removed during maintenance of Federal navigation channels in coastal Louisiana. The Program requires a non-federal cost share sponsor to share in the cost at 75%/25%. The first successful implementation of the program resulted in the construction of a 90-acre bird island in West Bay during 2015 maintenance of Southwest Pass, with a unique partnership with Plaquemines Parish. The program is intent on constructing a ridge feature north of Tiger Pass in 2016, partnering with Plaquemines Parish and the Coastal Protection and Restoration Authority of Louisiana. Lessons learned and aspects of the LCA BUDMAT process will be discussed.

Beneficial Use of Mississippi River Navigation Dredged Material

Brett McMann, P.E.[1], Paul Tschirky, Ph.D., P.Eng.[1] Mike Schulze [1], Ehab Mesehle, P.E., Ph.D.[2]

[1] ARCADIS U.S. Inc. [2] The Water Institute of the Gulf

In August of 2014, Plaquemines Parish Government, Louisiana entered into an agreement as local sponsor with the United States Army Corps of Engineers (USACE) to beneficially use material dredged from the Lower Mississippi River to restore wetlands and reduce land loss. The agreement is part of the Louisiana Coastal Area (LCA) Program and is for a 10-year period with an average of $10M per year for a total of $100M. The goal is to use dredged material from the federal navigation channel to create marsh and marsh features in the wetlands and bays adjacent to the Mississippi River to help restoration efforts.

Planning, engineering, design, hydrodynamic modelling, alternatives assessment, environmental assessment and construction for the first project has been completed in West Bay. The material placement objective was not merely to create wetlands but to develop a feature that would enhance the marsh and submerged aquatic vegetation (SAV) currently being created within the bay and the West Bay Diversion. Several disposal feature geometries were evaluated to optimize placement for enhanced outfall sedimentation of the West Bay Diversion through Delft3D modelling. Additionally, a cost/benefit analysis of not only direct acreage created, but also acreage anticipated to be created from the diversion enhancement were considered.

The second proposed project of the program is the beneficial use of dredged material in the vicinity of Spanish Pass. Alternatives being assessed include a forested ridge feature.

These activities represent the first beneficial use projects under the LCA program and aim to extend the beneficial use of navigation dredged material farther to the wetlands to placements areas that not only create marsh from the placement directly but help marsh restoration and retention in the surrounding

area. A multitude of lessons have been learned which will help facilitate the optimization of the BUDMAT program for future projects in the areas of transport analysis, contracting, design, and enhancement of diversion outfall areas.

Recent Construction of Ridge and Marsh Habitat under the CWPPRA Program

Kimberly Clements [1], Tye Fitzgerald, P.E.[2], and Matt Salmon, P.E.[3]

[1] NOAA, [2] CPRA, [3] AECOM

The Bayou Dupont (BA-48), Figure 1, and Grand Liard (BA-68), Figure 2, Marsh and Ridge Projects are coastal habitat restorations located on the west bank of the Mississippi River near Myrtle Grove and Buras, Louisiana, respectively. BA-48 consists of 331 acres of marsh restoration and 11,000 feet of Earthen Ridge. BA-68 consists of 432 acres of marsh restoration and 16,600 feet of Earthen Ridge. They are two of the first restoration efforts to design and build a ridge feature in coastal Louisiana, and to utilize multiple lift construction for marsh creation beginning at the design phase. This presentation will be a walkthrough of the challenges, and solutions, from design through construction.

The projects were planned and constructed with funding from the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) program. The National Oceanic and Atmospheric Administration (NOAA) led the planning and project management efforts as the Federal sponsor, while Louisiana Coastal Protection and Restoration Authority (CPRA) performed engineering and design, land rights services, and construction oversight as the state sponsored counterpart. The projects were designed to utilize local (i.e., in situ) material to restore the earthen ridge, and Mississippi River (BA-48) and offshore (BA-68) borrow material to build marsh platforms.

The design methodology for each project required the project team to overcome multiple challenges throughout planning and continuing into construction. Challenges include; project layout, deep gaps in proposed containment dikes, abandoned pipelines, oyster leases, access and land rights logistics, two lift marsh construction with large scale hydraulic dredging equipment, and lessons learned. Initial construction of both projects completed in Fall 2015. Layout of additional planning measures is underway to plant woody vegetation to implement another key restoration goal in 2017.

Natural Coastal Infrastructure III

Restoration of Whiskey Island, a.k.a. the NRDA Caillou Lake Headlands Project (TE-100)

Gregory Grandy [1], Michael Poff [1], Jon Staiger [1], Devyani Kar [2], and Jacques Boudreaux [2]

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[2]Louisiana Coastal Protection and Restoration Authority, Baton Rouge, Louisiana, USA

Whiskey Island is the middle island of the three extant remnants of Isle Derniere (Last Island), a once-inhabited Terrebonne Bay barrier island devastated by an 1856 hurricane. Stabilization and restoration of Whiskey Island was selected as the recommended first component for construction of the National Ecosystem Restoration Plan for the LCA Terrebonne Basin Barrier Shoreline Restoration project (TBBSR). The planning and alternatives evaluation described in the TBBSR Feasibility Study laid the foundation for the current Project.

