Climate Change, Community Resilience, and Restoration in the Gulf of Mexico

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Capstone Final Report
June 15th, 2015

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Preface

This report is the combined effort of independent research and an informational webinar co-hosted by the Environmental Law Institute, the Gulf of Mexico University Research Collaborative (GOMURC), and the Mississippi/Alabama and Louisiana Sea Grant programs. Held on April 10th, 2015, this webinar brought together a panel of experts to discuss the complex intersection of climate change, community resilience and Gulf of Mexico restoration. Panelists focused on challenges and opportunities for creating restoration projects that both incorporate climate change considerations and are responsive to the needs of coastal communities.

Independent research and key message synthesis was conducted to supplement information provided by each panelist as part of this Master's Capstone Project. A companion video was also produced in conjunction with the report. The video can be found at: https://vimeo.com/128644900

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Executive Summary

Purpose Statement: Promote understanding of known and potential impacts of climate change in Gulf of Mexico ecosystem restoration and community resilience.

The Deepwater Horizon oil spill disaster in 2010 devastated the Gulf Coast communities and is considered the worst spill in U.S. history. While some approaches exist on how to integrate climate change into restoration decision-making, many post-Deepwater Horizon restoration projects fail to adequately address climate change impacts. This report will discuss how to consider the known and potential impacts of climate change on restoration efforts in order to build resilience in coastal communities.

Climate change can affect restoration efforts in many ways. Sea level rise threatens coastal infrastructure and and restoration efforts, and may contaminate fresh groundwater supply. Hazards like storm surge and flooding result in loss of property or even life. Climate change may also cause serious drought or flooding in other regions that affect downstream Gulf ecosystems. Ocean acidification caused by increasing carbon dioxide (CO2) emissions and take-up by ocean waters, depletes the ocean of carbonate compounds that clams, oysters, coral, plankton, and other creatures need to build shells and skeletons; many of these species are commercially valuable in the Gulf of Mexico. At-risk communities are often at the frontline of these major changes and are directly tied to the resiliency of the natural environment. By protecting the natural environment, coastal communities and important sources of economic development can be more resilient.

Key Considerations:

- **Incorporate sea level rise considerations into restoration planning**: Long-term decision-making must ensure that built infrastructure in the near-term path of sea level rise has been adapted to future higher water levels.
- **Preparation today means savings tomorrow**: FEMA estimates that $1 of mitigation today results in $4 of future savings (FEMA, 2015).
- **Avoid quick fixes at the expense of long-term solutions**: Conflicts may arise when considering quick fixes, such as hardening shoreline (building seawalls), versus more environmentally friendly solutions that are longer lasting (Currin et al, 2010). Additionally, long term monitoring programs must be implemented to better understand and prepare for developing climate trends.
- **Restoration efforts must be tailored to specific regions, but in the context of the entire Gulf Coast**: Overall, post Deepwater Horizon restoration funds are managed at the state and regional levels providing the opportunity to adapt unique guidelines for each county's different coastal processes; however, this should not occur at the expense of ecosystem-level restoration efforts.
- **Achieving a healthy coastal environment requires healthy coastal communities**: Sustained health of the Gulf environment and economy relies on creating opportunities for at-risk communities to become more resilient to disaster events and long-term climate changes that impact Gulf coasts.

Figures

I. Introduction

The Gulf of Mexico is a dynamic ecosystem that is further complicated by human activities and the widespread effects of climate change. As one of the most ecologically and economically valuable marine ecosystems in the world, the fate of the Gulf is globally significant, particularly after natural and human-caused disasters (Karnauskas et al, 2015). Climate-related stressors such as ocean acidification, land subsidence, sea level rise, and storm surge conspire to make it a challenging marine and coastal ecosystem to manage.

The 2010 Deepwater Horizon oil spill exacerbated an already difficult situation in the Gulf. Citizens of coastal communities find themselves at the frontline of monumental changes, but are infrequently engaged in post-spill restoration projects (Andrew Shepard, personal communication, April 15, 2015; assessed through review of DWH Project Tracker, Gulf of Mexico Alliance, available at http://www.dwhprojecttracker.org/). Long-term efforts are needed to service the people and environment impacted by the Deepwater Horizon oil spill.

The relationship between post-Deepwater Horizon restoration, climate change adaptation, and community resilience is complicated. The spill dealt a debilitating blow to the Gulf's ability to bounce back from ecological, economic and social hardship. The disaster shifted attention back to the way "the Mississippi River Delta is being managed into oblivion" (Cheong, 2014). Over the last several generations, coastal communities have developed a close relationship with the wetlands. However, for the last few decades residents are moving away from the coast because of massive disruptions to the wetlands by human-induced and natural processes (Cheong, 2014). The oil spill and any future oil spills seriously cripple the natural system's ability to be resilient against previously mentioned phenomena like sea level rise and storm surge.

Cat Island, for example, was once a critical habitat for four large rookeries in Louisiana supporting brown pelicans, snowy egrets, roseate spoonbills, and lease terns. Prior to the oil spill, the island was largely a pristine nesting habitat. After the spill, encroaching oil killed most of the root system holding the island sediment together. Scientists estimate this bird sanctuary will last around one more year before it disintegrates entirely. This will be devastating not only for birds that nest there, but for the coastal communities who have lost another buffer against powerful storms (Faerber, 2015).

This report will discuss how to consider the known and potential impacts of climate change on post-spill restoration efforts in order to build resilience in coastal communities.

II. Unprecedented restoration opportunities post-Deepwater Horizon oil spill

The Deepwater Horizon Oil Spill

Until 2010, the Exxon Valdez oil spill in 1989 was the largest spill ever to take place within U.S. waters after a tanker released 11 million gallons of oil off Alaska (Short, 2014). Twenty-five years after the disaster, several fishing communities in one of the largest and most productive estuaries in North America have yet to recover (Elliot and Penaloza, 2014).

