# Louisiana Coastal Area
## Science & Technology Office


# Current Research Program
## October 2010

# Louisiana Coastal Area Science & Technology Office

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The coastal wetlands of Louisiana are among the Nation's most productive and important natural assets in terms of habitat, wildlife diversity, storm protection, port commerce, and oil and natural gas production. Unfortunately, Louisiana coastal wetlands account for 90 percent of the total coastal marsh loss occurring in the Nation. Hurricanes Katrina and Rita in 2005 accelerated the loss of Louisiana wetlands with deleterious effects on the ecosystem. The State of Louisiana and the U.S. Army Corps of Engineers established the Louisiana Coastal Area (LCA) Ecosystem Restoration Program to reverse the degradation trend of the Louisiana coastal ecosystem. The LCA Program emphasizes the use of restoration strategies towards achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana.

The LCA Program recognizes the importance of integrating the best available science and technology into restoration strategies. Consequently, the Science & Technology Office was established to ensure that integration into the design, construction and operation of LCA projects. The Science and Technology Office supports research efforts that address specific needs in ecosystem restoration project planning by:

- Providing the necessary science and technology to effectively address coastal ecosystem restoration needs
- Providing analytical tools and recommendations to reduce uncertainties
- Integrating the roles and resources of the scientific community and other coastal protection agencies and partners at the state, local and Federal level
- Providing internal and external technical review and a systematic approach for coordination with other ongoing and planned related research activities


# An Analysis of the Role of Coastal Landscape Features in Storm Surge and Wave Reduction

**Issue:** The loss of coastal wetlands in southern Louisiana has been a concern for several decades. Hurricanes Katrina and Rita exacerbated the loss through salt damage and physical erosion. Wetland and coastal features not only play an important role in the productivity and ecology of the area, but they also provide a natural protective buffer against damaging storm surges and waves. Restoration planning for south Louisiana requires the integration of wetland and coastal feature restoration with engineered solutions. In order to properly develop plans that fully address the ecology and storm damage reduction, more quantitative information is needed on how wetlands and coastal features provide storm surge and wave reduction benefits.

**Action:** This study will include:

- Performing numerical modeling experiments with ADCIRC and STWAVE.
- The development of a more complete understanding of the relationships between wetland frictional resistance, in the form of bottom friction, form drag and wind resistance, and storm surge and waves.
- The development of more information on the role of bathymetric and topographic change in storm surge and wave height reduction in the coastal zone.
- Collection of wave data in a wetland during a tropical event.

## Benefits:

- The experimental system will be used to test:
  - The effect of cross shore wetland extent (distance perpendicular to the surge).
  - The effect of wetland vegetation changes as parameterized by various roughness coefficients.
  - The effect of varying marsh platform elevations.
  - The effect of varying storm intensity.
- The development of draft design criteria that will guide the evaluation and construction of future coastal restoration efforts.

## Products:

- Influence of Marsh Restoration and Degradation on Storm Surge and Waves http://www.mvd.usace.army.mil/lcast/pdfs/chetn-i-77.pdf
- Idealized Marsh Simulations: Sensitivity to Hurricane Surge Elevation and Wave Height to Seabed Elevation http://www.mvd.usace.army.mil/lcast/pdfs/chetn-i-78.pdf
- Idealized Marsh Simulations: Sensitivity of Hurricane Surge Elevation and Wave Height to Bottom Friction http://www.mvd.usace.army.mil/lcast/pdfs/chetn-i-79.pdf
- Idealized Marsh Simulations: Sensitivity of Hurricane Surge Elevation and Wave Height to Marsh Continuity http://www.mvd.usace.army.mil/lcast/pdfs/chetn-i-80.pdf


# An Analysis of the Role of Coastal Landscape Features in Storm Surge and Wave Reduction

## Products Continued:

- Influence of Landscape Restoration and Degradation on Storm Surge and Waves in Southern Louisiana. 2009. *Journal of Natural Hazards,* 51, 1, 207-224. http://www.mvd.usace.army.mil/lcast/pdfs/storm%20surge%20natural%20hazards.pdf
- Sensitivity of Hurricane Surge to Morphological Parameters of Coastal Wetlands. 2009. *Estuarine, Coastal and Shelf Science*, 84, 4, 625-636. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WDV-4X087K8-1&_user=9107383&_coverDate=10%2F10%2F2009&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1545283099&_rerunOrigin=google&_acct=C000063448&_version=1&_urlVersion=0&_userid=9107383&md5=85cfc3c2b938657a4cdd1e35bb7a592a&searchtype=a
- The Potential of Wetlands in Reducing Storm Surge. 2010. *Ocean Engineering*, 37, 1, 59-68. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V4F-4X087R7-1&_user=9107383&_origUdi=B6WDV-4X087K8-1&_fmt=high&_coverDate=01%2F31%2F2010&_rdoc=1&_orig=article&_acct=C000063448&_version=1&_urlVersion=0&_userid=9107383&md5=262e1ba91fa473b3f400e01f035c1a60
- Technical Note and Journal Paper on wetland impacts on hurricane waves (in preparation)

## Results:

- Influence of Marsh Restoration and Degradation on Storm Surge and Waves
  - Different combinations of hurricane parameters may change the effects of landscape restoration/degradation on storm surge and waves in different ways.
  - Results indicate that coastal marsh does have surge and wave reduction potential.
  - Restoration and degradation of marsh resulted in decreases (for restoration cases) and Increases (for degradation cases) in both surge and waves for hurricanes of both moderate and severe intensity.
- Sensitivity of Hurricane Surge Elevation and Wave Height to Seabed Elevation
  - Due to the inverse relationship between storm surge and water depth, seabed lowering will generally result in reduced storm surge levels along the coast.
  - Throughout the marsh area, a three part effect is observed as the marsh depth is increased:
    - Wave setup is decreased along the boundaries of the marsh as wave breaking is reduced.
    - Surge gradient is decreased inversely with depth.


# An Analysis of the Role of Coastal Landscape Features in Storm Surge and Wave Reduction

## Results Continued:

- Friction is reduced and surge propagation is increase, causing the marsh to fill and drain more quickly.
- Elevation impacts are most noticeable with storms producing the lowest storm surge, with surge events of high potential being markedly less affected by seabed lowering.

♦ Sensitivity of Hurricane Surge Elevation and Wave Height to Bottom Friction
- Within an area of increased bottom friction, storm surge levels are reduced due to the slowing of surge propagation through the marsh.
- The increase in Manning's *n* from 0.020 to 0.035 results in a 15% reduction in surge at the coast and a 0.4 m reduction in peak wave heights, given a storm of low surge and wave potential.
- As surge potential increases, the sensitivity of storm surge levels to increased bottom friction decreases.

♦ Sensitivity of Hurricane Surge Elevation and Wave Height to Marsh Continuity
- Due to increased conveyance within a non-continuous marsh, surge is increased by as much as 70% along the coast for a storm of low surge potential. Accompanied with this increase is a decrease in peak surge in seaward portions of the marsh, a result of the distribution of surge waters within the marsh.
- A low continuity marsh results in the greatest conveyance of water, and therefore the most significant changes in peak surge levels.
- Peak wave heights are higher within the marsh channels, and locally decreased due to refraction around marsh segments.
- As surge and wave potential increases, the relative impact of marsh continuity diminishes.

♦ Influence of Landscape Restoration and Degradation on Storm Surge and Waves in Southern Louisiana
- Different combinations of hurricane parameters are expected to change the effects of landscape restoration/degradation on storm surge and waves in different ways.
- Coastal marsh does have surge and wave reduction potential.
- Magnitude of change in surge was greatest for storms with the greatest surge potential.
- In general, the wave change patterns are consistent with the water level changes.
- The impact of landscape features is amplified in areas where there are levee pockets, such as the funnel area between East Orleans and St. Bernard levees, and near Caernarvon where a pocket is formed by levees in Plaquemines and St. Bernard Parishes.


# An Analysis of the Role of Coastal Landscape Features in Storm Surge and Wave Reduction

## Results Continued:

- Barrier islands are important landscape features in reducing wave heights, and thus can reduce wave energy in wetland areas, protecting them from erosion.

♦ Sensitivity of Hurricane Surge to Morphological Parameters of Coastal Wetlands
- Marsh vegetation, elevation, and continuity have a definite and wide-ranging effect on peak surge levels.
- Increased bottom friction, due to marsh vegetation, decreases storm surge levels on the inland side of the marsh.
- Lowering of marsh elevation generally induces a decrease in surge level in the absence of vegetation.
- Segmentation of a marsh by channels results in increased surge levels for low to moderate surge potential events, but slightly decreases surge for high surge potential events.

♦ The Potential of Wetlands in Reducing Storm Surge
- Wetlands do have the potential to reduce surges dependent on the landscape (bathymetry, structures, and wetland characteristics) and storm characteristics (size, speed, track, and intensity).
- The effectiveness of wetlands at attenuating surge is primarily dependant on the surrounding coastal landscape and the strength and duration of the relevant forcing.
- The combination of the geometry of the coastal landscape and how a storm approaches that landscape determines the duration over which water is pushed inland.
- Analyses of model results indicate that surge attenuation rates estimated by a numerical modeling system that simulates all the relevant processes are consistent with observations.

## Recommendations:

♦ Wetlands do attenuate storm surge and waves and they should be considered when developing a comprehensive plan for coastal restoration and storm damage risk reduction.

♦ Numerical models that simulate the relevant physical processes can provide valuable information on how to best integrate wetlands for coastal protection.

♦ The potential of wetlands to attenuate surges and waves is dependant not only on wetland characteristics, but also on the surrounding coastal landscape and the strength and duration of the forcing as determined by storm characteristics.

♦ Changes in surge and wave levels have important implications for coastal storm damage risk reduction design and consideration of natural features is required for a holistic approach.


# An Analysis of the Role of Coastal Landscape Features in Storm Surge and Wave Reduction

## Recommendations Continued:

- Physical processes presently not represented but that should be developed for future numerical modeling include:
  - Changes to the wetlands such as stripping of vegetation cover and erosion of land masses that occur during a storms passage
  - Improved frictional formulations that explicitly accounts for both bottom friction and form drag; wave setup in the presence of vegetation
  - Consideration of three-dimensional effects
  - Consideration of sub-grid scale channels through marshes
  - Changes in the structure of the hurricane itself due to the landfall infilling phenomenon that may be influenced by the presence of wetlands

## Other Related Publications:


- Interaction of Hurricanes and Natural Coastal Features: Implications for Storm Damage Reduction. 2009. PhD Dissertation, Lund University, Report 1049.
- Potential impact of sea level rise on coastal surges in coastal Louisiana. 2010. *Ocean Engineering*, 37, 1, 37-47.