The Project proposes to restore the beach, construct a dune, and construct a marsh platform. The beach/dune feature will complement the beach previously restored Gulf-ward of the mangrove wetlands on the eastern half of the island. The marsh feature will complement the marsh previously constructed between the existing mangrove wetlands on the eastern half of the island.

Restoration of the geomorphic and ecological form and function of Whiskey Island is considered a priority because Whiskey Island cannot roll back on itself in response to storm overwash. The tidal channel behind it has sufficient flow to prevent accumulation of overwashed sediment. As the island thins, both the two mangrove wetlands and restored marsh between them become more susceptible to storm damage and loss from erosion. To combat this, and avoid impacting the wetlands, necessitates a restoration design that enlarges the beach Gulf-ward, rather than over the existing uplands; requiring more sediment, but protecting critical habitats.

Complying with the National Environmental Policy Act (NEPA) was a significant undertaking for the Project. Given that the project will utilize federal sediment resources and funding for construction of the Project is being provided through the Deepwater Horizon Oil Spill Phase III Early Restoration Program, significant coordination was required to satisfy the NEPA requirements in obtaining permits, sand lease from BOEM, and Programmatic Environmental Impact Statement from the NRDA Trustees.

Successful Swamp Restoration at the Caernarvon Freshwater Diversion and on the Maurepas Land Bridge, Southeast Louisiana

Theryn Henkel [1], Eva Hillmann [1], Kristen Butcher [1], David Baker [1], John Lopez [1]

[1]Lake Pontchartrain Basin Foundation

Because of the new wetland growth, planting of native swamp trees in the outfall area of the Caernarvon Freshwater Diversion began in 2010. A swamp in this area would reduce storm surge risk to federal and local levees, benefit from the exposure to Mississippi River water and help stabilize a growing Caernarvon delta. Rampant nutria herbivory would make natural establishment difficult if nearby seed sources existed. Monitoring the trees for survival and growth rates began in 2012 and

continues to the present. By the end of the 2015/2016 winter planting season, approximately 17,000 trees will have been planted in the area, over 300 acres restored and four years of monitoring data collected. Through 2014, survival averaged 70% and diameter growth averaged over a centimeter per year. Because of success in the Caernarvon area, other areas amenable to swamp restoration were sought. The Maurepas land bridge was chosen as a new site to test lessons learned from the Caernarvon project. The land bridge is a critical landscape feature that reduces storm surge risk to nearby communities and east Baton Rouge. One hundred trees were test planted in 2013 and with success of those trees, 6,000 were planted in 2014. By the end of the 2015/2016 planting season we will have approximately 13,000 trees planted in the Maurepas area and two years of monitoring data. At all plantings baldcypress (*Taxodium distichum*) is the dominant species planted but water tupleo (*Nyssa aquatica*), blackgum (*Nyssa sylvatica*), red maple (*Acer rubrum*) and green ash (*Fraxinus pennsylvanica*) are planted as well. Over the years of planting and monitoring, many lessons have been learned on how to effectively restore swamp habitat. In addition, most of the trees are planted using volunteers and partners, making this project an effective community outreach tool.

The Role of Stream Restoration and Natural Channel Design in Gulf Coastal Restoration

Lee Forbes

SWCA Environmental Consultants

The water quality of coastal estuaries is greatly affected by the water quality of the upland rivers and streams that outfall to them. Along the gulf coast, these upland rivers and streams pass through flat, relic coastal plain uplands or ridges prior to entering the coastal estuaries. Generally, urbanized communities have developed along these rivers and streams are largely regulated by Phase I and II Municipal, Separated Storm Sewer Systems (MS4) programs of Section 402 of the Clean Water Act (CWA). These programs are dominated by efforts to reduce pollutants to surface waters via watershed Best Management Practices (BMPs) focused on non-riparian, upland stormwater controls. Further, surface water management efforts are necessarily focused on drainage, flood control, and water supply objectives. What has been largely missed in the regulatory, drainage, flood control, and water supply programs is the sustainable management of the myriad open channels that convey these watershed runoff to the coastal estuaries. The hydrologic changes in these watersheds from urbanization have caused widespread geomorphological and water quality degradation of the upland rivers and streams, including downcutting, channel bank erosion, and sedimentation. Recent studies have shown that these geomorphic stream/channel failures result in negative water quality impacts to the outfall estuaries in far greater quantities than the impacts of urban watershed runoff, which is the focus of current BMPs. This presentation attempts to bring to light the regulatory and functional necessity and benefits of the sustainable management of these riverine systems through the application of stream restoration and natural channel design (NCD) practices, and posits an approach to include such management practices in overall coastal restoration strategies.