The 2010 BP oil spill, also called the Deepwater Horizon oil spill, easily surpassed the Exxon Valdez event, discharging 4.9 million barrels (210 million US gal; 780,000 m^3) (FOSC 2011). The spill lasted for 87 days as engineers frantically searched for a solution to cap the well. Several investigations, government reports, and impact statements later, faulty infrastructure and an underprepared crew were contributing causes to the accident (Barstow et al, 2014). In 2014, a federal Judge held the responsible parties grossly negligent (ELI, 2014a; Mufson, 2014).

New Opportunities

Given the unprecedented size of these restoration monies, there is enormous opportunity to build a healthy Gulf environment and economy. Although there are several other restoration programs active in the Gulf, this report will focus on those formed after the BP oil spill. This section will provide a break down detailing how much has been committed to five specific restoration programs to date.

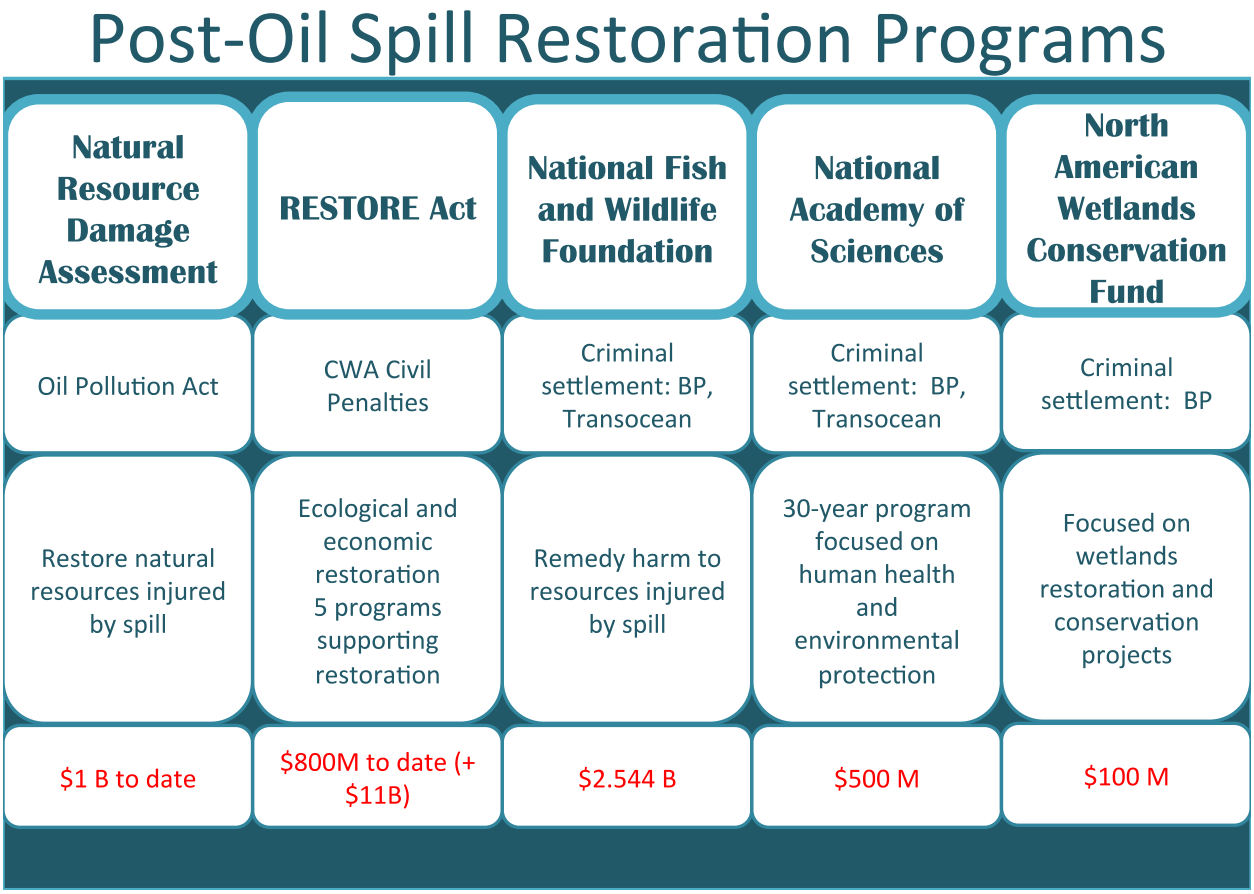

Figure 2.1. Post oil-spill restoration programs as of June 2015. Source: Mengerink, 2015.

As of June 2015, post-oil spill penalties include support from at least five major sources (Figure 2.1). The sum of these monies is substantial and provides an opportunity to address climate

change impacts and promote community resilience. As of June 2015, BP committed $1.5 billion for early restoration and the Gulf of Mexico Research Initiative. The RESTORE Act ensures that 80% of the Clean Water Act civil penalties are directed to the Gulf of Mexico for ecological and economic restoration. In 2013, Transocean's criminal settlement committed $800 million to the RESTORE Act. In July 2015, BP settled with the court to pay $18.7 billion for civil penalties including $7.3 billion for Natural Resource Damages, $5.5 billion for Clean Water Act penalties ($4.4 billion for RESTORE Act trust fund), and $5.9 to the Gulf states for their economic loss claims (ELI, 2015).

The BP and Transocean criminal settlements funded four key programs. The National Fish and Wildlife Foundation received $2.445 billion to remedy harm to natural resources injured by the spill; the National Academy of Sciences Program received $500 million for a 30-year program focused on human health, environmental monitoring and protection, and improving oil and gas safety; the North American Wetlands Conservation Fund received $100 million for wetland restoration and conservation; the RESTORE Act programs received $800 million from the Transocean settlement; and the Oil Spill Liability Trust Fund received $200 million from the Transocean settlement.

How do these programs address climate change?

