Regional Impacts of Coastal Land Loss and Louisiana's Opportunity for Growth

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Executive Summary

Louisiana is facing a coastal land loss crisis – nearly two thousand square miles of land have been lost over the last 100 years, and an equal amount could potentially be lost over the next 50 years. Businesses, homes, infrastructure and whole communities could be lost or suffer severe economic damages in a 'future without action' – a term used by state planners that means a future in which no coastal restoration projects or protection are completed. If nothing is done to address Louisiana's land loss problem, significant economic damage will occur at the national, state and regional levels through flooding and destruction of buildings, roads and railways, as well as having adverse impacts on jobs and disruption of the flow of commerce connected to Louisiana's coast.

Yet, as coastal restoration and protection projects are already being planned and implemented, there is hope that the state can avoid the worst-case scenario. The state has developed a comprehensive 50-year Coastal Master Plan to restore and protect Louisiana's coast, which will be boosted by new revenue streams that can help expedite the plan's implementation. These projects will not only reduce the risk of economic damages but will also provide economic benefits in the form of new jobs and economic growth in coastal areas and beyond. These opportunities will initially be concentrated in design, engineering, and construction jobs associated with restoration projects, but they will also help businesses develop expertise that can be exported to the world and foster continued economic growth.

Methods and modeling for this project build on a 2015 study, *Economic Evaluation of Costal Land Loss in Louisiana* (Barnes et al. 2015), prepared by Louisiana State University (LSU) and Rand for the state's Coastal Protection and Restoration Authority (CPRA) that detailed economic impacts at the statewide level.

Part one of this report analyzes the predicted regional economic losses under land loss scenarios developed for the 2012 Coastal Master Plan. The draft 2017 Coastal Master Plan incorporates a range of expectations indicating a greater amount of land loss than the 2012 plan considered. So the discussion in this report focuses on the "less optimistic" scenario from 2012 as the most relevant set of estimates moving forward.[1]

Part two analyzes the predicted economic benefits of the state's continued spending on coastal restoration and protection.

For the first time, this report analyzes economic impacts at the regional level. Specifically, this report investigates how these impacts are distributed across five regions (New Orleans, Baton Rouge, Houma, Lafayette, and Lake Charles). Not surprisingly, the direct impacts of land loss are highest in the areas closest to the coast and closest to the predicted storm paths. Yet there are also sizeable economic risks to areas much further inland than might be expected, reflecting the economic linkages across the coast.

What's at Risk

The risk of continued land loss is concentrated in coastal Louisiana, but the economic implications will also spread throughout the nation due to the state's importance in shipping, energy production, chemicals, and other sectors (Barnes et al. 2015).

- As much as $3.6 billion in Louisiana business, residential, and infrastructure assets are at risk due to land loss over the next 50 years if no action is taken to protect or restore the state's coast.
- These assets support an additional $7.6 billion in economic activity throughout the nation each year.
- In addition to the direct impact of land loss, Louisiana would also face increased storm damage further inland as the coastal buffer disappears. Up to $138 billion in business, residential, and infrastructure assets could be lost, along with an additional $53 billion in disrupted economic activity from just one storm.

[1] Louisiana law requires that the state Coastal Master Plan be updated every 5 years. The most recently available version at the time of this research was the 2012 Plan. CPRA is now developing its 2017 Plan, which will be released in early 2017. The 2017 Plan will reportedly focus on a higher range of land loss in part because of increasing expectations about future sea level rise, but the detailed 2017 maps were not yet available for modeling at the time of this research.

The five most heavily impacted regions in Louisiana are highlighted in the table below. The lost economic assets are heavily concentrated in the coastal regions facing more significant rates of land loss. The business disruption costs are distributed more evenly across the coast.

	Infrastructure Replacement Costs	Business Disruptions
United States Total	**$3.6 billion**	**$7.6 billion**
New Orleans	$1.7 billion	$1.7 billion
Baton Rouge	$60 million	$600 million
Houma	$1.4 billion	$1.4 billion
Lafayette	$140 million	$390 million
Lake Charles	$420 million	$490 million

All figures in 2015 dollars. The US total represents the total damages in both Louisiana and the country from land loss in Louisiana.