## Agencies/Partners:

- Louisiana Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- University of Notre Dame
- Texas A&M University


# Analysis of Pontchartrain Estuary Water Quality as Impacted by Opening of the Bonnet Carre Spillway

**Issue:** The Bonnet Carre Spillway (BCS) is opened to prevent the Mississippi River from exceeding a flow of 1.25 million cubic feet per second in the vicinity of New Orleans, Louisiana. There are concerns that the introduction of nutrient and sediment rich river water into the Pontchartrain Estuary may have unintended and unwanted consequences, including algal blooms and fish kills. There are similar concerns for proposed future diversions in other areas of the coast.

**Action:** Compile and analyze data that have been collected in the lake during years when the spillway was both opened and unopened to identify causal factors for the differences in the impacts of the river water on the lake system from the diversion operations that have occurred.

**Benefit:** This study will result in a better understanding of the impacts on water quality related to the release of Mississippi River water through a diversion which will not only help with BCS operations, but provide knowledge that will assist with projecting the impacts of future diversion projects in other areas along the Louisiana coast.

**Products:**

- Review and Analysis of Pontchartrain Estuary Water Quality as Impacted by Opening the Bonnet Carre Spillway. http://www.mvd.usace.army.mil/lcast/pdfs/LPB WQ analysis report.pdf
- Presentation of study results. http://www.mvd.usace.army.mil/lcast/pdfs/Bonnet Carre release study.pdf
- Additional Data and Models:

| Water Quality Data from lake Pontchartrain | Spreadsheet Response Models |
|---|---|
| • 2008 met data for New Orleans | • Chlorophyll models |
| • LP estuary combined observed WQ data 2008 | • Generic Response model |
| • LP trib USGS WQ data | • Salinity response model |
| • Mississippi River WQ Data 1997-2010 | • TN response model |
| • Model Inputs for Miss River Loading concentrations to LP | • TSS response model |
| • USGS LP trib flow for 2008l | |

**http://www.mvd.usace.army.mil/lcast**

**Project Completed October 2010**


# Analysis of Pontchartrain Estuary Water Quality as Impacted by Opening of the Bonnet Carre Spillway

## Results:

- The primary adverse water quality impact of BCS diversions is the potential for harmful algal blooms (HABs). The level of BCS release volume that results in a problematic HAB was not possible to definitively determine.
- Problem blooms are not expected for diversions occurring in the fall or winter, thus the timing of diversions is a factor to consider.
- Stimulation factors that contribute to the intensity of HABs include greater nitrate loading, lower salinity, sunlight intensity, and water temperature.
- Spreading diversion volume over a longer period can minimize HAB intensity.
- A numerical version of an analytical model for salinity and total nitrogen was developed in this study that is useful for evaluating the effects of diversion scenarios.
- This study supports the hypothesis that total phosphorus entering Lake Pontchartrain during a diversion rapidly settles out resulting in lake concentrations that are similar regardless of the size of the release.
- Lake Pontchartrain is nitrogen limited most of the time during normal years without BCS diversions, but is phosphorus limited during BCS releases and returns to being nitrogen limited after BCS releases have ceased and diversion water is dissipated.
- There is a need for collection of more Chl-a and algal data within the Pontchartrain Estuary and Mississippi Sound for years both with and without BCS diversions.
- A variety of relatively simple approaches for estimating Chl-a concentrations given nitrogen concentrations and loadings were presented and demonstrated to have utility.

## Recommendations:

- As a very rough guideline, it is suggested to avoid spring diversions through the BCS that constitute a release volume greater than 1.25 times the volume of Lake Pontchartrain, if the Mississippi River flood control requirements will allow such operation.
- Comprehensive hydrodynamic, sediment and water quality data should be collected in water bodies that receive water diverted from the Mississippi River.
- Data collection for the Pontchartrain Estuary should be expanded to include underwater light and depth integrated Chl-a and algal data.
- Spreadsheet and box models provide utility, but the best approach for modeling diversion impacts on water quality is to apply three-dimensional numerical hydrodynamic and water quality models. For the BCS diversion, the model domain should include the entire Pontchartrain Estuary and a portion of Mississippi Sound.

**http://www.mvd.usace.army.mil/lcast**

**Project Completed October 2010**


# Analysis of Pontchartrain Estuary Water Quality as Impacted by Opening of the Bonnet Carre Spillway

**Agencies/Partners**:

- U.S. Army Corps of Engineers (USACE)
- Louisiana Department of Natural Resources (LDNR)
- Moffatt & Nichol
- Funded by the American Recovery and Reinvestment Act

**http://www.mvd.usace.army.mil/lcast**

**Project Completed October 2010**

# Application of Long Distance Conveyance of Dredged Material to Habitat Restoration

**Issue:** Restoration of Louisiana's marshes and other coastal habitats will, in many cases, require dredged materials to provide suitable substrate for constructing sites. Potential restoration sites are often at great distances from the substrate source and will require special efforts, commonly referred to as long distance conveyance (LDC), to pump materials to the sites. While LDC is a mature technology for bulk transport, application to dredging and wetland restoration is relatively new. Various programs have been involved in investigating the feasibility, planning, designing, and/or conducting LDC dredging projects to restore wetlands and provide flood/surge protection. Significant amounts of baseline LDC information and knowledge gained from respective efforts has not been summarized and made readily accessible for optimizing future LDC projects.

**Action:** The work proposed is to review and synthesize information available concerning LDC. This will include:

- Review the scientific and technical literature and conduct personnel interviews in order to produce a summary of LDC-related dredging project information and knowledge.
- Synthesize these types of information in order to describe the state-of-the-art.
- Identify uncertainties related to LDC-related dredging projects.

**Benefits/Results:** A comprehensive document addressing technical issues and habitat infringement of LDC that can be integrated into master planning and design of LCD projects.

**Agencies/Partners**:

- Louisiana Department of Natural Resources (LDNR)
- U.S. Army Corps of Engineers (USACE)

# Atlas of Historic Daily Tide Data in South Louisiana

**Issue:** The U. S. Army Corps of Engineers New Orleans District has historically collected daily water level data of various water bodies, rivers, and streams throughout southern Louisiana. Some of these gages have collected data in tidal areas and have long periods of record, some exceeding 50 years. Over time unpublished adjustments may have been made to the data to compensate for datum shifts, correct leveling errors, or other reasons. These data must be referenced to a common datum for appropriate application of the data and to compute accurate estimates of relative sea level rise.

**Action:** Tide data across the region will be collected and analyzed to adjust the data to a common reference elevation and compute relative sea level rise estimates across south Louisiana.

**Benefit:** This study will result in a database of tide gauge data that will facilitate estimation of relative sea level rise and allow for consistent consideration of the effect of sea level rise on coastal restoration projects throughout south Louisiana.

**Product:**

- Atlas of U.S. Army Corps of Engineers Historic Daily Tide Data in Southern Louisiana (in preparation).

**Results:**

- Work is presently ongoing.

**Recommendation:**

- Work is presently ongoing.

**Agencies/Partners**:

- U.S. Army Corps of Engineers (USACE)
- Louisiana Office of Coastal Protection and Restoration (OCPR)

**http://www.mvd.usace.army.mil/lcast**

**Project Ongoing as of October 2010**


# Barrier Island Comprehensive Monitoring (BICM)

**Issue:** Hurricanes Katrina and Rita affected the condition and position of Louisiana's coastline and barrier islands, necessitating renewed baseline data collection. The Barrier Island Comprehensive Monitoring (BICM) program worked in collaboration with other coastal monitoring efforts to document the conditions characterizing Louisiana's shoreline following the 2005 hurricane season. A project to collect baseline data on all coastal shorelines provides a benchmark to measure the effectiveness of future restoration programs and the impact of future storms along Louisiana's shorelines.

**Action:** Data was collected for Louisiana's coastal shoreline that is more consistent, accurate, and complete than project specific barrier island data collection efforts. Greater quantities of longer-term data were made available to evaluate constructed projects, plan and design future barrier island projects, facilitate operations and maintenance activities, determine storm impacts, and evaluate FEMA claims. The following tasks were performed under this project:

- Barrier Shoreline Post-Storm Assessment
- Shoreline Configuration and Change
- Habitat/Land Cover Change
- Topographic/Bathymetric Analysis
- Sediment Sampling
- Final Report and Data
- Public Information Workshops

**Benefits:** This programmatic approach to shoreline monitoring:

- Assesses changes to barrier island and coastal shoreline morphology and habitat after Hurricanes Katrina and Rita.
- Provides resources to evaluate the effectiveness of current and future restoration projects
- Provides critical information for planning, engineering, design and maintenance of future projects.

**Products:**

- Louisiana Barrier Island Comprehensive Monitoring Program (BICM) Final Report
  - Volume 1: Barrier Shoreline Post-Storm Assessment
  - Volume 2: Shoreline Changes and Barrier Island Land Loss 1800s – 2005
  - Volume 3: Bathymetry and Historical Seafloor Change 1869 – 2007
  - Volume 4: Louisiana Light Detection and Ranging Data (Lidar)
  - Volume 5: Chenier Plain, South-Central Louisiana and Chandeleur Islands, Habitat Mapping and Change Analysis 1996 to 2005

**http://www.mvd.usace.army.mil/lcast**

**Project Ongoing as of September 2010**


# Barrier Island Comprehensive Monitoring (BICM)

## Products Continued:

- Aerial survey photography including 2005 post-hurricane, 2006/2007, and 2005 to 2006/2007 photo pairs
- Shoreline data 1800s to 2005
- Bathymetry data for southern Louisiana barrier islands, including the Chandeleur Islands, and the Caminada and western and central Chenier Plain barrier headlands 1869 to 2007
- Lidar data 2001, 2002, 2005, 2006, 2007
- Habitat data 1996 to 2005
- The Final Report, aerial photography and data can be found here.

## Results:

- Shoreline change analysis from 1855 to 2005 quantified rates of linear shoreline retreat across the entire Louisiana coast, defined the character and patterns of historical shoreline change, and established a baseline for future restoration efforts.
- A historical bathymetric database with bathymetric contour maps and seafloor change maps through 2006 was developed. Database includes data extending from Sandy Point to Raccoon Island and for the northern Chandeleur Islands.
- Lidar database including data from across the entire Louisiana coast collected during flights in the 2001 to 2007 time period.
- Land was classified by habitat for five delta shorelines over four different time periods. Comparisons of habitat between time periods were made to quantify habitat change.

## Recommendations:

- The bathymetry, topography, shoreline change, land loss, and habitat data collected under this monitoring program should be used to monitor the performance of new and existing coastal restoration projects and to facilitate the planning of future projects.