Although there is no explicit language in the RESTORE Act that requires projects to undertake actions that address climate change impacts, climate change must be considered to achieve the program objectives of the direct and spill impact components (components 1 and 3 in Figure 2.2), which include restoration and protection of coastal natural resources, mitigation of damage to these resources, and flood protection; all of these issues correlate with sea level rise, a direct consequence of climate change.

The Gulf Coast Ecosystem Restoration Council (component 2 in Figure 2.2 and responsible for oversight of component 3) will prioritize projects that address one of four criteria related to restoration and protection of resources injured by the spill including fisheries, marine and wildlife habitats, and beaches and coastal wetlands most impacted by the spill. The RESTORE Act Science Program (component 4 in Figure 2.2) is tasked with supporting marine and estuarine ecosystem research and monitoring.

Lastly, each Gulf state will host a Centers of Excellence Research Grants Program (component 5, Figure 2.2) to focus on science, technology, and monitoring. Eligible disciplines include: coastal and deltaic sustainability, restoration, and protection; sustainable and resilient growth and development; and comprehensive ecosystem observation, monitoring, and mapping.

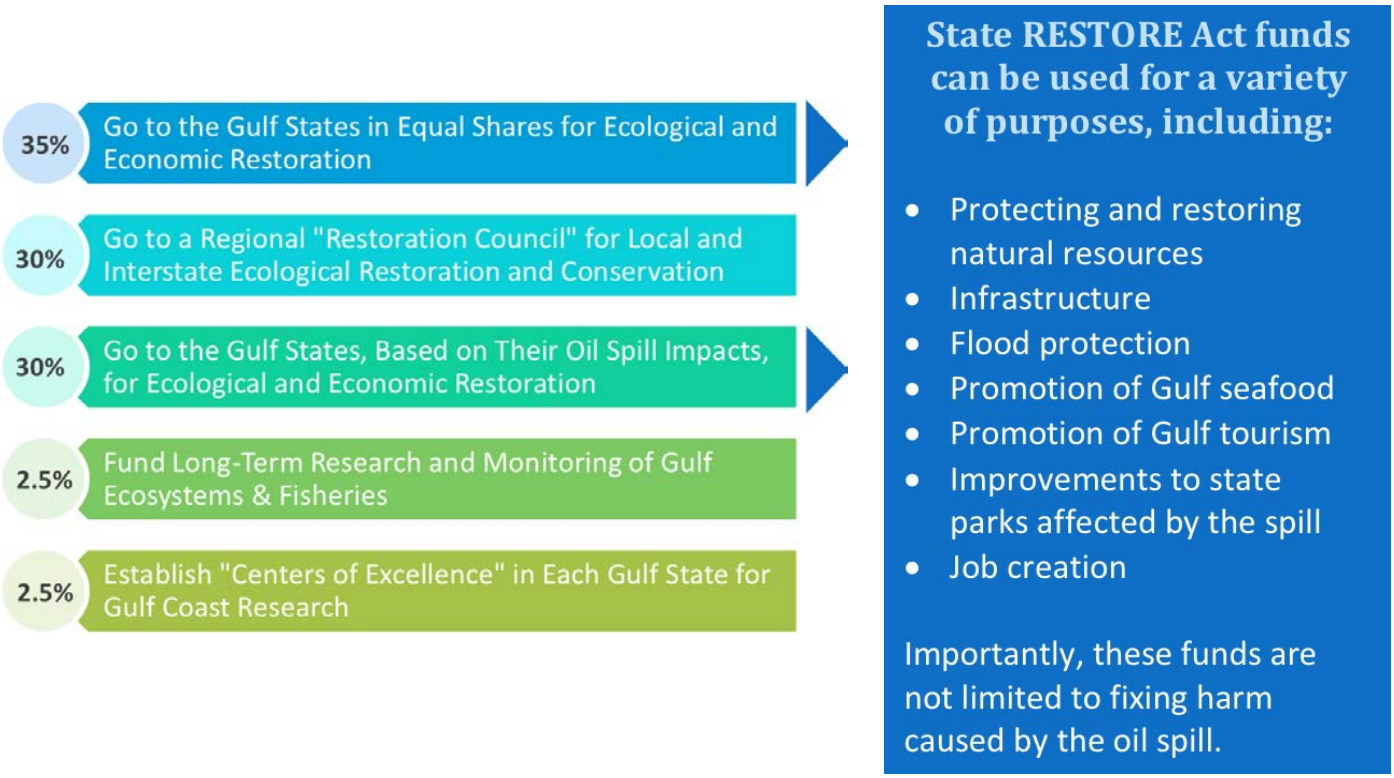

Figure 2.2. RESTORE Act funds are divided into five components. Source: ELI , 2014b.

III. Climate change's effect on restoration and the health of Gulf communities

The U.S. coastline bordering the Gulf of Mexico of 1,631 miles incorporates vastly different ecoregions as shown in Figure 3.1 (EPA, 2015). Restoration should be administered with these differences in mind based on the understanding that a blanket restoration approach may not serve every region of the Gulf appropriately. Each region should adapt unique design features for their coastal settings (Twilley, 2001). Additionally, land use change and other human modifications to coastal processes (and their watersheds) alter the features of ecosystems in coastal settings. This may include agriculture in the upper watershed or urban development in coastal watersheds.