Regional Impacts of Increased Storm Damage

Land loss also makes coastal areas more vulnerable to storm damage. We measure the increase in storm damage in a future without action for three storm scenarios to characterize the potential economic risks facing coastal Louisiana. The storms include an eastern-track storm with a path similar to Hurricane Katrina, a western-track storm with a path similar to Hurricane Rita, and a 100-year storm, which indicates the level of flooding across the coast that would be expected only once every 100 years. The highest damages in each region (and the U.S. overall) depend on the type of storm and how it affects each particular region. For example, increases in storm damage in New Orleans would be largest with the eastern track storm 50 years into a future without action because that storm leads to the highest storm surge in the eastern part of the state and greatest pressure on the levee system, which increases the risk of levee failure and widespread flooding inside the levee system. Economic risks for the storm case study showing the greatest risk for each region are summarized below.

	Storm with Greatest Risk	Replacement Costs	Business Disruptions
United States	**Eastern**	**$138 billion**	**$53 billion**
New Orleans	Eastern	$130 billion	$26 billion
Baton Rouge	Eastern	$86 million	$4.6 billion
Houma	100-Year	$20 billion	$5.6 billion
Lafayette	Western	$5.2 billion	$2.2 billion
Lake Charles	Western	$8.6 billion	$2.4 billion

All figures in 2015 dollars. The US total represents the total damages in both Louisiana and the country from one hypothetical storm that hits the eastern part of the state.

Opportunities for Economic Growth

In order to mitigate the risks of coastal land loss and create a more sustainable coast, Louisiana's CPRA along with local government agencies across the coast will be investing billions of dollars in protection and restoration projects in the coming decades. This spending will directly generate a sizeable economic opportunity for businesses interested in

protection and restoration work, as well as position the state for long-term growth in the decades to come. Thanks in part to dollars from the Deepwater Horizon oil spill, the state will have approximately $630 – $840 million per year in revenue for spending on coastal restoration and protection projects for at least the next 10 years, which is the time horizon considered in this report. While the state has already begun investing in the coast, the economic activity and jobs created by coastal protection and restoration spending to date have varied considerably from year to year and activity has fallen off during years of low spending. The availability of spill-related revenues and potential GOMESA funding will help establish a higher, more sustainable flow of funding and spur economic growth.

These dedicated investments will support the state's sizeable and growing restoration and protection economy consisting of:

- 7,800 to 10,500 jobs each year
- $460 to $620 million in wages each year
- $590 to $785 million value added to the state's economy each year
- $1.1 to $1.5 billion in annual output

Since spending on coastal restoration will still vary somewhat from year to year, the above figures represent average totals per year, which includes both new and existing jobs supported by the coastal restoration and protection economy.

Occupations directly associated with coastal restoration include construction laborers, dredge operators, carpenters, plumbers and pipefitters, drafters, engineers and architects, project managers, computer analysts and programmers, accountants and auditors (Hobor, Plyer, & Horwitz 2014; Louisiana Workforce Commission 2011). This core set of activities also supports a wide array of jobs across the economy through the indirect and induced economic effects included in these estimates.[2] The average wage for jobs created by coastal restoration spending is $59,000 per year, much higher than Louisiana's average wage of $41,000 per year (Bureau of Labor Statistics). These jobs will attract professional and skilled labor from many places as well as provide opportunity for local residents to enter high paying career paths.

While supporting thousands of jobs in the near term, these investments also offer an opportunity for Louisiana to continue developing expertise in coastal protection and restoration that will open new opportunities for economic growth working to help coastal communities around the world design and build solutions to similar land loss challenges.

[2] Indirect effect refers to the economic activity created when businesses with contracts for coastal protection or restoration work buy what they need from other companies in Louisiana and so forth. Induced effect refers to the economic activity generated by employees of companies with coastal protection or restoration contracts and at companies benefiting from indirect effects spend their wages.