## Agencies/Partners:

- Louisiana Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- University of New Orleans (UNO)
- U.S. Geological Survey (USGS)


# Breton Sound Estuary Post-Hurricane Characterization & Recovery Assessment

**Issue:** Hurricane Katrina lead to habitat destruction and a possible shift in the ecological baseline in the Breton Sound Estuary in Southeastern Louisiana. The diversion from the Mississippi River at Caernarvon can deliver river water and sediments to aid in storm recovery. The Caernarvon Interagency Advisory Committee (CIAC) will operate the diversion to the maximum extent possible in support of marsh recovery efforts, but research is needed to determine the presence and extent of an ecological baseline shift within the basin.

**Action:** This study will determine the response of Breton Sound coastal ecosystems to Hurricane Katrina and the ability to restore these ecosystems through freshwater diversions. These efforts include studies of:

- Wetlands habitat productivity and recovery.
- Functional relationships and responses by higher trophic levels.
- Shifts in the ecological baseline due to the recent hurricanes and associated impacts.
- Impacts and benefits of pulsed river diversions on the estuary.

## Benefits/Results:

- This research will determine whether the use of pulsed river diversions can lead to restoration of ecosystem function, the recovery of damaged marshes, and a shift of the ecological baseline back towards pre-storm conditions.
- Data gathered on the Breton Sound Estuary will form the basis for future large-scale efforts to restore estuaries along with ecosystem goods and services.
- A final report that synthesizes data and provides recommendations on operating diversions to mitigate storm impacts.

## Agencies/Partners:

- Louisiana Department of Natural Resources (LDNR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- Louisiana Department of Wildlife and Fisheries (LDWF)
- Caernarvon Interagency Advisory Committee (CIAC)

# Chenier Plain Water and Sediment Model Development

**Issue:** The Chenier Plain in the western region of Louisiana's coast extends from Freshwater Bayou to Sabine Lake. Hydrologic and ecologic characteristics of this region are unique and complex, and an accurate accounting of water and sediment volumes is currently lacking. Information collected on the hydrology, sediment distribution, and ecology of the area is being utilized to create water and sediment models in support of the LCA (Louisiana Coastal Area) efforts to implement a comprehensive ecosystem-level restoration plan.

**Action:** This study will entail:

- Field data collection including surface water velocities, discharge, salinities, stage, and turbidity
- A comprehensive regional-scale water, salinity, and sediment budget analysis for the Chenier Plain
- Development of a hydrodynamic model that will assist in formulating and testing region-wide alternatives and providing both local and regional assessment of effects

**Benefits/Results:**

- Data collection and modeling efforts will be crucial to the comprehensive development of viable large-scale restoration or rehabilitation strategies
- Oral presentations and status reports to manager and decision makers
- A complete field measurement data set
- Copies of the model, model output, input files, and the bathymetric data.
- A final report highlighting the model's capabilities and limitations, and outlining the model's applicability and utility for planning region-wide coastal restoration strategies.

**Products:**

- Report I: Regional Model
  http://el.erdc.usace.army.mil/lcast/pdfs/Chenier%20Plain%20-%20Report%20I.pdf
- Report II: Analysis of Fine Sediment and Salinity Using a 3-D Model
  http://el.erdc.usace.army.mil/lcast/pdfs/Chenier%20Plain%20-%20Report%20II.pdf
- Report III: Sediment Budget
  http://el.erdc.usace.army.mil/lcast/pdfs/Chenier%20Plain%20-%20Report%20III.pdf

**Agencies/Partners:**

- Louisiana Department of Natural Resources (LDNR)
- U.S. Army Corps of Engineers (USACE)
- University of Louisiana at Lafayette (ULL)
- Coastal Restoration through Enhancement of Science and Technology (CREST)


# Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) Framework Refinement

**Issue:** The Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) framework is intended to develop computer-based, interdisciplinary ecosystem forecasting capabilities for restoration alternatives and environmental benefits. A modeling tool was developed for the Louisiana Coastal Area (LCA) Study using modules that predict physical processes, geomorphic features, and ecological succession. A reduction of scientific uncertainty in model forecasts of restoration projects is needed to improve the tool. CLEAR will continue to improve conceptual and simulation models consistent with an ecosystem forecasting system that integrates the elements of comprehensive monitoring and adaptive management.

**Action:** A skill assessment will be performed with the CLEAR model framework and components to enhance the efficiency, improve the accuracy, and extend the scope of forecasting coastal ecosystem endpoints under various restoration alternatives. Existing models will be used along with modules that integrate modeling with monitoring, data management, and risk assessment skill sets. The following tasks will be performed:

- Integration and skills assessment of
  - Coastwide hydrodynamic model
  - CELSS deterministic numerical landscape model.
  - Princeton Ocean Model
  - Mississippi River Model
  - Water Quality Box Model
- Development of
  - Uncertainty Analysis Module
  - Inland waters component of the LCA *System-Wide Assessment and Monitoring Plan*
  - Data Management System

## Benefits/Results:

- Improve the accuracy of the CLEAR model framework
- The Uncertainty Analysis Module will improve the capability to compare information produced by this suite of models
- A data management system which will operate in a collaborative environment.

## Products:

- http://www.clear.lsu.edu/

## Agencies/Partners:

- Louisiana Department of Natural Resources (LDNR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- University of New Orleans (UNO)
- U.S. Geological Survey (USGS)
- University of Louisiana at Lafayette (ULL)


# Coastwide Conceptual Ecological Model Development

**Issue:** Conceptual Ecological Models (CEMs) can be used to explain technical concepts to non-technical audiences and to identify technical relationships, monitoring needs and information gaps, and focus predictive forecasting tools. Within the framework of utilizing CEMs in a complex restoration program, an Adaptive Ecosystem Assessment and Management (AEAM) process is critical for bridging communication gaps between component organizations.

**Action:** CEMs will communicate scientific knowledge to the restoration community for use in focusing research, developing scientific syntheses, designing monitoring and modeling programs, and identifying management priorities under an adaptive management framework.

- Develop CEMs representing important natural and sociological processes within the Louisiana coastal zone
  - Flood Protection for coastal Louisiana
  - Coastal process in the Deltaic and Chenier Plains
  - Ecosystem Services and the need for aggressive future restoration efforts
- The Collaborative Adaptive Management Network (CAMNet) will assist and facilitate communicating and implementing CEMs within the Louisiana Coastal Area (LCA) program.

## Benefits/Results:

- Three CEM newsletters intended to increase public understanding of coastal processes
- The development of scientifically rigorous coastal CEMs will identify knowledge gaps in ecosystem processes and improve existing ecosystem modeling capacity
- Communication facilitated by CAMNet will ensure that the science is usable and understandable to stakeholders and decision-makers.
- A final report outlining implementation of conceptual models under an adaptive management framework

## Agencies/Partners:

- Louisiana Department of Natural Resources (LDNR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- University of Maryland (UM)

# Geomorphic Assessment for Pass a Loutre and South Pass

**Issue:** The dominant morphological processes that shape the lower Mississippi River channel and deltaic channels such as Pass a Loutre and South Pass can operate over very large spatial and temporal scales. There are many factors, both natural and anthropogenic that can contribute to these processes. Formulating the most accurate assessment of river morphology over large scales requires the evaluation of long-term trends in geometry adjustment, flow distribution, and sediment loading based on observed data.

**Action:** This geomorphic assessment includes analysis of discharge, sediment, channel geometry, and dredging records data. These analyses are integrated to formulate an overall understanding of the dominant processes that have shaped and formed the system from Head of Passes to the gulf outlets for Pass a Loutre and South Pass.

**Benefit:** The results from this study will form the basis for a comprehensive understanding of the study area, establishing trends in river morphology and sedimentation from a historic perspective and determining the cause and effect of observed changes.

**Products:**

- Technical Report.
- Conference or journal paper.

**Results:**

- Work initiated October 2010.

**Recommendation:**

- Work initiated October 2010.

**Agencies/Partners:**

- U.S. Army Corps of Engineers (USACE)
- Louisiana Office of Coastal Protection and Restoration (OCPR)


# Inventory of Numerical Models Applied to the Louisiana Coastal Zone

**Issue:** Scientific and technological uncertainties have posed challenges to the development of Louisiana's coastal restoration program. There is a need for an integrated Federal-State data management framework to inform coastal managers of available tools, facilitate a comprehensive assessment of restoration progress, and foster decision making.

**Action:** This study conducted an inventory of hydrodynamic, sediment transport, water quality, and ecosystem models that have been or are being developed for the Louisiana coastal zone for State and Federal agencies.

**Benefit:** The model inventory will inform coastal managers of available tools for planning and assessment activities, providing documentation of where historical and existing modeling efforts have been applied.

**Product:**

- An Inventory of Hydrodynamic, Water Quality, and Ecosystem Models Applied to the Louisiana Coastal Zone. http://www.mvd.usace.army.mil/lcast/pdfs/Final Inventory of Models Ver2 rev 2.pdf

**Results:**

- All metadata and a GIS map of the spatial domain for each model, where available and applicable, are presented in the Catalog of Models.

**Recommendation:**

- The State and Corps of Engineers should continue to update the model catalog for all future model development and applications, maintaining an up to date model inventory.

**Agencies/Partners**:

- U.S. Army Corps of Engineers (USACE)
- Louisiana Office of Coastal Protection and Restoration (OCPR)
- Battelle

# Lessons Learned from the Operation of Freshwater Diversions in South Louisiana

**Issue:** The concept of diverting the flow of the Mississippi River to distribute water and sediment into the Delta vicinity as a means of building marsh areas and sustaining existing wetlands has received much attention. Lessons can be learned from the design and operation of existing diversions that will inform the feasibility, design, and operation of proposed diversions.

**Action:** This study will collect and review literature related to freshwater diversions in south Louisiana and develop a diversion technical information database that collates the literature in a single access point. The literature for the Caernarvon and Davis Pond diversion projects will be analyzed to document lessons learned and identify data gaps.

**Benefit:** The information and lessons learned from existing diversion projects will aid project managers and decision makers in developing future strategies for diversion projects and in the proposal, planning, and design of new diversion structures.

**Products:**

- Interim Report: An Assessment of 'Lessons Learned' from the Operation of Existing Freshwater Diversions in South Louisiana. http://www.mvd.usace.army.mil/lcast/pdfs/An Assessment of Lessons Learned-Document-March 2010.pdf Bibliography of identified literature is provided in the Interim Report.
- Diversion technical information database (in preparation).
- Final Technical Report on lessons learned from the Caernarvon and Davis Pond freshwater diversions (in preparation).