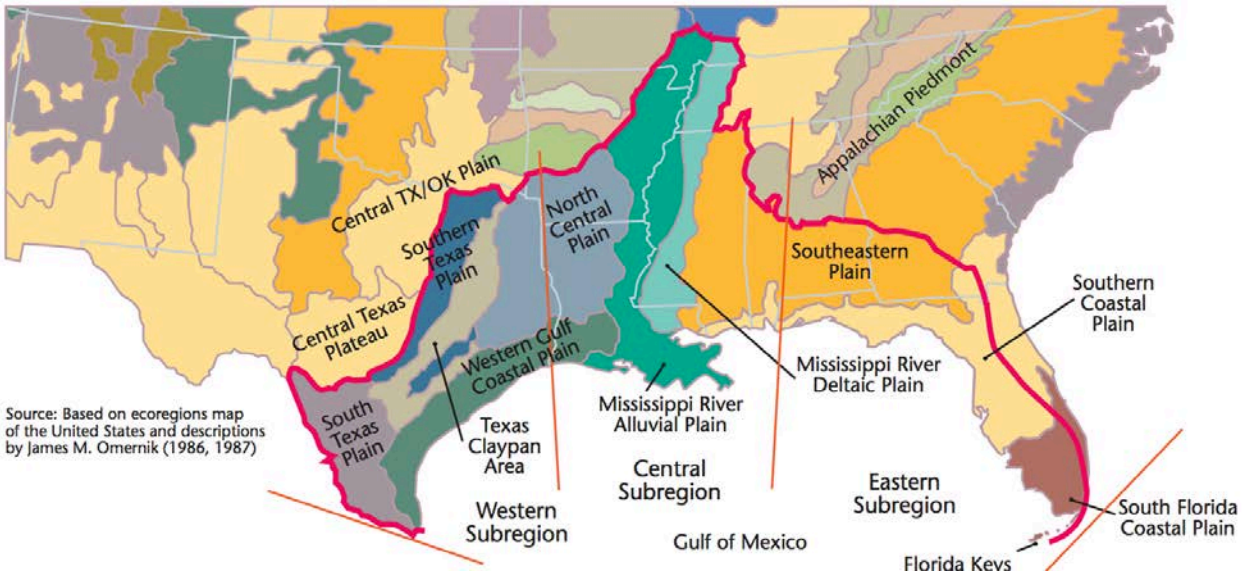

Figure 3.1. The gulf coastline is characterized by several different ecoregions with varying climates. Source: Twilley et al, 2001.

Climate change will amplify the effects of land use change on coastal processes and coastal ecosystem stability (Twilley, 2001). Restoration plans must account for the interactive effects of both impacts (land use and climate change) to ecosystem services.

One way in which climate change can compromise resiliency is by influencing the net balance of water. Water is a critical design feature related to ecosystem restoration. As shown in Figure 3.2, water appears in several forms including evapotranspiration, precipitation (runoff), sea level, and glacier melt (land ice to ocean). These elements exist in a balance that is disrupted by climate change (Twilley, 2001).

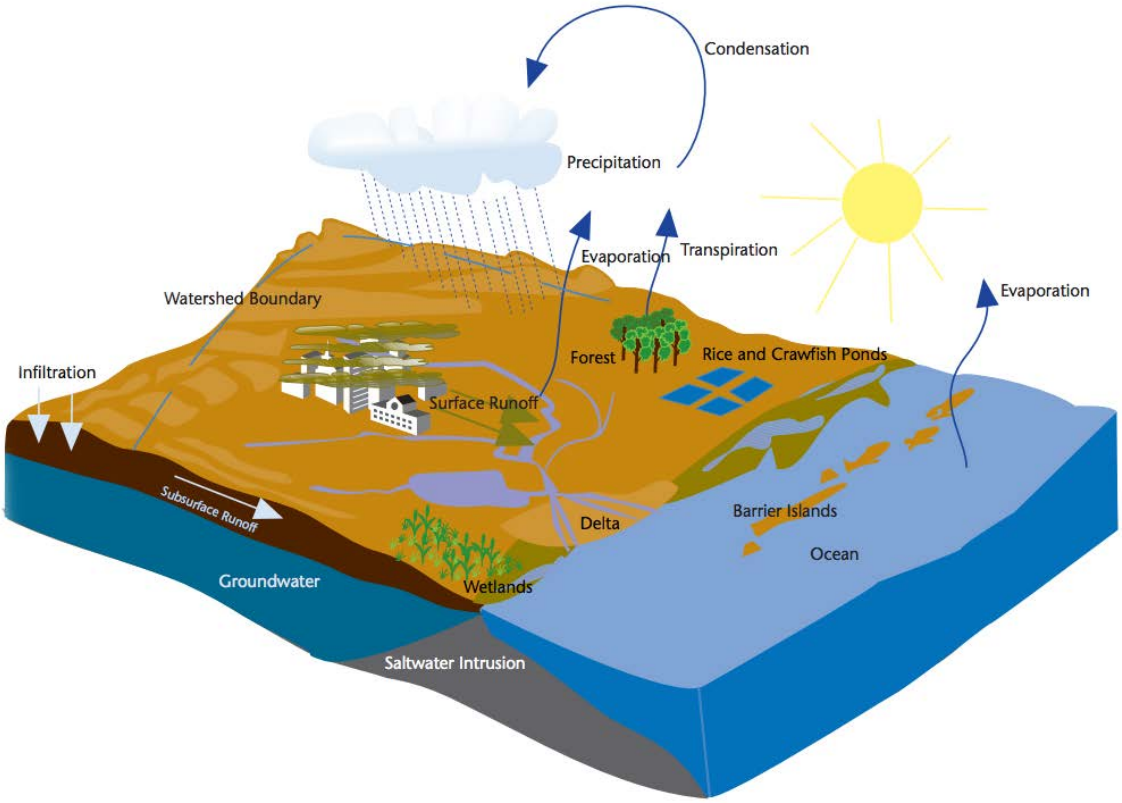

Figure 3.2. Net balance of water is impacted by simultaneously occurring events. Source: Twilley et al, 2001.

Evapotranspiration, the sum of evaporation and plant transpiration from the Earth's land and ocean surface to the atmosphere, affects the salinity of a system. A proper balance in salinity is imperative to ecosystems that rely on a specific ratio of salty to fresh water to support the organisms that live in it. An example of this occurs when rising sea level inundates previously fresh or brackish water systems that contain species like oysters that are reliant on low salinity. Related, the amount of precipitation from upstream (drought or inundation) also greatly influences the amount of freshwater introduced into a system (Twilley, 2001).