I. Introduction

Louisiana has experienced a rapid loss of land over the last century as the result of coastal erosion, land subsidence, channeling the river, and sea level rise. Projections suggest that in a future without action, the next 50 years could result in the loss of 1,750 additional square miles of land area. Coastal land loss will directly affect many homes and businesses along the coast. A recent study (Barnes et al. 2015) found that land loss in Louisiana poses a direct risk to as much as $3.6 billion in assets that support $7.6 billion in economic activity each year (updated to 2015 dollars). More importantly, land loss reduces the storm protection services of coastal wetlands. This study estimated that land loss in Louisiana may increase storm damage from a single storm by as much as $138 billion and generate an additional $53 billion in lost economic output from storm disruptions (updated to 2015 dollars).

Land loss brings more densely populated and heavily built areas such as the cities of New Orleans, Houma, and Lake Charles closer to the Gulf of Mexico and increases the risk of storm damage to those areas. The economic links across the state mean that the impact of land loss and the subsequent increase in storm damage will be felt further inland than the highly publicized land loss maps suggest. A primary goal of this study is to investigate how land loss impacts different regions along the coast considering both the direct damage facing coastal regions and the economic disruptions generated from land loss impacts across the coast.

In order to protect the well-being of its residents and its economic base, the state of Louisiana and coastal parishes plan to invest billions of dollars in coastal restoration and protection projects. This large-scale investment seeks to reduce the long-term consequences of land loss, but also provides a real business opportunity for firms engaged in coastal protection and restoration-related work. To help policy makers, the business community, and the public better understand the economic opportunity created by implementing the state's Coastal Master Plan, this report also summarizes the economic activity generated by continued efforts to protect and restore Louisiana's coast.

II. Regional Impacts of Land Loss and Storm Damage

Louisiana's coast is losing large areas of once-productive and healthy coastline. These environmental changes will damage physical assets and disrupt economic activity linked to these areas. The extent and timing of land loss along Louisiana's coast remain uncertain, as do the impacts to coastal communities. To evaluate those risks, the state of Louisiana incorporates a range of future scenarios and time horizons into the coastal master planning process.

The research underpinning the most recently released Coastal Master Plan in 2012 included a range of environmental assumptions, which were each evaluated at 25 and 50 years in a future without action. The results of this analysis were four potential cases of land loss on the future coast considering each of the two environmental scenarios and two time horizons. These four land loss cases, and assessments of how storm surge would change in each case, have provided a common reference point for evaluating potential risks in a future without action since the release of the 2012 Coastal Master Plan.

In 2015, a team of researchers from the LSU Economics & Policy Research Group and the Rand Corporation used these four cases to evaluate the potential economic consequences of land loss in Louisiana in the *Economic Evaluation of Coastal Land Loss in Louisiana* (Barnes et al. 2015). In addition to considering the loss of businesses, homes, roads, and other infrastructure situated on lands directly touched by land loss, the research also considered the effect that storms would have on businesses and homes further inland when there was less of a protective "buffer zone" along the coast to protect those areas from storm damage. The authors estimated the damages caused by two hypothetical storms, an Eastern Storm somewhat like Hurricane Katrina and a Western Storm somewhat like Hurricane Rita, in both current coastline conditions and the four future land loss conditions. In addition, the study considered the effects of a statistically-constructed 100-year storm across the coast, which indicates the level of storm-related flooding across the coast that would be expected only once every 100 years. The economic impact of land loss and storms on a variety of physical structures in Louisiana, including businesses, homes, roads and rail, pipelines, transportation, gasoline prices, and others, are enumerated in full in that report.

In this study, we further develop the previous economic analysis with a more narrow focus on identifying how damage is spread across regions of the state as well as how regional economies within the state are linked to land loss and storm damage risks. Areas along the coast can see firsthand how natural resource-dependent segments of the economy face serious risks due to land loss. However, we also investigate and quantify the broader economic linkages across regional economies in coastal Louisiana and linkages to areas further inland, which have less direct land loss but strong economic ties to those impacted areas.

A. Methodology for Estimating Regional Impacts

For the 2012 Coastal Master Plan, a team of environmental scientists and computer modelers produced several maps depicting potential land loss under different environmental scenarios and time horizons. Researchers also modeled the storm surge from a series of storms on both the future projected coast and the current coast. This report investigates the value of assets and economic activities currently located across Louisiana's coast and overlays the future environmental changes of land loss and increasing storm damage to estimate the value at risk for five regional labor market areas in the southern portion of Louisiana: New Orleans, Baton Rouge, Houma, Lafayette, and Lake Charles.

