REDUCING FLOOD DAMAGE IN COASTAL LOUISIANA: COMMUNITIES, CULTURE & COMMERCE

Based on Conceptual Ecological Model Workshop, November 2005
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Louisiana's national contribution (% of US total)

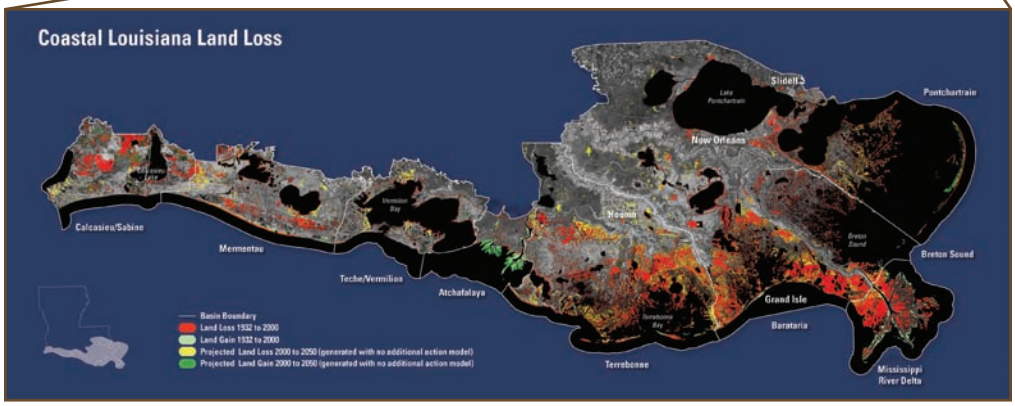
- 27% of crude oil
- 15% of natural gas
- 30% of commercial fisheries
- 21% of waterborne commerce

Map modified & reproduced from Theodora Maps

The Mississippi River is the largest and longest river in North America, and its drainage area includes over 1.8 million square miles.

The river provides drainage for 41% of the continental U.S., including all or part of 31 states and two Canadian provinces.

Of the world's rivers, the Mississippi River ranks third in length, second in watershed area and fifth in average discharge.



Historical and projected land loss from coastal Louisiana.
Map reproduced from Barras, J., Beville, S., Britsch, D., Hartley, S., Hawes, S., Johnston, J., Kemp, P., Kinler, Q., Martucci, A., Porthouse, J., Reed, D., Roy, K., Sapkota, S., and Suhayda, J. 2003. Historical and projected coastal Louisiana land changes: 1978–2050: USGS Open File Report 03-334, 39 pp.

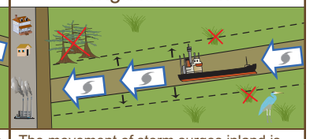
Flood damage following Hurricanes Katrina and Rita.

Protecting and restoring coastal Louisiana is a national priority

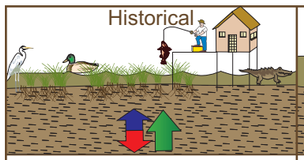
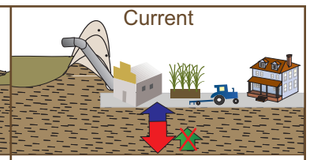
Coastal Louisiana is home to the nation's largest port complex in both tonnage and infrastructure, and produces or transports nearly one-third of the nation's oil and gas supply. In addition, the coastal Louisiana ecosystem provides nationally-important fish and wildlife habitat that supports the nation's second-largest commercial fishery and over $1 billion per year in recreational fishing and hunting revenues. All of these activities are supported in Louisiana because of the close proximity of its skilled workforce to the Gulf of Mexico. Coastal land loss has placed these economic and natural resources at increased risk of loss due to the intense effects of waves and storm surges from hurricanes. Restoration of the coastal ecosystem can work synergistically with levees and floodgates to provide an integrated flood protection system that allows continued resource production and sustains the ecosystem services on which the nation relies.