One of the most critical changes to coastal settings will be future sea levels, which will increase environmental and human risks along the coast. Illustrated in Figure 3.3, higher water levels are especially significant for Gulf states, which are expected to undergo more extreme changes than other coastal areas of the nation (NOS, 2011). In some places where land is subsiding, such as in the MS River Delta, the relative sea level rise may be even more extreme. Restoration plans should include adaptation measures for coastal areas proportional to predicted changes in elevation.

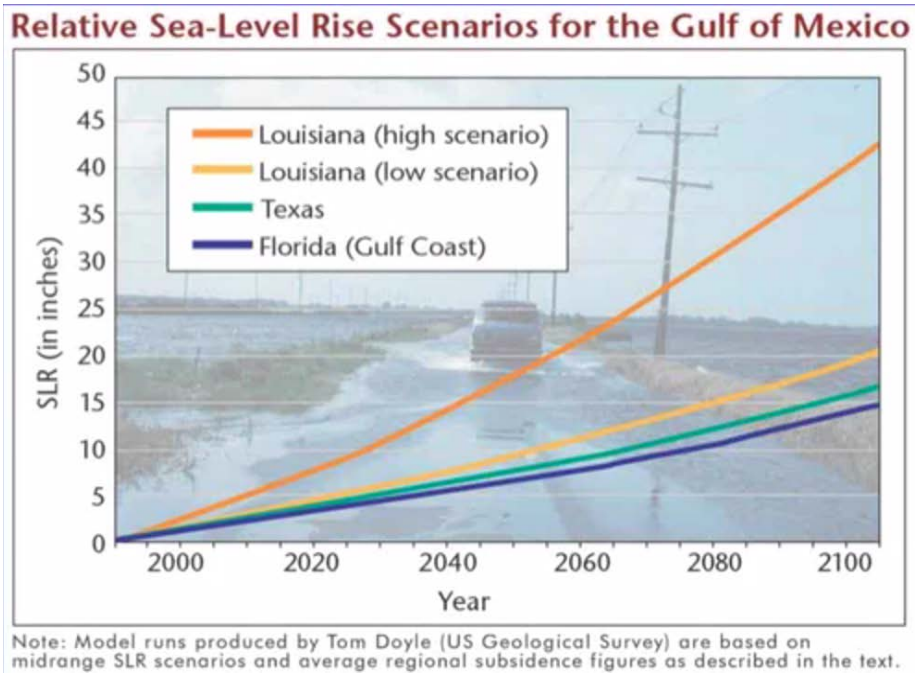

Figure 3.3. Projected sea level rise across Louisiana, Texas, and Florida. Source: Twilley et al, 2001.

Increased ocean acidification presents another challenge. Increasing anthropogenic carbon dioxide in the atmosphere causes oceans to become acidic, reducing the calcium carbonate saturation state for organisms that build their shells and skeletons using this mineral (Ries, 2009). Decreased ability to produce carbonate shells will continue to significantly damage some commercially viable fisheries such as clams, shrimp, scallops, and oysters (Ries, 2009). Additionally, fish and other organisms can develop metabolic, immune, and reproductive issues. These effects ripple through food webs as ocean acidification may decrease prey for higher trophic levels (Twilley, 2001).

To promote Gulf coast community resilience, ecosystem restoration programs need to plan for future scenarios and create aggressive implementation plans that account for storm surges, ocean acidification, and other climate change-related issues.

IV. Communities most impacted by climate change and other disasters

Coastal communities of all economic classes and ethnicities are vulnerable to climate change impacts. As shown in Figure 4.1, 49% of Louisiana's population lives within a Gulf Coast Special Flood Hazard Zone. These flood zones are situated in coastal areas that have additional hazards due to wind and wave action.

Estimated Total Population

	Population in the Gulf Coast Special Flood Hazard Area	Gulf Coast Special Flood Hazard Area Population as Percent of Population in Gulf Counties Containing FEMA V-Zones
Texas	1,072,642	18%
Louisiana	1,290,051	49%
Mississippi	129,265	37%
Alabama	83,881	15%
Florida	1,645,514	29%

Figure 4.1 Estimated populations within the Gulf coast Special Flood Hazard Area by state compared to population in counties containing FEMA V-Zones, based on data collected from 2005 to 2009. Source: NOS, 2011.

Most at risk are poor/low income families, the elderly and disabled, those coming from cultures that rely heavily on coastal resources to survive, citizens who speak English as a second language, and communities located near extractive industries (Battle, 2015). In the Gulf Coast region 17% of the population falls below the poverty line in the Gulf Coast region (national average is 13%) making resilience in the face of environmental disasters extremely difficult (NOS, 2011). Poor communities who subsist off of seafood they catch themselves struggle significantly after a major storm or oil spill. For example, eighty percent of the Vietnamese community is involved in the fishing industry and is therefore also disproportionately affected by hurricanes and oil spills (NOS, 2011).

In order to lessen and dissolve the unequal burdens created by climate change on poor communities, restoration projects must take extra steps to engage with at-risk communities, including providing them with employment opportunities in the restoration efforts (Beatley, 2009).

V. Integrating climate change into local and regional restoration decision-making

State RESTORE Act funds can be used for a variety of purposes like protecting and restoring natural resources, but also building infrastructure and providing flood protection. Importantly, these funds are not limited to fixing harm caused by the oil spill (ELI, 2014b). Movement towards integrating climate change resilience into local and regional restoration decision-making already exists in several municipalities. The Alabama-Mississippi Sea Grant Office has developed several key visual tools to help start a conversation around sea level rise with city officials. By asking them how they interpret strategically selected pictures presented to them during focus groups, they can assess whether they are seeing climate stressors around various parts of their cities.