This research builds on methods developed by LSU's Economics & Policy Research Group and the Rand Corporation, which are published in full detail in the study *Economic Evaluation of Costal Land Loss in Louisiana* and briefly summarized here (Barnes et al. 2015). Business locations are drawn from the 2012 Info-USA business database to identify the number of businesses by industry, firm size, and size of structure. Damage estimates are calculated for most asset classes using the damage curves built into the Federal Emergency Management Agency's HAZUS- MH model. A literature review was also conducted to validate each damage curve and in a small number of cases estimates from more recent or robust studies were used to calculate damages. Agricultural sector losses are estimated from the U.S. Department of Agriculture's National Agricultural Statistics Service CropScape database and commodity prices are pulled from Louisiana State University Agricultural Center's annual AgSummary.

Residential property damage is based on census tract-level estimates of housing stock value from the American Community Survey. Because land loss within a census tract is likely to impact lower elevation and less developed areas,

the number of structures within a census tract was further subdivided using night-time population estimates from LANDscan to provide better estimates of how much of the housing stock within each census tract would be impacted.

Road locations came from two separate geodatabases: state-maintained roads from the Louisiana Department of Transportation & Development and local/all roads from the U.S. Census Bureau. Road damage was estimated using the Rhine Atlas curve. Data from the National Transportation Atlas Database 2014 was used to identify rail lines in coastal Louisiana and rail damage estimates were drawn from the Damage Scanner curve (Kellerman et al. 2015).

Results from each region will be split into two sections: Land Loss Results (red maps) and Storm Damage Results (blue maps). The businesses and residences at risk directly from land loss represent those physical assets located today on land that is expected to be lost in a future without action (the red areas on the map of land loss). Many more businesses and residences are expected to face a higher degree of storm damage in a future without action, which is illustrated with the three storm cases discussed previously. Incremental storm damage was calculated from the maps of storm surge developed for the 2012 Coastal Master Plan (from the blue map in a future without action) minus the damage from a blue map with the current coastline.

The potential damage in each case is characterized in terms of both the stocks and flows associated with lost land and presented in 2015 dollars. For each region, we break out the two major categories of physical damage, business and residential. Separately, we calculate the total business activity affected by damage across the coast in terms of employment, labor productivity (wages), and output. Note that because of the interconnectedness of the coastal economy, these disruptions in flows take into account how damage all across the coast would impact each region. For example, physical damage in the Houma region may generate larger impacts up the supply chain in the Lafayette region.

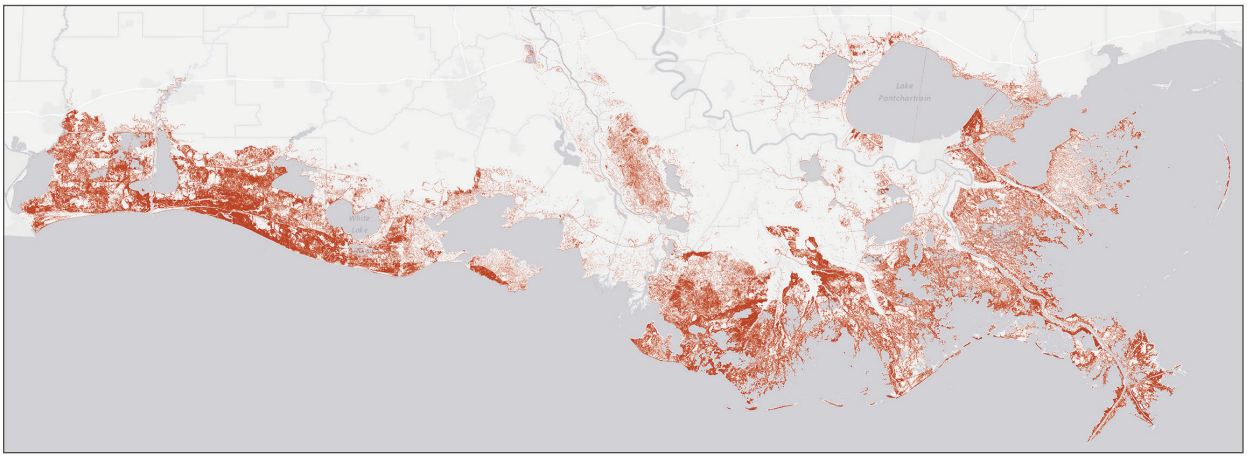
While the 2012 Coastal Master Plan included two sets of environmental scenarios, research released since 2012 suggests that the speed and extent of land loss may increase with the range of risks facing coastal Louisiana appearing to shift toward worse outcomes (Meselhe, White and Reed 2016). Accordingly, the "less optimistic" scenario from the 2012 Master Plan appears more consistent with a more moderate set of environmental assumptions given current expectations. Therefore, while we will include analysis of all scenarios and time horizons in order to provide a more comprehensive assessment of available land loss data, we will focus on the less optimistic scenario from 2012 in our discussions.