Methods of Community Engagement

Visualizing Coastal Landscape Dynamics: an Overview of the LSU Coastal Sustainability Studio Visual Communication Program

Jeff Carney,[1] Jacob Mitchell, Karen May, Leanna Heffner, Keith Maung-Douglass, Sarah Schramm

[1]LSU Coastal Sustainability Studio

The complexity of the land loss crisis facing coastal Louisiana renders evident the need for effective communication surrounding protection and restoration projects proposed by the State. Often, restoration projects are highly technical and complex requiring sophisticated planning and tools to achieve success. The explanation of this process can seem overly complex and obscure to the general public, as specialized knowledge is needed to evaluate proposals.

While projects such a dredge based marsh creation are relatively easy to comprehend because they restore land directly with immediately visible results, this is not so with strategies that restore processes. The benefits of projects that restore hydrological connections and delta building processes are not necessarily immediately evident, making it more difficult to explain as the benefits of these projects are realized over the long term, and over vast areas, often not resulting in visible land for decades.

The ability to project into the future and visualize the effects and benefits of large-scale coastal infrastructure projects becomes an essential communication tool for public outreach and engagement. It is within this context that the State of Louisiana's protection and restoration master plan faces communication challenges surrounding its call for deltaic system restoring sediment diversions. To address this gap the LSU Coastal Sustainability Studio has developed a visualization program partnering with local and national NGO's and the CPRA to develop a variety of tools in anticipation of the upcoming 2017 Coastal Master Plan. This presentation will outline the components of this communication program, present examples of ongoing work, as well as examine techniques developed in service of this challenge. The discussion will focus on work pertaining to river diversions, describe approaches taken to explaining issues of scale in both time and space, and key takeaways in the evolution of this program. Challenges to visualizing landscape processes and change over time will be reviewed in depth.

Climate Change Adaptation: A Case Study of the Town of Jean Lafitte

Jeannette Dubinin [1]

[1] Center for Planning Excellence

Jean Lafitte has a long history of living with water. For centuries, residents in the Barataria Bay area have lived off of the water and adapted to the events associated with living in this natural ecosystem. Since the late 19th and early 20th centuries residents in the Jean Lafitte area have harvested shrimp, crabs, oysters and fish from the estuaries. They logged the forests, harvested moss for filling mattresses and furniture, and trapped mink, muskrats and alligators for their skin and fur. Along with a knowledge of how to make a living off of the natural resources, residents also gained knowledge of how to weather storms and to live in this constantly changing environment.

The Flood Emergency Preparedness Plan (FEPP) and Toolkit for Jean Lafitte build off historic knowledge and suggest tools and strategies to enable Jean Lafitte's residents to live in in harmony with an environment that continues to be threatened by natural and manmade events, and recommend building and landscape design guidelines.

Effective and continuous collaboration between state, local and federal agencies is critical to successfully reducing the risk of flooding and other natural disasters in the United States. No single agency has all the answers, but often multiple programs can be leveraged to provide a cohesive solution. The recommended projects and programs in the FEPP focus primarily on "nonstructural" solutions such as elevation, public education, and preservation of natural assets, but "structural" investments like levees are also included.

The FEPP and Toolkit leverage existing planning work at the state, parish, and municipal levels to situate such projects and programs within Jean Lafitte's unique risk profile. If Jean Lafitte is to survive as a community and thrive economically, the town must continue to pursue an approach to flood resiliency that allows it to "live with water."

Engaging Stakeholders through Design Research

Kari J. Smith [1] and JoAnne DeRouen [1]

[1]University of Louisiana at Lafayette

RESEARCH QUESTION: Groundwater overuse is a critical problem in the South, which is characterized by abundant rainfall and surface water. While many are experiencing severe groundwater shortages, surface water management efforts focus on shunting excess water to prevent flooding. The question becomes, can readily available surface water be used to augment groundwater in agricultural and aquaculture practices in southwestern Louisiana?

METHODS: Research was structured in a 3-credit architectural design course, studying the Chicot aquifer of southwest Louisiana and the associated Bayou Grand Marais watershed was used as a case study area. Design research explored transformative concepts that integrated the social and biophysical dimensions of water systems into a unified framework for improved management of surface water resources. Consideration was given to the balance between water demand for humans and ecosystem services. The course was supported by an expert research team including scientists in the fields of geochemistry, geology, environmental sociology, ecology, and Geographic Information Systems, and farmers in the LSU AgCenter Master Farmer Program.

FINDINGS: The approach to developing a new management paradigm for these surface water resources must be rooted in the concepts of systems analysis, resiliency, transformability, and adaptive management. Scientists and stakeholders provided recurring feedback allowing for improvements and refinements to student-driven designs that included the manipulation and use of existing waterways to supply surface water for irrigation, the revitalization of historic canals in places underutilized or fallow, promoting wildlife and new habitat creation in perpetually flooded low-lying areas, accessing bottomland hardwood forest to create reservoirs providing 600 acre feet of surface water for use in farming, and providing favorable conditions for agri- and eco-tourism industries.

CONCLUSION: The use of an expert research team, stakeholder involvement and student driven design research provided examples of practical ways to use surface water to augment the use of groundwater in agricultural and aquaculture practices.