**Results:**

- A database of over 500 documents relevant to diversions in south Louisiana was developed.
- Work is presently ongoing.

**Recommendation:**

- Work is presently ongoing.


# Lessons Learned from the Operation of Freshwater Diversions in South Louisiana

**Agencies/Partners**:

- Louisiana Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- Gulf Engineers and Consultants (GEC)


# Louisiana Coastal Area (LCA) Data Management Strategies

**Issue:** The need to organize the data from disparate resource management efforts within the Louisiana coastal zone into a robust data management system has long been recognized. As new ecological baselines are predicted to result from the widespread impacts of Hurricanes Katrina and Rita, the need to standardize data management and data collection is even more evident.

**Action**: Data management strategies include:

- A program-wide approach to acquisition and management of data and information, resulting in distributed, but linked architecture and decision support system for all entities participating in LCA
- Creation of a geospatial data and information viewer to provide comprehensive access to uniform, quality-assured coastal observations in the Gulf region through an Internet-accessible database of state, local, and federal data
- Development of querying processes and on-line mapping tools to enhance data acquisition networks

## Benefits:

- Computer-based data management standards and procedures will integrate data and information
- A Digital Library with a web-based data access and delivery system will include the Spatial Data Viewer capable of navigating data, viewing and querying data attributes, overlaying layers, and printing maps
- Data Management strategies will support resource managers involved in monitoring, modeling and assessment by providing consolidated database systems

## Products:

- LCA S&T Map Viewer http://lcast.sam.usace.army.mil
- Bonnet Carre' Spillway Spatial Viewer http://deltas.usgs.gov/BonnetCarre.aspx

## Results:

- The LCA S&T Map Viewer is an internet-accessible database of Federal, State and local data sources representing coastal ecosystem projects in the Gulf region. The prototype is a distributed geospatial data information based viewer intended to provide comprehensive access to data sources. The Viewer includes tools for navigating data, viewing and querying data attributes, and overlaying data layers.
- The Bonnet Carre' Spillway Spatial Viewer provides a monitoring location map viewer for data collected during the required April 2008 partial opening of the Bonnet Carre' Spillway to reduce the risk of flooding in southern Louisiana by the Mississippi River.


# Louisiana Coastal Area (LCA) Data Management Strategies

## Results Continued:

- The data, collected by Federal and State agencies, academic institutions and non-government organizations, represents water quality changes in Lake Pontchartrain and adjacent waters affecting estuary hydrology, fishery resources and endangered species. Map features include:
  - Location of sampling sites
  - The agency, institution or organization collecting samples
  - Information being collected (ie. water quality, invertebrate, plankton, hydrography)
  - Frequency of collection
- Actual data is available through the site, by linkages to supporting agency websites, or acquired by contacting the appropriate collecting agency. The Viewer also links supporting final documents presented by representative agencies.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- U.S. Geological Survey (USGS)
- Louisiana State University (LSU)

# Louisiana Coastal Subsidence Workshop

**Issue:** In Louisiana, coastal area studies have focused on various aspects of measuring and understanding subsidence. However, uncertainties exist that require additional attention and discussion. Specifically, details of various data collection methods must be fully understood by the scientific community, prior to communicating the current understanding of subsidence processes and rates to coastal resource managers and local government officials. Once the uncertainties are resolved, guidance for coastal managers on how to incorporate understanding of subsidence rates and processes into restoration and infrastructure planning is needed.

**Action:** In order to develop and communicate guidance to coastal managers and planners on a synthesis of current understanding of subsidence processes rates in Louisiana, the following objectives will be accomplished:

- Convene a technical workshop to discuss various methods of estimating subsidence
- Synthesize current understanding and uncertainties regarding subsidence and identify additional subsidence studies that are essential to restoration planning efforts.
- Develop guidance for coastal managers on how to incorporate this understanding into their planning and management activities

## Benefits:

- Peer-reviewed synthesis of current understanding of subsidence processes and rates in coastal Louisiana
- Guidance for coastal managers on how to incorporate understanding of subsidence rates and processes into restoration and infrastructure planning

## Products:

- Understanding Subsidence in Coastal Louisiana
  http://www.mvd.usace.army.mil/lcast/pdfs/UNO_SubsidenceinLA_09.pdf

## Results:

- There are several processes contributing to subsidence in coastal Louisiana, including:
  - Tectonics
  - Holocene sediment compaction
  - Sediment loading
  - Glacial isostatic adjustment
  - Fluid withdrawal
  - Surface water drainage and management


# Louisiana Coastal Subsidence Workshop

## Results Continued:

- Each process produces a range of subsidence rates dependent on local environmental factors.
- Each process spans a unique distribution of temporal and spatial scales, contributing to the net observed subsidence at different rates.
- There are many different ways subsidence is currently measured, including:
  - Re-leveling survey
  - Continuosly operating reference stations (CORS)
  - Tide gauges
  - InSAR
  - Sediment elevation tables (SETs)
  - Peat chronostratigraphy
  - Extensometers
- Knowing the range of spatial and temporal scales that each technique best measures helps determine the appropriateness in effectively recording specific subsidence processes.
- Extensometers, SETs, and CORS record subsidence at small spatial scales.
- Peat chronostratigraphy, InSAR, and re-leveling surveys take measurements over a much broader area.
- The most effective methodologies to monitor and measure subsidence will likely include an integrated approach, employing multiple measurement techniques.
- Subsidence will affect each resource management project differently dependent on the project's temporal and spatial scale. These temporal and spatial scales, and their location within the coastal landscape, determine how susceptible different projects are to subsidence effects.

## Report Recommendations:

- If a project has a designed life expectancy much less than the time scale it takes subsidence to reduce the project's effectiveness, then the effects of subsidence may be disregarded – otherwise its effects should be considered in the project design and maintenance schedule.
- The large spatial and temporal scales in which levee systems operate make it probable they will be affected by subsidence, specifically due to compaction related subsidence. To prevent a loss of protection effectiveness over time, levee systems should be designed with safety factors high enough to account for subsidence uncertainties, and should be monitored for subsidence related damage and make design adjustments as needed.


# Louisiana Coastal Subsidence Workshop

## Report Recommendations Continued:

- Introduction of sediment deposited in barrier island restoration may promote subsidence due to sediment compaction and compression. Barrier islands located in the delta margins in the Barataria and Terrebonne Basins are likely to experience large rates of subsidence caused by multiple processes. Such high rates of subsidence may affect restoration projects even with short life expectancies and should be factored into the design criteria.
- Mechanical marsh creation is susceptible to high rates of subsidence due to newly deposited marsh sediments compacting as they settle, but are expected to be self sustaining through natural sediment deposition and organic accumulation. Borings should be taken to measure geotechnical properties of underlying soil with data results incorporated into design specifications.
- River diversion projects designed to build land will likely experience similar amounts of net subsidence as marsh creation; however, it will occur over a longer period of time and over a wide spatial area leading to a greater possibility of and tolerance for variable results. Longer life spans of river diversions make it more likely a project will experience significantly different subsidence rates, making it necessary to plan for a dynamic subsidence rate rather than a singular value. It is advantageous to monitor project results over time to adjust operations to correct evolving problems.
- Coastal Louisiana is experiencing large rates of environmental change and these rates are expected to increase in the future due to climate change and eustatic sea-level rise, producing a high degree of uncertainty in both the prediction of the future environmental conditions and the magnitude and character of future subsidence. It is wise to consider the full range of future scenarios involving what the coastal environment will be and how subsidence will impact it.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- University of New Orleans (UNO)
- National Geodetic Survey (NGS)
- U.S. Geological Survey (USGS)

# Louisiana Coastwide Hurricane Impact Assessment

**Issue:** New ecological baseline conditions must be established to document impacts from Hurricanes Katrina and Rita, to both track ecosystem recovery and guide restoration planning under the Louisiana Coastal Area (LCA) and other programs. A suite of environmental drivers to predict responses in hydrology, land building, vegetation community change, habitat utilization, and water quality is needed to interpret the ecological effects of the hurricanes on a coastwide basis.

**Action:** This project leverages existing monitoring efforts and post-hurricane assessments to determine the new ecological baseline, allow pre- and post-hurricane impact assessments, and document the response and recovery of the Louisiana coastal ecosystems to large-scale perturbations. The project will:

- Collect data to support the development of a new 2006-2007 baseline of coastal land area and vegetation communities
- Use GIS technology to describe the interrelationships between site-specific processes and landscape-level response

## Benefits:

- The project improves our conceptual understanding of the effects of large-scale disturbances on ecosystem function and resilience to support a logical interpretation of hurricane impacts and subsequent recovery.
- Produce GIS maps of sampling flight lines, sampling locations, parameters sampled, and associated photographs
- GIS maps and associated data layers will
  - Describe new coastal vegetation communities and boundaries
  - Quantify new land-water change analyses for southwest Louisiana
  - Describe relationship between spectral signature and plant vigor
- Periodic and final reports that synthesize pre- and post-hurricane data and evaluate new trends

## Results:

- This research quantified the large spatial extent of vegetation impacts in coastal Louisiana associated with Hurricanes Katrina and Rita and provided a better understanding of the susceptibility of specific habitat types to hurricane-induced effects.
- The research was comprised of five tasks. A separate fact sheet follows for each task:
  - Task 1: Hurricane influences on vegetation community change in coastal Louisiana
  - Task 2: Geomorphic and ecological effects of Hurricanes Katrina and Rita on coastal Louisiana marsh communities
  - Task 3: Land area changes in coastal Louisiana after Hurricanes Katrina and Rita
  - Task 4: Vegetation types in coastal Louisiana in 2007
  - Task 5: Monitoring vegetation response to episodic disturbance events by using multitemporal vegetation indices


# Louisiana Coastwide Hurricane Impact Assessment

## Results Continued:

- Tasks 1, 2, 3, and 5 all corroborated hurricane induced vegetation impacts were initially greatest in fresh marsh habitats.
- Tasks 1, 3 and 5 confirm that the negative influences of Hurricane Rita on vegetation (i.e., reduced vigor, new open water areas, shifts in species composition) were greater than those associated with Hurricane Katrina due to the prolonged exposure of marshes to high salinity waters in the western region.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- Louisiana Department of Wildlife and Fisheries (LDWF)
- U.S. Geological Survey (USGS)


# Louisiana Coastwide Hurricane Impact Assessment

# Task 1: Hurricane Influences on Vegetation Community Change in Coastal Louisiana

**Issue:** New ecological baseline conditions must be established to document impacts from Hurricanes Katrina and Rita, to both track ecosystem recovery and guide restoration planning under the Louisiana Coastal Area (LCA) and other programs. A suite of environmental drivers to predict responses in hydrology, land building, vegetation community change, habitat utilization, and water quality is needed to interpret the ecological effects of the hurricanes on a coastwide basis.