We use a multi-regional input-output model in IMPLAN to assess regional economic linkages and the indirect and induced effects of land loss and storm damage. IMPLAN draws from historical trade flow patterns to measure how increases and decreases in activity in one industry impact other industries. Direct damage due to land loss or increased storm damage is linked to the regional economy in each of the five labor market areas in southern Louisiana to measure the broader economic impacts of land loss.

B. Maps

In this section, a coastwide view of land loss and storm case studies are displayed.

Red Map: Land Loss in Less Optimistic Environmental Scenario, 50-Year Time Horizon

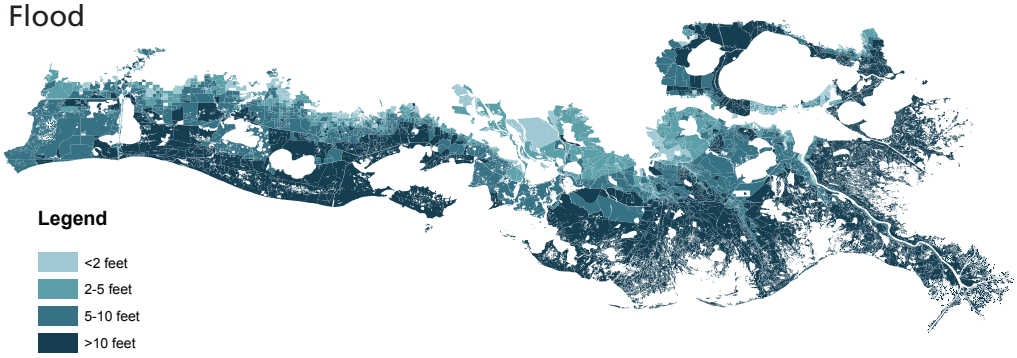


Source: Author based on 2012 Coastal Master Plan projections. Red pixels denote projected land loss.

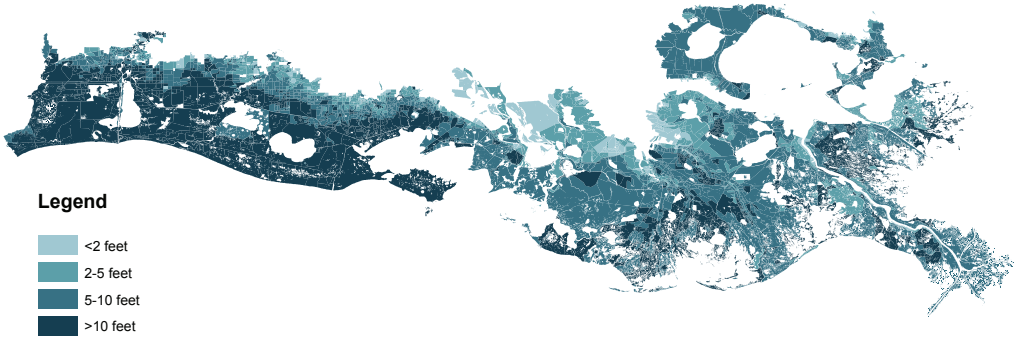
Blue Map: Storm Surge in Less Optimistic Environmental Scenario, 50 Year Time Horizon

Eastern Storm

100 Year Flood



Western Storm



Source: CLARA model output mapped to GIS by authors.