Sea Grant provides cities with a community self-assessment to identify vulnerabilities and strengths using a resiliency index. It also uses visualization tools, such as NOAA's sea level rise viewer and the Community Health and Resource Model (CHARM). Through these different

tools, Sea Grant has found that communities are relating climate change to increases in hurricanes, sea level rise, storm surge, and in some areas, drought based upon what they are experiencing in their local proximity.

Case Studies: How are communities adapting?

Communities often interpret climate change based on their localized impacts (Sempier, 2015). Waveland, Mississippi has seen significant recent impacts. In 2005, Waveland was Ground Zero for Hurricane Katrina, receiving 26 feet of storm surge. Instead of creating a separate Sea Level Rise Action Plan, city planners integrated climate information directly into their Hazard Mitigation Plan. This approach allowed the City to participate in the National Flood Insurance Plan, a program that incentivizes sea level rise and storm surge preparedness with discounted flood insurance rates (Sempier, 2015). In addition, Waveland created an index of potential loss estimates that includes percent of land inundated and structural damage at various levels of flooding. The index helps city officials calculate how much one, three, and six feet of sea level rise will cost them in future damage if they do not take action (Sempier, 2015).

Another community taking steps towards resilience is Orange Beach, Alabama. City planners use the Vulnerability and Consequences Adaption Planning Scenario (VCAPS) to facilitate discussion through interactive concept mapping to create visual summaries of local knowledge and vulnerability and resilience (Sempier, 2015). VCAPS is a tool assisting decision-makers in small municipalities to explore the potential outcomes and consequences of climate change in their town (Figure 5.1), and identify how to best respond to these challenges. First, the city identifies a management concern and the climate stressor. Assuming no mitigation is conducted, they then look at outcomes and consequences of the climate stressor on the management concern. By using the mental map illustrated in Figure 5.2, planners can determine what type of actions should be taken to avoid the aforementioned consequences.

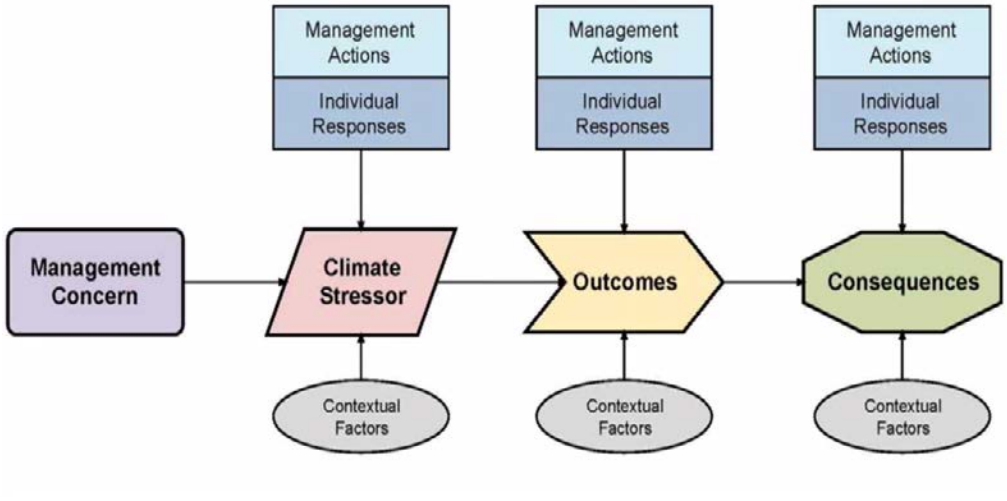

Figure 5.1. The VCAPS mental model helps planners map unattended management concerns. Source: Sempier, 2015.

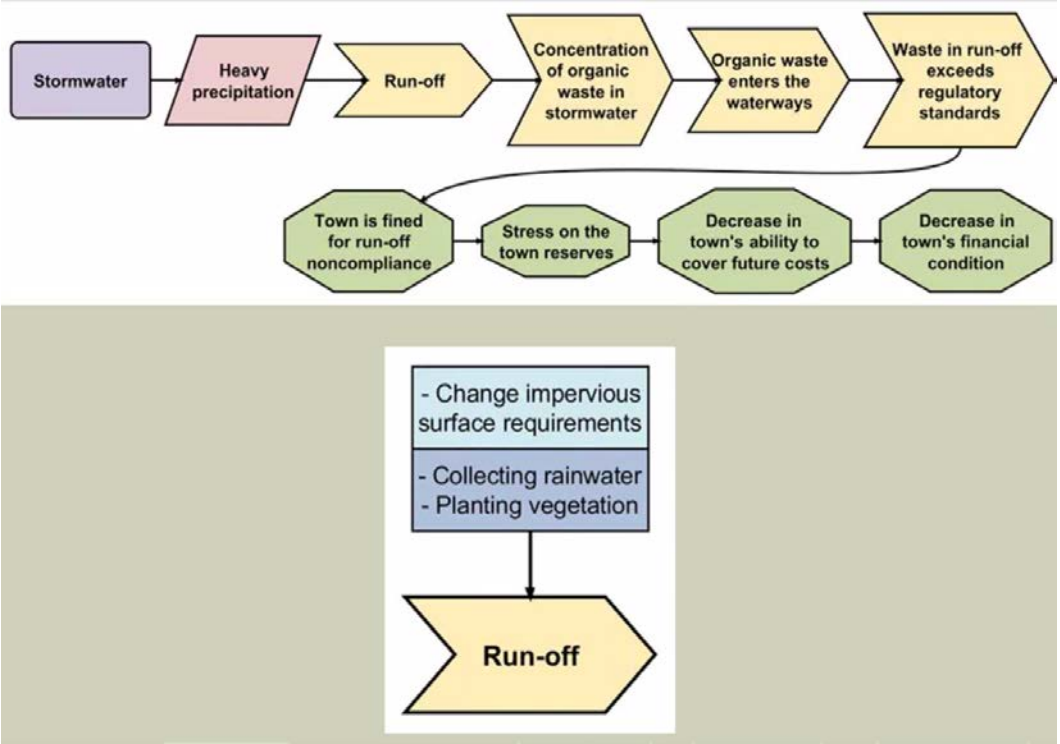

Figure 5.2 Each climate stressor is assessed individually to determine the best method of mitigation. Source: Sempier, 2015.