**Action:** This task will access hurricane impacts on vegetation community dynamics through coastwide data acquisition of vegetation cover, species composition, and height of dominant plants, along with soil porewater, salinity and sulfide values. Data acquisition will occur through remote sensing techniques and field investigations at 100 sampling sites established across the coast in fresh, intermediate and brackish habitat.

## Benefits:

- Vegetation characterization will provide a broader spatial assessment of how the hurricanes of 2005 influenced vegetation changes in coastal Louisiana.
- The project improves our conceptual understanding of the effects of large-scale disturbances on ecosystem function and resilience to support a logical interpretation of hurricane impacts and subsequent recovery.
- Produce GIS maps of sampling flight lines, sampling locations, parameters sampled, and associated photographs
- GIS maps and associated data layers will
  - Describe new coastal vegetation communities and boundaries
  - Quantify new land-water change analyses for southwest Louisiana
  - Describe relationship between spectral signature and plant vigor
- Periodic and final reports that synthesize pre- and post-hurricane data and evaluate new trends

## Products:

- Conference Presentations
  - Effects of Hurricanes on Marshes Under Hydrologic Management - 3rd National Conference on Coastal and Estuarine Habitat Restoration
  - Influence of Saltwater Storm Surge from Hurricanes Katrina and Rita on Coastal Louisiana Marsh Landscapes - 19th Biennial Conference of the Estuarine Research Federation
- Publications
  - Potential Consequences of Saltwater Intrusion Associated with Hurricanes Katrina and Rita http://pubs.usgs.gov/circ/1306
  - Hurricane Influences on Vegetation Community Changes in Coastal Louisiana (in prep)


# Louisiana Coastwide Hurricane Impact Assessment

# Task 1: Hurricane Influences on Vegetation Community Change in Coastal Louisiana

## Results:

- Salinity and sulfide values highly exceeded typical ranges in fresh marsh within the west region through 2006 and in fall 2007.
- The persistent stress contributed to low vegetation cover, conversion to open water or conversion to more saline habitat types.
- Percent cover of vegetation within each marsh type in the east region were not severely impacted by salinity and sulfide stress even though the marshes were exposed to substantial storm surge.
- The east region had the highest abundance and cover of disturbance species in fresh and intermediate habitat types and major changes in species dominance.
- Vegetation changes in the east region were primarily driven by physical impacts; whereas changes in the west region were primarily due to physiochemical stressors.

## Report Recommendations:

- Vegetation impacts and resulting recovery are influenced by exposure length to stressors, providing a basis for predicting hurricane event outcomes on plant communities.
- Even though short duration exposures to high salinity can cause large initial reductions in vegetation cover, the plants typically are resilient enough to recover within one full growing season.
- Long duration exposures to high salinity were found to significantly reduce vegetation cover of typical dominant perennials and/or lead to shifts in species composition, especially when marshes are exposed to multiple stressors (salinity and sulfide in excess of 10 psu and 1.6 mM, respectively) in which they convert to open water within one full growing season.
- Effective management practices for vegetative coastal restoration in response to hurricane events should include a high priority to removing hydrologic impediments in order to alleviate persistent flooding and allow flushing of high salinities.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- Louisiana Department of Wildlife and Fisheries (LDWF)
- U.S. Geological Survey (USGS)


# Louisiana Coastwide Hurricane Impact Assessment

# Task 2: Geomorphic and Ecological Effects of Hurricanes Katrina and Rita on Coastal Louisiana Marsh Communities

**Issue:** New ecological baseline conditions must be established to document impacts from Hurricanes Katrina and Rita, to both track ecosystem recovery and guide restoration planning under the Louisiana Coastal Area (LCA) and other programs. A suite of environmental drivers to predict responses in hydrology, land building, vegetation community change, habitat utilization, and water quality is needed to interpret the ecological effects of the hurricanes on a coastwide basis.

**Action:** This task will document the effect of saltwater storm surge and sedimentation from Hurricanes Katrina and Rita on marsh community dynamics in coastal Louisiana. Quarterly data from spring 2006 through fall 2007 will track vegetation cover, species composition, biomass, surface and porewater salinity, as well as sediment accretion, elevation change, bulk density properties, and nutrient accumulations rates.

## Benefits:

- Documentation of post hurricane ecological baselines and site specific hurricane impacts, recovery, and potential changes in ecological trajectories will provide resource managers and modelers information to evaluate changes in ecological trajectories and to anticipate influences of future landscape scale disturbances on the coastal landscape.
- The project improves our conceptual understanding of the effects of large-scale disturbances on ecosystem function and resilience to support a logical interpretation of hurricane impacts and subsequent recovery.
- Produce GIS maps of sampling flight lines, sampling locations, parameters sampled, and associated photographs
- GIS maps and associated data layers will
  - Describe new coastal vegetation communities and boundaries
  - Quantify new land-water change analyses for southwest Louisiana
  - Describe relationship between spectral signature and plant vigor
- Periodic and final reports that synthesize pre- and post-hurricane data and evaluate new trends

## Products:

- Conference Presentations
  - Impacts and Recovery of Vegetative Structures in Coastal Louisiana Marsh Communities Following the Hurricanes of 2005 – 19th Biennial Conference of the Estuarine Research Federation
- Publications
  - Geomorphic and Ecological Effects of Hurricanes Katrina and Rita on Coastal Louisiana Marsh Communities (in prep)


# Louisiana Coastwide Hurricane Impact Assessment

# Task 2: Geomorphic and Ecological Effects of Hurricanes Katrina and Rita on Coastal Louisiana Marsh Communities

## Results:

- In general, fresh marsh sites experienced more negative effects of the hurricanes than brackish/intermediate and saline marsh sites.
- Hurricane induced elevated porewater salinities in fresh marshes were observed through the end-of-season 2007 resulting in low aboveground and belowground biomass and a significant contribution of disturbance species to overall community composition.
- Location, pre-storm dominant vegetation, and surrounding hydrologic conditions likely influenced site specific post-storm recovery.
- The most extreme negative effects were observed at fresh marsh sites with near complete dieback of aboveground vegetation and slow recovery.
- Saline marsh sites faired well based on the dominant vegetation being better adapted to salinity surges.
- Organic matter accumulation rates explain much of the variability associated with vertical accretion in brackish/intermediate and saline marshes, whereas mineral accumulation explains more of the variability associated with vertical accretion in fresh marshes.

## Report Recommendations:

- The post hurricane baseline data should be used to refine desktop models and enhance future modeling efforts that try to capture landscape change associated with hurricane disturbance.
- Data resulting from this effort would be valuable in habitat switching models by providing insight to salinity thresholds that contribute to vegetation community change and reductions in productivity.
- Long-term accretion estimates and bulk density data could be used as input data to refine land building models.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- Louisiana Department of Wildlife and Fisheries (LDWF)
- U.S. Geological Survey (USGS)

# Louisiana Coastwide Hurricane Impact Assessment

# Task 3: Land Area Changes in Coastal Louisiana After Hurricanes Katrina and Rita

**Issue:** New ecological baseline conditions must be established to document impacts from Hurricanes Katrina and Rita, to both track ecosystem recovery and guide restoration planning under the Louisiana Coastal Area (LCA) and other programs. A suite of environmental drivers to predict responses in hydrology, land building, vegetation community change, habitat utilization, and water quality is needed to interpret the ecological effects of the hurricanes on a coastwide basis.

**Action:** Landsat Thermaric Mapper™ satellite imagery acquired before and after landfall of Hurricanes Katrina and Rita will be used to determine hurricane impacts of land area changes into open water. Comparison of historic datasets will identify cumulative land loss over specified time periods.

## Benefits:

- Preliminary information on water area changes in coastal Louisiana due to impacts of hurricanes Katrina and Rita will serve as a regional baseline for monitoring post-hurricane wetland recovery.
- The project improves our conceptual understanding of the effects of large-scale disturbances on ecosystem function and resilience to support a logical interpretation of hurricane impacts and subsequent recovery.
- Produce GIS maps of sampling flight lines, sampling locations, parameters sampled, and associated photographs
- GIS maps and associated data layers will
  - Describe new coastal vegetation communities and boundaries
  - Quantify new land-water change analyses for southwest Louisiana
  - Describe relationship between spectral signature and plant vigor
- Periodic and final reports that synthesize pre- and post-hurricane data and evaluate new trends

## Products:

- Land Area Change in Coastal Louisiana After the 2005 Hurricanes – A Series of Three Maps http://pubs.usgs.gov/of/2006/1274/
- Land Area Changes in Coastal Louisiana After Hurricanes Katrina and Rita http://pubs.usgs.gov/circ/1306/pdf/c1306_ch5_b.pdf
-

## Results:

- Comparison of classified satellite imagery acquired before and after the landfalls of Hurricanes Katrina and Rita demonstrated that water area increased by 217 square miles in coastal Louisiana:
  - Approximately 82 square miles of new open water areas were in areas primarily impacted by Hurricane Katrina


# Louisiana Coastwide Hurricane Impact Assessment

# Task 3: Land Area Changes in Coastal Louisiana After Hurricanes Katrina and Rita

## Results Continued:

- 117 square miles were in areas primarily impacted by Hurricane Rita
- Barataria basin contained new water areas caused by both hurricanes, resulting in some 18 square miles of new water areas

- Fresh marsh and intermediate marsh communities land areas decreased by 122 square miles and 90 square miles, respectively.
- Brackish marsh and saline marsh communities land areas decreased by 33 square miles and 28 square miles, respectively.
- Hurricane Rita produced substantial amounts of new open water areas in western Louisiana while Hurricane Katrina's immediate land changing impacts were largely in coastal hydrologic basins within eastern Louisiana.
- Cumulative hurricane impacts contribute significantly to coastal land loss, ranging in scale from specific localities to entire hydrologic basins, and cause permanent pond formation at varying spatial scales and temporal frequencies.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- Louisiana Department of Wildlife and Fisheries (LDWF)
- U.S. Geological Survey (USGS)


# Louisiana Coastwide Hurricane Impact Assessment

# Task 4: Vegetation Types in Coastal Louisiana in 2007

**Issue:** New ecological baseline conditions must be established to document impacts from Hurricanes Katrina and Rita, to both track ecosystem recovery and guide restoration planning under the Louisiana Coastal Area (LCA) and other programs. A suite of environmental drivers to predict responses in hydrology, land building, vegetation community change, habitat utilization, and water quality is needed to interpret the ecological effects of the hurricanes on a coastwide basis.