C. Results

The following sections highlight direct damage to businesses, residences and infrastructure in each region associated with land loss and increases in storm damage. In addition, the economic activity lost due to land loss and storm-related disruptions is estimated at a regional scale by taking into consideration the indirect and induced impacts of a region's economy of damage elsewhere along the coast. As discussed in each regional section, the size of direct damage and total economic disruptions can vary considerably across different scenarios and storms due to economic effects generated by linkages across the regional economies.

1 New Orleans Region

The New Orleans region has the largest population base among coastal regions and encompasses the following parishes: Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, and St. Tammany. The New Orleans region is home to the City of New Orleans, Slidell, Covington, and LaPlace. Thanks to the region's position at the mouth of the Mississippi River, New Orleans has long been an economic powerhouse for the state and is currently home to 36,000 businesses and 537,000 jobs, as well as the highest concentration of built infrastructure along Louisiana's coast. The top 5 industry sectors in the New Orleans region are shown in Table 1.

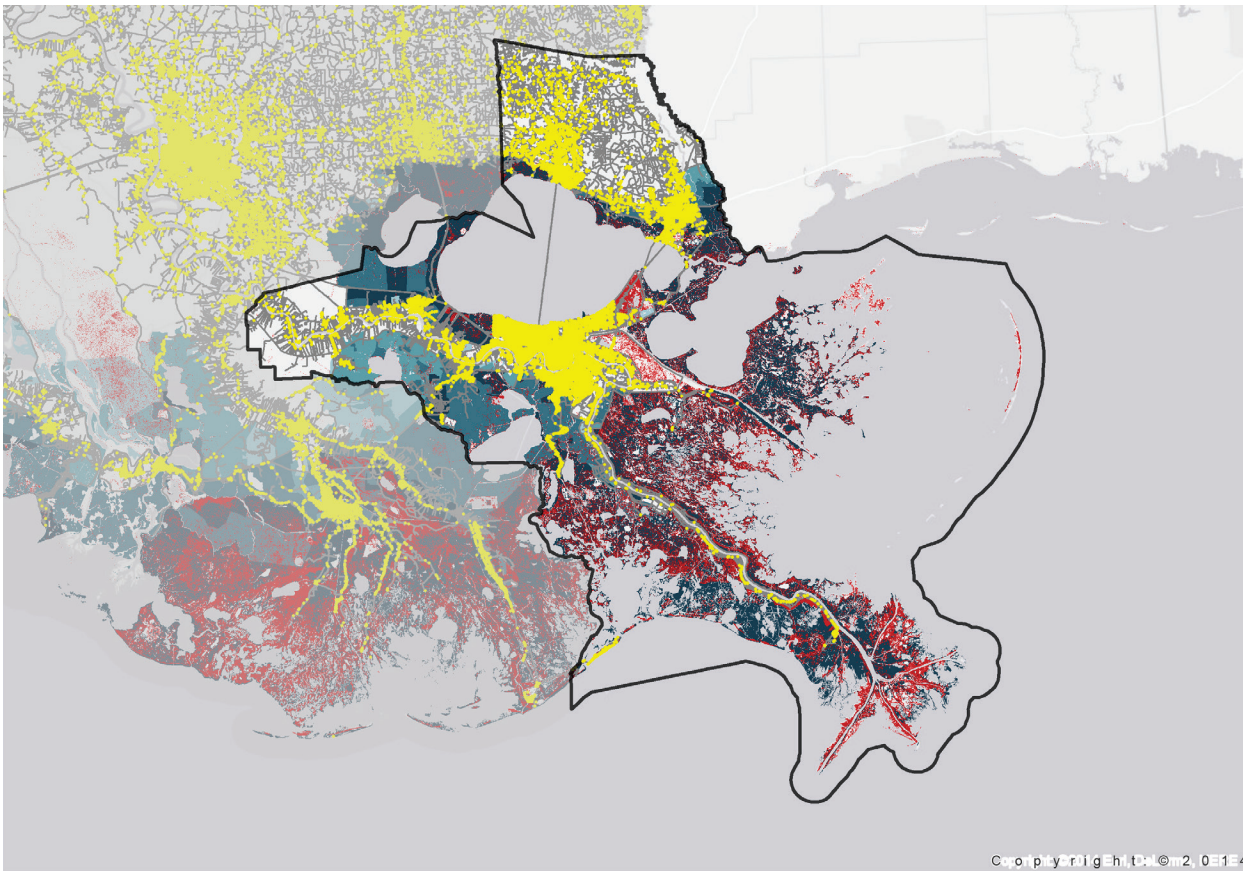
Table 1.1: Top Industries in New Orleans