COASTAL FLOOD PROTECTION VIGNETTES

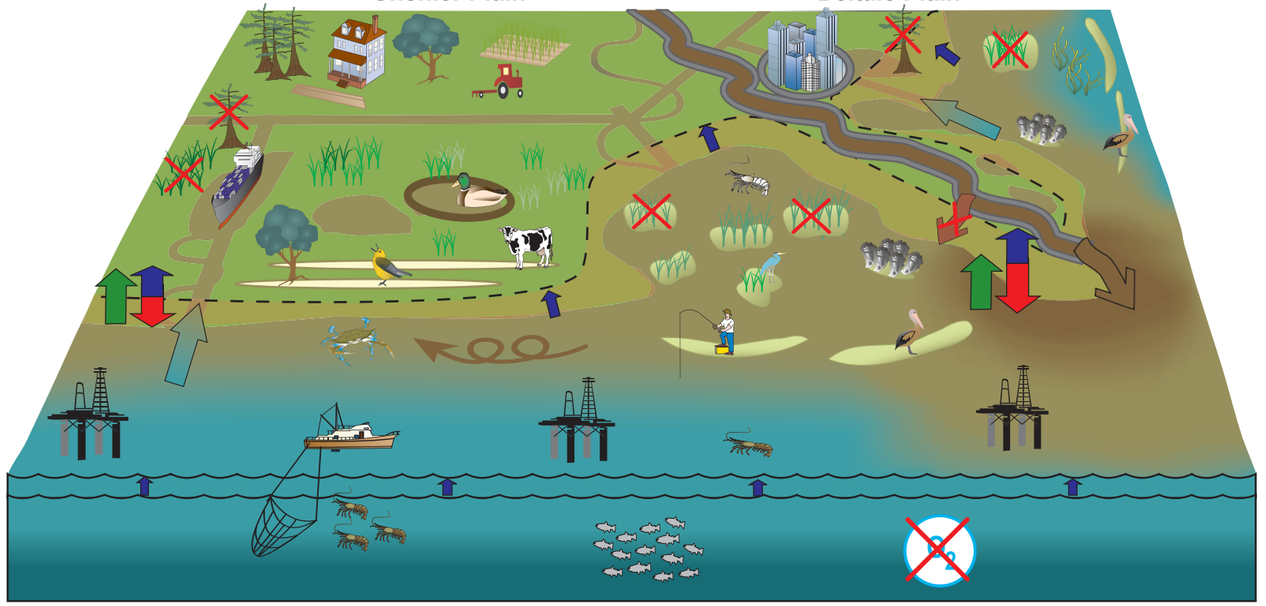
1. Storm surge impacts

Natural channel	Navigation channel
	
The movement of storm surges inland can be dampened via overland flow of healthy marshes & cypress swamps & flow through natural meandering channels. Unleveed, natural channels allow for sediment & nutrient exchange with the landscape. Shallow, narrow channels are generally traversed by fishing vessels & other recreational boaters.	The movement of storm surges inland is uninhibited when flowing through straight, deep navigation channels created for large commercial vessels. This requires construction and maintenance of large, flood protection levees. These channels also provide a pathway for saline water to move inland, resulting in the death of cypress swamps & freshwater marshes. Leveed channels inhibit sediment & nutrient exchange with the landscape. Over time, navigation channels tend to widen & deepen.

2. Sacrificing renewable natural resources

Historical	Current
	
Healthy coastal wetlands support diverse fauna. Fish find nutrition & mature along the marsh edge; songbirds & waterfowl spend critical time in the coastal wetlands during yearly migrations. In natural systems, subsidence combined with sea level rise is compensated by soil accretion (deposition from rivers, coastal resuspension, & plant biomass). These sustainable processes keep the marshes healthy, intact, & above the water level.	Human intervention in these processes has converted sustainable wetlands to pastures, agricultural lands, & cities that require higher levees & larger pumps for flood protection. By converting wetlands to other uses & eliminating the natural process of soil accretion, the landscape no longer builds vertically. In combination with sea level rise & increased subsidence, the landscape eventually sinks below the water level.

Chenier Plain — Deltaic Plain

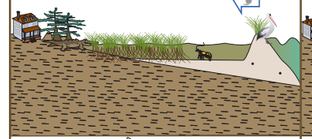
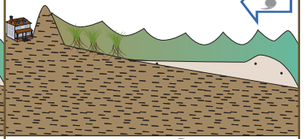


Coastal Louisiana Features

The Chenier and Deltaic Plains of coastal Louisiana are comprised of a complex and highly dynamic ecosystem created by 7,000 years of sediment deposition from the Mississippi River. The diversity of coastal habitats & landforms range from natural levees, beach ridges, chenier ridges, & barrier islands, to the expanses of forested wetlands, & fresh, brackish, & saline marshes, & seagrass beds. These unique habitats are hydrologically connected to each other & to the Gulf of Mexico. These coastal ecosystems support migratory routes for waterfowl, neotropical songbirds, various fish species, & commercially important shellfish including white shrimp, brown shrimp, blue crabs, & oysters. Longshore transport of sediments is generally from east to west, & inshore sediment is distributed during high water events. Sediment subsidence combined with sea level rise exceeds sediment accretion throughout many coastal areas; however, the greatest net subsidence occurs in the Deltaic Plain.

Louisiana's coastal wetlands are also the center of a culturally diverse society that relies heavily on the utilization of these resources. Oil & gas activities, navigation, levees, agriculture, & other land uses have disrupted the natural hydrologic & sediment transport processes, & along with natural factors such as land subsidence, sea level rise, & storm events, significant coastal erosion & land loss have occurred. Elevated nutrient concentrations in the Mississippi River result in a hypoxic zone in the northern Gulf of Mexico. Salt water intrusion is also an issue within coastal Louisiana. As saline marine water encroaches further into the fresher, sediment-rich coastal water, salinity increases, resulting in the loss of forested wetlands and freshwater marshes. Coastal protection & restoration features are designed to work with nature to provide the necessary freshwater, sediment, & nutrients to sustain coastal systems.