**Action:** New post-hurricane baseline vegetation type mapping will be established by surveying vegetation stations along north-south oriented transects from the Texas to Mississippi state lines. Marsh vegetation types will be identified and mapped, with habitat types classified as fresh, intermediate, brackish and salt marsh zones.

## Benefits:

- The marsh type map prepared from these data can be used as on overlay to identify marsh classification changes between any previous surveys and 2007.
- The project improves our conceptual understanding of the effects of large-scale disturbances on ecosystem function and resilience to support a logical interpretation of hurricane impacts and subsequent recovery.
- Produce GIS maps of sampling flight lines, sampling locations, parameters sampled, and associated photographs
- GIS maps and associated data layers will
  - Describe new coastal vegetation communities and boundaries
  - Quantify new land-water change analyses for southwest Louisiana
  - Describe relationship between spectral signature and plant vigor
- Periodic and final reports that synthesize pre- and post-hurricane data and evaluate new trends

## Products:

- Vegetation Types in Coastal Louisiana http://pubs.usgs.gov/of/2008/1224/

## Results:

- Marsh vegetation type reflects gradients in salinity and elevation and are roughly distributed in zones that run parallel to the Gulf of Mexico, with salt marshes furthest south, followed by brackish, intermediate, and fresh marshes further inland.
- Delineation of marsh boundaries usually followed natural levees, bayous, or other features that impede or restrict water flow.
- In total, 159 different species were identified, with *Spartina patens* being the most common species. Other common species include *Spartina alterniflora*, *Sagittaria lancifolia*, *Typha* spp., *Vigna luteola* and *Schoenoplectus americanus*.


# Louisiana Coastwide Hurricane Impact Assessment

# Task 4: Vegetation Types in Coastal Louisiana in 2007

## Results Continued:

- Intermediate vegetation type accounted for the largest marsh area, followed by fresh, saline, and brackish vegetation types.

## Report Recommendations:

- Future assessments of environmental drivers used to project responses in hydrology, land building, vegetation community change, habitat utilization and water quality should utilize the new 2007 marsh classification.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- Louisiana Department of Wildlife and Fisheries (LDWF)
- U.S. Geological Survey (USGS)


# Louisiana Coastwide Hurricane Impact Assessment

# Task 5: Monitoring Vegetation Response to Episodic Disturbance Events by Using Multitemporal Vegetation Indices

**Issue:** New ecological baseline conditions must be established to document impacts from Hurricanes Katrina and Rita, to both track ecosystem recovery and guide restoration planning under the Louisiana Coastal Area (LCA) and other programs. A suite of environmental drivers to predict responses in hydrology, land building, vegetation community change, habitat utilization, and water quality is needed to interpret the ecological effects of the hurricanes on a coastwide basis.

**Action:** Normalized Difference Vegetation Index (NDVI) calculated from MODerate-resolution Imaging Spectroradiometer (MODIS) Terra satellite imagery was utilized to quantify the extent and severity of damage from Hurricanes Katrina and Rita to vegetative communities and their subsequent recovery. Post storm data was compared to pre-storm baseline averages to create a departure from average statistic to analyze storm impacts coastwide.

## Benefits:

- The ability to integrate geographic information systems and remote sensing, using both multisource and multitemporal imagery, is critical for the evaluation of impacts and recovery from large episodic disturbance events that influence multiple habitat types.
- The project improves our conceptual understanding of the effects of large-scale disturbances on ecosystem function and resilience to support a logical interpretation of hurricane impacts and subsequent recovery.
- Produce GIS maps of sampling flight lines, sampling locations, parameters sampled, and associated photographs
- GIS maps and associated data layers will
  - Describe new coastal vegetation communities and boundaries
  - Quantify new land-water change analyses for southwest Louisiana
  - Describe relationship between spectral signature and plant vigor
- Periodic and final reports that synthesize pre- and post-hurricane data and evaluate new trends

## Products:

- MODerate Resolution Imaging Spectroradiometer (MODIS) Normalized Dierence Vegetation Index (NDVI) Composites in Coastal Louisiana Following Hurricanes Katrina and Rita – USGS Map ID: 2007-11-0192
- MODerate Resolution Imaging Spectroradiometer (MODIS) Enhanced Vegetation Index (EVI) Composites in Coastal Louisiana Following Hurricanes Katrina and Rita – USGS Map ID: 2007-11-0193


# Louisiana Coastwide Hurricane Impact Assessment

# Task 5: Monitoring Vegetation Response to Episodic Disturbance Events by Using Multitemporal Vegetation Indices

## Products Continued:

- The Use of Vegetation Indices to Track Marsh Changes Following Hurricane Disturbances – 19th Biennial Conference of the Estuarine Research Federation
- Monitoring Vegetation Response to Episodic Disturbance Events Using Multitemporal Vegetation Indices (in prep)

## Results:

- Departures suggest that over 33% of the pre-storm, coastal wetland area experienced a substantial decline in the density and vigor of vegetation in October 2005.
- New open water areas caused by the immediate removal of wetland or flooding of burned marsh represent approximately 17.4% of the area immediately damaged in the east, 6.6% in the central, and 28.2% in the west regions.
- The percentage of area of persistent vegetation damage accounted for by persistent new open water was 91.8% in the east, 81.0% in the central, and 29% in the west regions.
- Remaining damage was likely associated with other factors including saltwater intrusion, flooding, and burial by wrack.
- Although below average NDVI values were observed in most marsh community types through November 2006, recovery of vegetation is evident.

## Report Recommendations:

- The trend observed from the spatial values of the NDVI suggest that vegetation impacts and recovery patterns can be accurately determined using the NDVI, especially when integrated with assessments of physical landscape changes and field verifications.
- This NDVI technique has been incorporated in the Coastwide Reference Monitoring System to improve assessments of vegetation change at multiple scales.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- Louisiana State University (LSU)
- Louisiana Department of Wildlife and Fisheries (LDWF)
- U.S. Geological Survey (USGS)


# Measurement and Analysis of Water and Sediment Transport in the Mississippi River from Myrtle Grove to Venice during Low Flow

**Issue:** Multiple large fresh water diversions for the purpose of land building have been proposed on the Mississippi River between Myrtle Grove and Venice, LA. An evaluation of expected diversion performance and proper design requires an understanding of water and sediment transport during low river flow conditions.

**Action:** A field survey was carried out from 21-24 September, 2009. The data collected was analyzed to determine water and sediment transport rates. Data analyzed includes total water discharge as well as both bed and suspended sediment load. The data collection was conducted concurrent with a USACE survey done in the vicinity of West Bay.

**Benefit:** This work will result in an understanding of the suspended and bedload transport of sand and mud within the river and in waters that exit the river, at low flow conditions along the measured river reach. The data compliments collection of similar data both north and south this studies survey area. The primary benefit is that this study will quantify any loss of water and sediment from the Mississippi River channel up river from Baptiste Collette.

**Product:**

- Data Analysis and Survey of Water and Sediment Transport From Empire to Venice, LA and Surrounding Mississippi River Exit Channels http://www.mvd.usace.army.mil/lcast/pdfs/WestBayUTIGstudyAllisonJuneFinalReport.pdf
- Digital data files. See above report for links to data.

**Results:**

- Bedload transport rates were calculated to be approximately 3800 metric tons/day at Empire for a river flow of about 325,000 cfs.
- Approximately 25% of the water discharge in the Mississippi River is removed through Baptiste Collette and Tiger Pass.
- There is no measurable loss of water from the Mississippi River channel above Baptiste Collette.

**Recommendation:**

- High-quality field measurements of water and sediment should continue to be collected at different river stages to further understanding of river processes.


# Measurement and Analysis of Water and Sediment Transport in the Mississippi River from Myrtle Grove to Venice during Low Flow

**Agencies/Partners**:

- U.S. Army Corps of Engineers (USACE)
- Louisiana Office of Coastal Protection and Restoration (OCPR)
- University of Texas

**http://www.mvd.usace.army.mil/lcast**

**Project Completed June 2010**


# Mississippi River Gulf Outlet Water Quality Monitoring

**Issue:** Closure plans for the Mississippi River Gulf Outlet (MRGO), a deep-draft ship channel east of New Orleans, call for a rock barrier to be constructed across the channel near Bayou La Loutre. The installation of the rock barrier may result in environmental shifts in the MRGO and nearby water bodies. Water quality, velocity and channel configuration of the MRGO should be monitored before and after the installation of the rock barrier to document potential environmental changes.

**Action:** Monitoring efforts will be performed prior to the installation of the rock barrier to provide a baseline with which future assessment can be compared. Monitoring locations will include the MRGO, along with adjacent water bodies including Lake Pontchartrain and Lake Borgne. Monitoring efforts will focus on:

- Water quality synoptics
- Continuous salinity
- Streamflow and channel bathymetry
- Bed sediment

## Benefits/Results:

- A comprehensive document including data collected and method descriptions that will assist in addressing and recommending ecosystem restoration measures
- The monitoring data should provide a basis from which future adaptive management plans can be developed

## Agencies/Partners:

- U.S. Geological Survey (USGS)
- Louisiana Department of Natural Resources (LDNR)
- U.S. Army Corps of Engineers (USACE)


# Mississippi River Sediment Availability Study

**Issue:** The concept of diverting the flow of the Mississippi River to distribute water and sediment into the Delta vicinity as a means of building marsh areas and sustaining existing wetlands has received much attention. The sediment load of the Mississippi River has been reduced through dam construction and bank stabilization in the Mississippi basin, which could adversely affect diversion plans. Understanding the availability of sediment in the Mississippi River is necessary for effective diversion planning and design.

**Action:** An inventory of available discharge, stage, and sediment data was conducted for the Lower Mississippi River and its main tributaries. The findings of the study were documented in a technical note.

**Benefit:** This study provides an overview of available sediment data in the Lower Mississippi River and identifies data gaps that must be addressed to properly design and construct land building diversions. Links to available data are provided.

**Products:**

- Mississippi River Sediment Availability Study: Summary of Available Data http://libweb.wes.army.mil/uhtbin/hyperion/CHL-CHETN-IX-22.pdf
- See Appendix E of CHETN-IX-22 for links to data sources.

**Results:**

- There is a paucity of available long-term sediment data on the Lower Mississippi. The only long-term sediment data record is operated by the U.S. Army Corps of Engineers and is located at Tarbert Landing, MS (river mile 305).
- There has been a decrease in measured suspended sediment loads along the Mississippi River over the last 50 years.
- For the Atchafalaya River, a long-term sediment record is available at Simmesport, LA.

**Recommendation:**

- Additional long-term sediment measurement stations should be established on the Lower Mississippi below Tarbert Landing.