Industry Sector	Total Business Locations	Employment
Health care and social assistance	3,442	72,465
Accommodation and food services	3,367	71,515
Retail trade	4,714	62,327
Educational services	431	43,364
Professional and technical services	4,887	33,448

Source: Quarterly Census of Employment and Wages 2014.

Tourism is a particularly important industry to New Orleans. A larger percent of the population works in accommodation and food services in New Orleans than any other region. In 2015, the city of New Orleans hosted 9.78 million visitors who spend $7.05 billion while in the city, which is more than 60% of tourism spending statewide (New Orleans Area Visitor Profile, 2015). The most recent statewide analysis of tourism's total impact on the state's economy found that tourism created 2.6% of Gross Domestic Product in Louisiana and over 147,000 Louisiana jobs, (Tourism Satellite Account, 2011). A majority of the state's tourism spending is directly tied to New Orleans and coastal land loss poses serious risks to the attractiveness of New Orleans and Louisiana as a destination for tourists. A secure plan to protect New Orleans from flooding is essential to maintaining the industry and continuing to reassure and attract visitors.

In general, New Orleans is likely to see more damage than most of the other regions due to its sizeable population, vulnerability and other factors. New Orleans supports 25% more jobs than the next largest region (Baton Rouge) and more than 5 times the jobs of the smallest southern region (Houma).



May key: yellow represents current location of businesses, red represents land loss in 50 years from 2012 less optimistic scenario, and blue represents flooding from a 100-year storm after the land loss shown in red.

Land Loss Results (Red Map)

Total physical damage in the New Orleans region could be as high as $1.3 billion in 25 years and $1.7 billion in 50 years. Table 2 presents the physical damage to the New Orleans region in terms of business and residence counts and replacement costs in several given scenarios and time horizons. The New Orleans region, with its large population and economy and wide expanse of coastal land, is expected to be one of the hardest hit, particularly in St. Bernard and Plaquemines Parishes. In the less optimistic scenario in 50 years, New Orleans accounts for approximately 40% of total damages to businesses and 76% of damage to residences in Louisiana.

Table 1.2: Physical Damage to Assets in New Orleans, Red Map

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$661	$293	$142	$1,095
Moderate	**50**	$811	$331	$201	$1,343
Less Optimistic	**25**	$766	$336	$193	$1,295
Less Optimistic	**50**	$957	$410	$302	$1,669

The loss of these businesses would lead to lower employment, wages, and output in the region, which ripples out to affect other businesses in New Orleans and more broadly to impact other parts of the state and nation. At the same time, affected businesses elsewhere along the coast would impact businesses in the New Orleans as well-established trade flows are disrupted. Table 3 presents the total economic impact of coastal land loss on New Orleans in terms of total lost jobs, wages, and output.

Table 1.3: Annual Economic Activity Lost Impacting New Orleans, Red Map

2012 Environmental Scenario	Time Horizon	Total Lost Jobs	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	6,780	$392	$1,179
Moderate	**50**	7,630	$457	$1,377
Less Optimistic	**25**	7,430	$429	$1,272
Less Optimistic	**50**	9,470	$568	$1,653

The analysis shows that more than 9,000 jobs and $1.7 billion in output could be impacted annually. This region accounts for 42% of the employment impacts across the coast.

Incremental Storm Damage Results (Blue Map)

The New Orleans metropolitan region has a long history of hurricanes inflicting substantial damage because of its proximity to the coast, dense population and infrastructure, and extremely low elevation in parts of the City of New Orleans, which sits below sea level in some portions of the city. Even with the recently upgraded levee system and other hurricane protection measures, a certain degree of risk remains and that risk is expected to grow in a future without action.