3. Storm protection

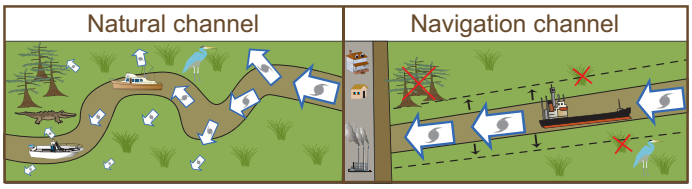
Historical	Current
	
Barrier islands & continuous marsh act as buffers to reduce storm surge penetration & wave impacts along the coast. With the presence of healthy, intact barrier islands & extensive wetlands, only small flood protection levees are required.	As barrier islands erode, their buffering capacity is lost. Storm surges & wave impacts penetrate farther inland with increased magnitude and frequency. This results in the need to build and maintain larger levees & more complex pumping systems to protect communities & commercial infrastructure.

4. Maintaining flood protection

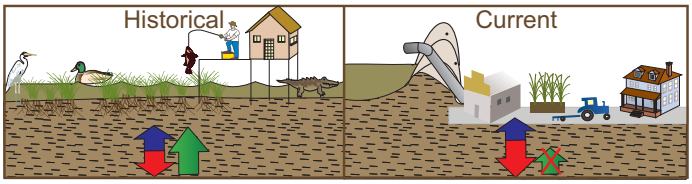
Natural environment	Human environment
	
Before levees were built, regular flooding from rivers & bays added sediments, & healthy wetland plants added organic matter (accretion). This allowed the land elevation to remain stable relative to sea level rise & soil subsidence.	Levees disrupt the delivery of sediments, & pumping water from the soil increases soil subsidence. Maintaining dry land within levees reduces soil accretion & requires increasing both the levee height & pump capacity as the land continues to sink & the sea level rises.

CONCLUSIONS AND RECOMMENDATIONS

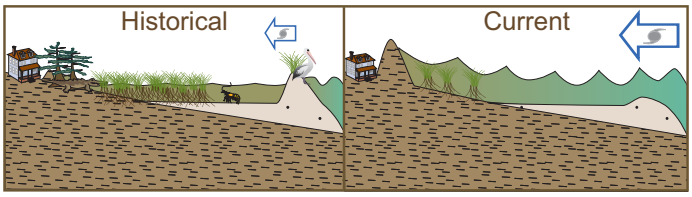
1. Unintended consequences of flood protection measures & individual public work projects have increased risks to natural resources & human settlements resulting in a more dangerous place to live & work.



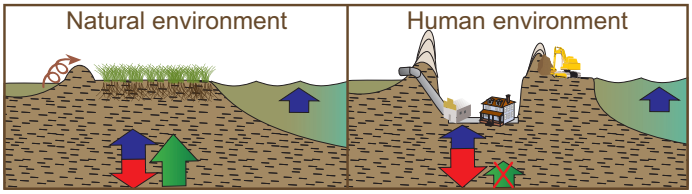
2. Many previous flood protection projects sacrifice production of renewable natural resources to provide occasional benefits to the human environment.



3. Natural coastal landscapes including wetlands, barrier islands, & ridges provide storm protection by dampening waves & reducing storm surge.



4. Traditional flood protection approaches require continual maintenance to remain effective against relative sea level rise, in contrast to self-sustaining natural systems.



1. ***Ensure*** that flood protection planning is integrated with comprehensive ecosystem restoration goals.
   a. ***Integrate*** restoration projects with large-scale public works or private development projects (e.g., port & highway development within areas influencing coastal ecosystems).
   b. ***Minimize*** duplication & missed opportunities for partnerships, & ***avoid*** possible conflicts & unintended consequences.

2. ***Maintain*** ecosystem services by constructing flood protection measures that allow tidal exchange except under threat of catastrophic flooding.
   a. ***Elevate*** and/or bury structures in flood-prone areas.
   b. ***Provide*** opportunities for natural processes to distribute sediments through flood protection structures.

3. ***Rehabilitate*** coastal landscapes to reduce storm damage.
   a. ***Rebuild*** & ***maintain*** barrier shorelines to minimize wave damage to vulnerable coastal infrastructure.
   b. ***Extend*** wetland landscapes to reduce flood risks to coastal communities.

4. ***Implement*** a flood protection program that relies on a combination of levees, floodgates, & ecosystem restoration.
   a. ***Evaluate*** flood risks & levels of protection at regular intervals.
   b. ***Modify*** protection measures to maintain flood protection.

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Some of the participants in the Conceptual Ecological Model Workshop.

FURTHER INFORMATION
SCIENCE COMMUNICATION

Coastal Louisiana Ecosystem Assessment & Restoration (CLEAR) www.clear.lsu.edu
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