# Mississippi River Sediment Availability Study

## Other Related Publications:


- Demas, C. R., and P. B. Curwick. 1987. Suspended-sediment, bottom-material, and associated-chemical data from the Lower Mississippi River, Louisiana. U.S. Geological Survey Water Resources Basic Records Report 14.
- Thorne, C. R., O. P. Harmar, and N. Wallerstein. 2000. Sediment transport in the Lower Mississippi River. Final Report, Contract Number N68171-00-M-5982. London, England: U.S. Army Research, Development and Standardization Group-U.K.
- Thorne, C. R., O. P. Harmar, and N. Wallerstein. 2001. Morphodynamics of the Lower Mississippi River. London, England: U.S. Army Research, Development and Standardization Group-U.K.
- Thorne, C. R., O. Harmar, C. Watson, N. Clifford, D. Biedenharn, and R. Measures. 2008. Current and historical sediment loads in the Lower Mississippi River. Final Report, Contract Number 1106-EN-01. London, England: United States Army, European Research Office of the U.S. Army.


## Agencies/Partners:

- Louisiana Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)


# One-Dimensional Sediment Transport Modeling of the Lower Mississippi River

**Issue:** One-dimensional (1D) numerical modeling of the lower Mississippi River is an important component to the overall understanding of the dynamics of the lower river, particularly decadal- and regional-scale processes. To date, there have been several 1D model applications on the lower river for various purposes. These models include HEC-6T and HEC-RAS/Sediment. A comprehensive evaluation of the existing models and their predictive skill is needed to achieve an overall assessment of 1D model usage in addressing sedimentation issues associated with existing and proposed river diversions on the lower Mississippi River.

**Action:** The existing 1D-models will be evaluated in terms of model formulation, input data, and boundary conditions. The 1D HEC-RAS/Sediment model, that presently covers the river reach from Tarbert Landing to Venice, will be extended to include the reach between Venice to Head of Passes. The model will be applied for the period of 2003 to spring 2009, a period previously modeled with the HEC-6T model. Model results will be compared with data and to each other. Model similarities, discrepancies, and predictive skill will be evaluated.

**Benefit:** Comparison of existing models, along with data used in their development and calibration, and a comparison of model results, will increase our knowledge of:

- diversion effects on the lower Mississippi River,
- the capabilities, strengths, and limitations of 1D modeling for such applications, and
- spatial and temporal flow and sediment relationships and patterns on the lower river.

1D modeling also contributes to the development of multi-dimensional numerical models.

**Products:**

- Draft Report summarizing the modeling effort. The summary will be incorporated into a final report by ERDC which will include field data used for model input and evaluation.
- HEC-RAS/Sediment model that extends from Tarbert Landing to Head of Passes.

**Results:**

- Work is presently ongoing.

**Recommendation:**

- Work is presently ongoing.


# One-Dimensional Sediment Transport Modeling of the Lower Mississippi River

**Agencies/Partners**:

- U.S. Army Corps of Engineers (USACE)
- Louisiana Office of Coastal Protection and Restoration (OCPR)
- University Louisiana and Lafayette

**http://www.mvd.usace.army.mil/lcast**

**Project Ongoing as of October 2010**


# Potential for Introduction of Invasive Plant Species from Illinois River Dredged Material

**Issue:** Louisiana coastal areas are in need of enormous amounts of suitable sediment for restoration projects that will ameliorate damages caused by Hurricanes Katrina and Rita in late 2005. Such sediment, in the form of displaced soil dredged from Illinois River backwaters, may be available from an Illinois State program. The sediment consists primarily of uncontaminated topsoil. Used in a pilot project, sediment was transported by barge to the south side of Chicago and installed at depths of 2 to 4 feet depth across 100 acres of steel-mill slag. Planted grass and alfalfa readily established on the site after just a few months, as did 79 species of vascular plants, 17 of which were wetland species. Thus, the possibility of introducing species not currently present in Louisiana as well as species that might be present in the state but are currently absent from the site of deposition through a "mud to marshes" project exists.

**Action:** Of major concern in a sediment-relocation project is the potential for transfer and/or spread of invasive biota from Illinois backwater sediments to Louisiana. A literature search would:

- Identify invasive species that could potentially be transported in the sediments from Illinois. Identify those invasive species that would constitute new introductions and/or reintroductions to Louisiana and the potential ramifications if they were to establish.

**Benefits:** The comprehensive literature report will provide information that can be integrated into master planning and expert system software, playing a role in decision making that could help to avoid future costly eradication projects.

## Products:

- Potential for Introduction of Invasive Species into Louisiana from Illinois River Dredged Material http://el.erdc.usace.army.mil/elpubs/pdf/trel08-21.pdf

## Results:

- New introductions of species to Louisiana are highly unlikely.
- Reintroduction of species already present in Louisiana is a possibility; infestations could occur at sites previously not inhabited.
- Appearance of Eurasian watermilfoil and phragmites warrants genetic analysis to identify whether plants are native or invasive biotype species.
- Disturbance of marsh reclamation has the potential to open new corridors for invasive species movement and establishment.


# Potential for Introduction of Invasive Plant Species from Illinois River Dredged Material

## Report Recommendations:

- A pre-project species survey should be conducted on the project site to detect and map the current biota. Test sites should be monitored on a regular basis to document any changes that occur over time.
- Additional greenhouse seed bank studies are also recommended to analyze seed bank composition and test for viability and tolerance in relation to project site salinity concentrations.
- An invasive species management program, to include an early warning rapid response plan, should be implemented to identify prevention, control and eradication measures necessary to avert potential infestations.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)


# Regional Sediment Management Program

## Louisiana eCoastal Geographic Information System

**Issue:** Efforts to restore coastal Louisiana will require both the availability of large amounts of sediment and the understanding of sediment movement, processes, characteristics, availability and needs on a regional scale. A project-by-project approach to sediment management does not consider the regional impacts of sediment processes on coastal environments. The Regional Sediment Management (RSM) Program will provide the data and understanding required to manage Louisiana's sediment resources in a comprehensive, balanced and sustainable context.

**Action:** Implementation of a Regional Sediment Management Geographic Information System (GIS), named eCoastal, will support the development of a calibrated sediment budget, a gauged numerical regional prediction system, and a regional data management structure. eCoastal was created to assist coastal engineers with data organization, accessibility, and analysis and is also extendable to inland features and datasets.

Regional sediment management requires interaction with multiple stakeholders to draw on combined strengths and to leverage the resources of the public and private sectors to meet regional and national needs. Linkage of Louisiana geospatial databases, within the RSM context, from multiple agencies will synchronize data collection efforts of each participating organization. Data or links to data from all participating agencies will be served from one physical location through a website or web mapping services medium. This decision supported GIS will enable coastal engineers, scientists and managers direct access to all spatial datasets across the entire study area, enabling each stakeholder to make educated, informed decisions in the management of Louisiana's valuable sediment resources.

**Benefits:** An interagency regional sediment management GIS will provide significant cost and time savings throughout sediment related programs and projects by allowing managers:

- Direct access to spatial datasets across the Louisiana Coastal region
- To explore broad spatial and temporal impacts of potential directive actions
- To efficiently share and leverage multi-agency data, avoiding data duplication
- To make educated, informed decisions in the management of sediment resources
- Improved interagency and stakeholder relationships, producing opportunities for leveraging financial and manpower resources

**Product:**

- RSM website http://rsm.mvn.usace.army.mil/


# Regional Sediment Management Program

## Louisiana eCoastal Geographic Information System

### Results:

- Integrates projects and studies related by the sediment system and sediment resource issues that address the critical needs to save the Louisiana coast, maintain waterways through dredging, and protect the state from flooding.
- Unifies and integrates the sediment activities ongoing with partnering agencies reducing duplication of efforts and utilizing shared resources saving considerable time and funding.
- Interactive website allows data to be downloaded and linkage to and leveraging of existing spatial datasets into local projects.

### Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)

**http://www.mvd.usace.army.mil/lcast**

**current as of December 2009**

Louisiana Coastal Area Science & Technology Office

# River Diversion Induced Shoaling

**Issue:** The concept of diverting the flow of the Mississippi River to distribute water and sediment into the Delta vicinity as a means of building marsh areas and sustaining existing wetlands has received much attention. One concern with this management option is the impact of such diversions on shoaling in the navigation cannels of the river system. Morphological changes due to diversions could impact navigation, resulting in increased dredging actions in shoaled areas or protection of areas of induced erosion. A thorough review is necessary to document whether or not shoaling in navigation channels with diversions is a real issue and, if so, how big of an issue it is.

**Action:** Several tasks will be undertaken to provide the needed information on the impact of diversions on morphology in a river, the impact these changes have on maintenance, and the tools and approaches available for addressing the issue including:

- Collaboration between State and Federal agencies to fully understand the concern and issues of diversion related shoaling
- A review of current literature associated with shoaling and diversions
- A description of tools, models, and approaches that could be used to address the issue of shoaling and diversions, either quantitatively or qualitatively

## Benefits:

- A formal document will be provided summarizing the above tasks, along with a description of approaches that could be employed to quantitatively address shoaling issues for a particular project

## Products:

- River Diversions and Shoaling http://www.mvd.usace.army.mil/lcast/pdfs/chetn-vii-9.pdf

## Results:

- Any change in the magnitude of flow has a direct impact on stream power; the time rate ability of the flow within a channel to do work, that work being energy available to transport sediment. With diversions, as flow is diverted from the main channel, the stream power of the main channel is reduced, resulting in a reduction in the ability of the main channel flow to transport sediment.
- Unless the diversion is designed to take a disproportionate fraction of the sediment with the diverted water, there will be deposition downstream of the diversion.
- If too much bed material is diverted, the sediment transport capability of the stream may increase, thus accelerating channel instability through degradation.


# River Diversion Induced Shoaling

## Results Continued:

- Wash load from the main channel may convert to bed material load in the diversion channel, resulting in sedimentation in the diversion channel.
- Characteristics of river behavior makes the location of diversion structures very important in the control of sediment entry into the diversion channel – clear water in the upper layers of the flow is diverted to the outside or concave bank, and the sediment laden low layers of water are diverted to the inside or convex bank. Diversion structures built on the convex bank will receive a heavy load of sediment while a diversion on the concave bank will receive a much lesser load.
- Case studies are provided that identify unintended consequences of diversions, such as downstream sediment deposition and unanticipated dredging, in large part due to the lack of tools or a strategy to address the large-scale impacts of the diversion.
- The majority of numerical modeling studies show that flow diversions cause a depositional response in the river downstream of the diversion, particularly in the reach immediately downstream of the diversion.
- Numerical analysis tools, such as SIAM, HEC-RAS, TABS-MD, ADH, CH3D-SED, and ADCIRC are described for developing tools and performing analysis in each of the dimensional formulations.