The last case study comes from Ocean Springs, Mississippi where the town uses flood inundation maps to determine where the greatest damage will occur from stormwater inundation through storm drains. As the city explored different mitigation strategies, they discovered that implementing living shorelines in place of riprap was not only less expensive, but also more effective at slowing erosion (Currin et al, 2010).

Incentives for taking action

There are a number of financial incentives for communities to take action. The National Flood Insurance Program Community Rating System rewards cities with discounted insurance rates for including future scenarios in their hazard mitigation plans, such as improving storm water management or creating and implementing watershed plans. There are also significant potential savings by using the program; the Federal Emergency Management Agency (FEMA) estimates that $1 spent on mitigation can yield over $4 in future savings (FEMA, 2015).

As communities take action to protect their built infrastructure, there are also opportunities to save the natural infrastructure. For instance, careful stormwater management planning could help or prevent outfall pipes from becoming inlets and pushing stormwater further inland. Additionally, preservation of trees and vegetation on uninhabited properties can improve stormwater management and flood control. Ecosystems, communities, and the economy all affect each other, and disasters and climate change have a significant impact on all three areas.

VI. Creating restoration programs to help the communities most at-risk for climate change and other regional disasters

Creating restoration programs to help at-risk communities requires a multi-pronged approach. From an economic argument, there could be several avenues towards resiliency. Diversified economies that allow money to stay in local circulation offer a greater chance of bouncing back after a disaster (Beatley, 2009). Green and sustainable industries that utilize local materials and laborers also provide a greater opportunity for resiliency. Leadership at the Gulf Coast Center for Law & Policy has offered several suggestions for restoration programs. The Center proposes to set aside funds for workforce development rooted in renewable energy with appropriate labor practices. By doing so, at-risk communities can shift away from extractive industries (Battle, 2015). As the likelihood of climate refugees becomes more real, restoration must also consider creating plans for controlled migration as well as building the capacity of neighboring communities to handle an influx of residents in the coming years.

The natural environment is both a catalyst and moderator of coastal vulnerability. Although storms have the capability to undermine built environments, natural solutions like living coastlines can help mitigate erosion (Currin et al., 2010), especially in habitats that fringe vulnerable communities and infrastructure (Arkema, 2013). In fact, coastal habitats that remain intact offer the greatest opportunity to not only prevent property value from declining, but also reduce the occurrence of environmental hazards by half for vulnerable coastal communities (Arkema, 2013).

Conclusions: Spill Restoration Action Plan in an Era of Abrupt Climate Change

The Gulf of Mexico is entering a period of new and uncertain norms. Weather patterns, climate, and ecosystem function are rapidly reorganizing emphasizing the importance of adaptive and agile management. Sea level rise adaptation in the form modified built infrastructure and city planning is crucial to the longevity of Gulf coastal regions. Because climate change occurs slowly over many years, it can often take a backseat to more visible hazards like flooding. However, preparation today could result in four times the savings tomorrow (FEMA, 2015). Restoration managers must also consider that conflicts may arise when considering quick fixes, such as building seawalls. Additionally, management must be tailored to specific regions, but in the context of the entire Gulf Coast. Most importantly, restoration managers must understand how communities, climate, and economy are intertwined. The sustained health of the Gulf environment and economy relies on creating opportunities for at-risk communities to become more resilient to disaster events and long-term climate changes that impact Gulf coasts. Therefore maintaining a healthy environment for sustainable development and robust coastal communities is dependent on intelligent, preventative restoration design.

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Appendix

Companion video: https://vimeo.com/128644900

Recording of webinar: http://eli-ocean.org/gulf/climatechangewebinar/

Webinar panelist information:

MODERATOR

- **Andrew Shepard**, Florida Institute of Oceanography, Gulf of Mexico University Research Collaborative

SPEAKERS:

- **Dr. Kathryn Mengerink** (Director, Ocean Program, Environmental Law Institute) Overview of Gulf Restoration Programs
- **Dr. Robert Twilley** (Executive Director, Louisiana Sea Grant) Ecosystem Adaptation Climate Change Impacts on the Gulf Coast and Restoration Efforts
- **Colette Pichon Battle** (Executive Director, Gulf Coast Center for Law & Policy) Climate Impacts on Communities and Options for Response
- **Dr. Tracie Sempier** (Coastal Storms Outreach Coordinator, Mississippi-Alabama Sea Grant) Climate Change Decision-Making by Coastal Communities
- **Jonathan Porthouse** (Senior Manager, Coastal Habitat Restoration, Gulf Environmental Benefit Fund) Integrating Climate Change Impacts into Restoration Planning and Project

Webinar Q&A (Authored by GOMURC):

How do we achieve climate justice through the Deepwater Horizon *restoration processes and programs? What does that look like?*
Ms. Pichon Battle said that restoration programs need to devote resources to support not just natural resource restoration, but also jobs and workforce development for citizens of the Gulf coast, especially communities most at risk and in need. She said that we should invest in innovation rooted in renewable energy and/or labor practices that reduce inequities and promote justice. As an example, projects funded to date do not provide support for Native American communities and their land.