## Report Recommendations:

- Successful planning for diversion projects requires understanding of the critical processes that impact the hydrodynamics and sediment transport within the river system. This planning should include:
  - A detailed geomorphic assessment to evaluate channel morphology and sediment transport impacts. It is essential to consider potential morphologic effects on both the main channel as well as the receiving channel.
  - Application and development of conceptual models that inform the geomorphological analysis and provide understanding of the underlying processes.
  - Development, validation and use of physics-based tools and models based on hydrodynamic and sediment transport, guided and informed by the geomorphologic assessment and the conceptual model process.
  - A regional-scale analysis of diversion impacts on water flow and sediment transport to include use of computational tools for screening purposes such as regional, one-dimensional models integrated with localized higher dimensional models at diversion sites and in receiving basin. Time scales for evaluating system-wide assessments should be at least decades.


# River Diversion Induced Shoaling

## Report Recommendations Continued:

- Model codes and computational tools, in concert with a geomorphologic assessment and appropriate conceptual models provide a means of exploring solutions that consider both the needs of restoration and wetland management and the needs of navigation and flood control.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)


# Sea-Level Rise in the Northern Gulf of Mexico

**Issue:** Properly accounting for relative sea-level rise is a critical aspect of ecosystem restoration and management and land-use planning throughout the northern Gulf of Mexico. While this topic is important in all coastal areas, it is more critical in Louisiana than in any other region of the United States, due to coastal Louisiana's unique geology and deltaic coastal system. Compounding the problem of high historic relative sea-level rise rates is the likelihood of a 21st century acceleration in the global sea level rise rate due to climate change. It is important that current and future planning for the northern Gulf of Mexico properly consider both historic data and future projections for sea-level rise.

**Action:** Develop a synthesis document describing both historic rates and future projections for relative sea-level rise throughout the northern Gulf of Mexico. This project will:

- Compare the results of previous investigations of historic rates of relative sea-level rise in the northern Gulf of Mexico with the Intergovernmental Panel on Climate Change projections for global sea-level rise in the 21st century to determine projections of relative sea-level rise throughout the northern Gulf of Mexico in the 21st century.
- Describe the uncertainties associated with calculating historic rates of subsidence and projecting future rates of relative sea-level rise.

**Benefits/Results:** A comprehensive document will facilitate discussion about the appropriate use of sea-level rise information in the planning and design of barrier island and coastal wetland restoration projects as well as in general land-use planning efforts.

**Agencies/Partners**:

- Louisiana Department of Natural Resources (LDNR)
- U.S. Army Corps of Engineers (USACE)
- U.S. Geological Society (USGS)

# Sediment Transport Modeling Tools for the Mississippi and Atchafalaya Rivers

**Issue:** The Mississippi River Delta area of coastal Louisiana is deprived of much of the river's sediment. Therefore, alternative solutions to recover or re-direct portions of this valuable sediment to benefit Louisiana coastal lands should be carefully investigated. The determination of the fate of suspended sediment and bed load sand is important to the successful design and implementation of Mississippi River diversions in the coastal zone. To build a sustainable and healthy wetland system that contributes to hurricane protection, the sediment resources from the Mississippi and Atchafalaya Rivers must be properly managed.

**Action:** This project will initiate development of and identify future research and development needs for physically-based quantitative numerical models to describe the dominant physical processes of sediment transport in the Mississippi and Atchafalaya Rivers by:

- Reviewing literature and compiling historic data
- Collecting high-quality and extensive field measurements of sediment and flow
- Calibration and validation of one- and multi-dimensional river models

**Benefits:** Successful implementation of solutions to reintroduce river sediments to coastal marshes requires that the impact of the restoration projects on the river and the receiving basin be considered. Extensive field measurements and numerical modeling of hydrodynamics and sediment transport within the rivers will help assess the potential impacts of restoration options.

## Products:

- Calibrated and validated HEC-RAS model of the Mississippi from river mile 11 to river mile 306.
- Technical Report – Morphological and Sediment Transport Modeling Tools for the Mississippi and Atchafalaya River and Deltas (in preparation).

## Results:

- The HEC-RAS model (both quasi-unsteady and unsteady), with the sediment option, were calibrated and validated. Comparisons to data were acceptable.
- The three-dimensional model FVCOM was calibrated for hydrodynamics between river miles 11 and 74.
- Preliminary tests for modeling sediment were performed with FVCOM. It was concluded that additional work is required to verify and calibrate the FVCOM sediment module.


# Sediment Transport Modeling Tools for the Mississippi and Atchafalaya Rivers

## Recommendations:

- Several critical river-side observational needs were identified including study of:
  - Meander-bend effects on suspended sediment concentrations that is relevant to diversion siting.
  - River flows at which coarse material (sand) is available in suspension.
  - The total volume and spatial distribution of sand stored in lateral and point bars in the river from New Orleans to Head of Passes.
- Alteration of the USGS-NASQAN water quality monitoring strategy in the lower river that supplies suspended sediment information critical to diversion planning.
- Examination of USACE decadal navigation survey methodology for the Mississippi and Atchafalaya channels and consideration of upgrading to multi-beam technology.
- Perform extensive calibration of numerical models against high-quality field measurements. Sufficient data should be collected such that the capability to simulate separate physical processes can be assessed.
- Quantify the confidence level of the various numerical models to simulate variables such as velocities, secondary motion, and spatial variability of sediment concentrations.
- Conduct further field research to improve model multiple size-class sediment mixture modeling and provide viable prediction of the temporal and spatial variability of the sediment load.
- Conduct research to improve our understanding of the interaction between salinity and sediment settling.
- Adopt a multi-scale modeling approach to establish an adequate level of confidence in the predictions provided.

## Agencies/Partners:

- Louisiana Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)
- University of Louisiana at Lafayette
- University of Texas
- University of New Orleans


# Thin Layer Disposal of Dredged Sediment

**Issue:** Louisiana coastal areas lose large amounts of sediment, mostly as a function of the balance between sediment accretion, marsh subsidence and sea-level rise. Other contributing factors are controlling the flow of the Mississippi River, construction of levees that restrict the supply of sediment to marshes, and intrusion of salt water due both to construction of pipeline canals and reduced freshwater inflow. One method of potentially slowing wetland loss is to artificially supply sediments to subsiding marshes. Thin layers of dredged materials have been placed on the Gulf and Atlantic Coasts; this technique shows promise for general application. In order to consider such methods for the Louisiana coastal areas, techniques employed, resulting effects on marsh sustainability, and potential ecological impacts to receiving marshes must be explored.

**Action:** The proposed work includes review and synthesis of available scientific and technical literature on thin layer disposal of dredged materials in wetlands, specifically:

- Reviewing literature for techniques employed, the resulting effects on marsh sustainability, and potential ecological impacts to receiving marshes.
- Identifying remaining issues to be resolved and factors affecting or limiting the potential for general application.

## Benefits:

- Produce a concise document to assist resource managers in evaluating the usefulness of thin layer placement of dredged materials to counteract sediment loss in deteriorating marshes.

## Product:

- Thin Layer Placement of Dredged Material on Coastal Wetlands
  http://www.mvd.usace.army.mil/lcast/pdfs/Thin%20Layer%20Placement%20Tech%20Note.pdf

## Results:

- Traditional methods of sediment application have limited physical range and tend to deposit materials in uneven layers of poorly mixed sediments.
- Spray disposal is capable of handling a variety of soil types, and can be modified to target specific sites and avoid sensitive areas.
- High pressure spraying is limited to an area less than 100 m from the spray equipment.
- Appropriate thickness of material application range from a few millimeters in freshwater wetlands to tens of centimeters in coastal marshes.


# Thin Layer Disposal of Dredged Sediment

## Report Recommendations:

- The dredging site should be relatively close to the placement area to avoid costs associated with barge or pumping transport.
- The proximity of habitats sensitive to turbidity and sedimentation, such as oyster beds and seagrass meadows, should be identified prior to material placement to avoid adverse impacts to life-cycle processes and survivability.
- Calculating appropriate thickness of material to apply requires an understanding of the desired elevation, the nature of the material being applied to include the extent of dewatering and subsequent compression, as well as the determination of sufficient slope to ensure proper hydrologic flow so that ponding does not occur that may drown the receiving area.

## Agencies/Partners:

- Office of Coastal Protection and Restoration (OCPR)
- U.S. Army Corps of Engineers (USACE)


# Vertical Accretion Rates in Coastal Louisiana Marshes

**Issue:** Coastal marshes in Louisiana continue to deteriorate and are being lost at an average rate of nearly 90 $km^2$ per year. Coastal marsh stability is governed by many complex processes and is a balance between sediment accretion, marsh subsidence, and eustatic sea-level rise. The potential for marsh substrate accretion to keep pace with sea level rise depends on processes involving sediment deposition on the marsh surface and production of organic matter. These processes vary both spatially and temporally and are not well understood in many Louisiana marsh systems.

**Action:** A review and synthesis of the available scientific literature concerning vertical accretion rates in Louisiana coastal marshes in response to a changing environment was conducted. The findings of the literature review were documented in a technical note.

**Benefit:** This study provides an overview of the present state of knowledge regarding vertical accretion rates in coastal Louisiana and the complex processes that govern them. The review identifies knowledge gaps and identifies future data and research requirements.

**Product:**

- Vertical Accretion Rates in Coastal Louisiana: A Review of the Scientific Literature http://libweb.wes.army.mil/uhtbin/hyperion/EL-TN-10-5.pdf

**Results:**

- Measurements of accretion rates across coastal Louisiana are presently 0.7 to 0.8 cm/yr on average and are therefore not adequate to keep up with present rates of sea level rise in most regions.
- Marsh substrate elevations are negatively affected by changes in hydrology, local subsidence, compaction, and oxidation of surface sediments that vary over small spatial scales, resulting in net accretion rates varying significantly on a local level and over time.
- Accurate measurements of accretion on a site by site basis are necessary to understand how the site is responding to sea level rise, determine what management and conservation practices best address the site, and to predict how the site will respond to projected increases in sea level.

**Recommendations:**

- Collection of accretion rate data should be paired with concurrent measurements of elevation change to determine if accretion rates are keeping pace with changes in rates of subsidence.


# Vertical Accretion Rates in Coastal Louisiana Marshes

## Recommendations Continued:

- Potential impacts of eutrophication on below ground biomass production and sediment compaction should be quantified.
- Spatial biological-physical feedbacks related to the development of vegetation-channel patterns in wetlands need to be considered.

## Agencies/Partners:

- U.S. Army Corps of Engineers (USACE)
- Louisiana Department of Natural Resources (LDNR)