Some marsh restoration projects in New York/New Jersey did not take sea level rise into consideration. Are Gulf of Mexico marsh restoration projects being done with future sea level rise taken into consideration? If so, how?
Dr. Twilley said that that some projects may not have directly factored in sea level rise scenarios. He said that the master planning process in Louisiana has specifically looked at sea level rise relative to long term stability of wetlands systems. LA Sea Grant is now funding a project to predict how proposed river diversions to supply needed sediments to wetlands may be affected over time in the face of relative sea level rise and saltwater intrusions.
Mr. Porthouse said that NFWF projects are required to consider and monitor significant changes that may occur over the project design-life. As sea level rise continues in some of these areas, some wetlands may be cut off from sediment supplies and so impacted by saltwater that they may not be sustainable long-term, when viewed in a 50-60 year timeframe, while in the shorter

term, impacts can be monitored and controlled. He stated that NFWF may still fund projects that may be negatively impacted by changes if they provide needed benefits over the accepted project life.

How do you navigate the political context (especially in states where "climate change" is not recognized) in integrating climate change considerations into restoration projects?
Ms. Pichon Battle stated that the shift around the issue of climate change needs to come from having an informed community and constituency that can change and hold accountable decision makers. She said that we must connect peoplee decision makersiences to climate change and have them ask policy makers to put climate change on the agenda the agenda he agen many marginalized peoples have not been taught to do.
Dr. Sempier said that she was less concerned about what terms local communities use when describing climate change. She asserted that we should not care about labels as much as the outcomes and that changes in terminology will come as more communities become familiar with hazard mitigation strategies.

How much is long-term monitoring being incorporated into the restoration process? Are any funds being held over for longer term use or placed in a trust to bolster restoration in response to future change and/or for long-term management of restored sites?
Dr. Twilley emphasized the importance of monitoring, which is critical in any restoration project. With all the money invested in restoration, he stated that we have to have an adaptive management framework where we can learn from our mistakes and incorporate better designs as we move forward with the investments that we are making. Some programs have monitoring measures built in, but a lot of restoration money in Louisiana has not included an extensive monitoring program.
Mr. Porthouse stated that monitoring and adaptation is a central part of what NFWF is trying to accomplish. NFWF has specific monitoring requirements for all its projects, which are linked to specific goals and methodologies to track performance. Restoration requires an adaptive management approach based on ecosystem monitoring that assesses many relevant indicators over the many scales of this massive recovery effort. Mr. Porthouse said he spent a lot of time working with other programs to ensure that monitoring is as consistent across programs as possible, so that there may eventually be a region-wide assessment.

Is NFWF conducting or supporting social vulnerability analysis in the identification of priority projects for restoration? Not just understanding where communities are but understanding what communities are most vulnerable to impacts and in need of restoration?
Mr. Porthouse said that NFWF itself is not conducting those analyses, but is looking to the states to be in the forefront of prioritizing projects. He cited the state of Mississippi as an example of a state making a concerted effort to reach out to minority communities, especially the Vietnamese fishing community in the state, and to understand development patterns along the coast and what the community truly values and what to restore.

Where do SLR scenarios that communities are using (1 ft. vs. 6 ft. sea level rise by 2100) to plan for mitigation come from? Are there discussions between local experts and the community, or is it an internal government process?

Dr. Sempier said that data for SLR scenarios is readily available from a variety of academic and federal sources. The City of Waveland, for example, used Stennis Space Center GIS data developed for a NASA planning exercise. NOAA and USGS provide commonly used SLR viewers with predicted inundation levels. Local managers often utilize contractors to synthesize these data and products for local application and planning. The hazard mitigation planning process for many cities and counties includes engagement of steering committees that engage citizens and local stakeholders.

Louisiana has a massive amount of infrastructure (e.g., cities, oil/gas and ports) on the coast in harmactors to synthesize these data anor climate resilience for Louisiana be developed, and who is developing that plan? Are parish floodplain managers involved?
Dr. Sempier replied that, at the parish and the municipality level, the floodplain managers are usually involved in the hazard mitigation process. Sometimes comprehensive planning and hazard mitigation planning are not done at the same time, but some communities have both. A lot of times, if a municipality does not have enough funds to create a hazard mitigation plan, they will adopt the county's plan.
Dr. Twilley was unsure if large port systems factored in sea-level rise and climate change in their infrastructure needs over the life cycle of their port facilities. He noted that LA Sea Grant has been working to educate and assist parish managers through extension programs and materials (e.g., *Homeowners Handbook to Prepare for Natural Disasters*). One challenge is that most local plans do not look out far enough to handle expected changes; managers need tools to transition to longer range plans.

Do you see any potential conflicts between addressing both ecological and community resilience in restoration projects? If so, are there ways to mitigate these conflicts?
Ms. Pichon Battle said that they are closely aligned in scope and purpose and that strong and healthy local communities are the most important stewards for a healthy environment. Restoration programs need to engage and value local knowledge as well as high level scientific expertise. She also said that what is needed is a "both/and" approach. If we are working with ecosystems, then we need to have a new system of management; we need to have conversations about our economy and who drives it and who participates in it. Restoration programs should support activities that value and restore socio-economic conditions with a racial and social equity lens.
Dr. Twilley said he was trained that people are part of ecosystems. In coastal Louisiana, there was a coevolution of how the ecosystems developed and where people live and how they live. Saltwater intrusion affects all coastal species, whether we consider drinking water for humans or the survival of plants and trees. He said that conflicts may arise when we look for quick fixes, such as hardening shoreline (building seawalls) to hold off the sea, versus more environmentally friendly solutions that may be cheaper and longer lasting.

Acknowledgements

I would like to acknowledge the support and invaluable expertise of my Capstone Committee Chair, Dr. Kathryn Mengerink as well as my Capstone Committee members, Mr. Andrew Shepard, Dr. Richard Somerville, and Mr. Scott Ressler.

I would also like to recognize and thank the six webinar participants whose presentations were synthesized to create this report: Mr. Andrew Shepard, Dr. Kathryn Mengerink, Dr. Robert Twilley, Ms. Colette Pichon Battle, Dr. Tracie Sempier, and Mr. Jonathan Porthouse.