Case study: Eastern, Katrina-Like Storm

If another storm similar to Hurricane Katrina hit the coast in 50 years, the damage could be much worse than it would be for that storm to hit today's coast. The future loss of wetlands that currently serve as a "buffer zone" to protect the coast from storm surge makes it more likely that the levees in New Orleans would fail and devastating flooding occur throughout the city. The probability of levee failure underpinning the 2012 Master Plan storm damage maps was determined by extensive modeling to estimate the likelihood that storm surge in a future coast could lead to overtopping or breaching of levees at any point along the storm protection system. To simplify the economic analysis, the median flood depth was used across all simulations, which means that there is a greater than 50% chance the levees protecting the City of New Orleans would fail in the hypothetical "Eastern" (Katrina-like) storm. This levee failure would lead to significant increases in damage relative to what is expected if the same storm were to hit today.

Table 1.4 presents the increase in damage to physical assets in New Orleans in a future without action over what we would see today. The change between 25 and 50 years in the less optimistic scenario shows a dramatic jump in risk. Total increases in replacement costs jump from $5.5 billion to $129.6 billion. This dramatic increase in damage is due to the modeled failure of the levees in the city of New Orleans in this case study. These levees fail to protect the bulk of the capital stock in the region in a future without action and the less optimistic environmental scenario from 2012. In this case, approximately 92% of coastwide damage in the coast comes from New Orleans.

Table 1.4: Incremental Physical Damage to Assets in New Orleans, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$1,751	$2,623	$73	$4,447
Moderate	**50**	$2,985	$3,916	$101	$7,001
Less Optimistic	**25**	$2,251	$3,167	$86	$5,504
Less Optimistic	**50**	$68,266	$60,907	$473	$129,647

In addition to the substantial risk to property, the eastern-track storm would also result in sizable impacts to jobs, leading to reduced labor productivity (wages), and output in the New Orleans region.

In New Orleans, approximately $12 billion in labor productivity could be lost (as measured by wages). This is equivalent to 44% of total annual labor productivity in New Orleans. Businesses could lose $26 billion in output. While New Orleans houses 92% of the physical damage, the effects on economic activity are spread across a much wider geographic area reaching beyond the New Orleans region.

Table 1.5: Incremental Lost Economic Activity Impacting New Orleans, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	$434	$1,057
Moderate	**50**	$665	$1,579
Less Optimistic	**25**	$546	$1,333
Less Optimistic	**50**	$11,558	$26,482

Case Study: Western, Rita-Like Storm

The next two tables display the expected impact from a storm more similar to Hurricane Rita, where the brunt of the impact is in the western part of the state, particularly around Lake Charles. In this case, only about 20% of the physical damage comes from the New Orleans region; however, damage could still reach $9 billion in replacement costs, $1.7 billion in lost labor productivity, and $3.9 billion in lost output in the New Orleans region from a severe western-track storm.

Table 1.6: Incremental Physical Damage to Assets in New Orleans, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$3,001	$2,128	$71	$5,200
Moderate	**50**	$4,434	$2,689	$110	$7,233
Less Optimistic	**25**	$3,258	$2,510	$96	$5,864
Less Optimistic	**50**	$5,373	$3,439	$158	$8,969

Table 1.7: Incremental Lost Economic Activity Impacting New Orleans, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	25	$669	$1,575
Moderate	50	$923	$2,267
Less Optimistic	25	$869	$2,173
Less Optimistic	50	$1,663	$3,871

100-Year Storm

In the 100-year storm, the physical damage in New Orleans region could reach $6.7 billion in 25 years and $37.6 billion in 50 years. The 100-year storm in the less optimistic environmental scenario at a 50-year time horizon does project a moderate amount of levee failure, particularly around Houma and in areas adjacent to the city of New Orleans like St. Bernard, Plaquemines, and Jefferson parishes, but not in the city proper. In this storm, New Orleans region faces the potential of $37.6 billion in damage. This significant amount of damage represents well over half of coastwide damage because of the dense population and concentration of built infrastructure of the New Orleans region.

Table 1.8: Incremental Physical Damage to Assets in New Orleans, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	25	$2,510	$2,938	$83	$5,531
Moderate	50	$3,549	$3,788	$123	$7,460
Less Optimistic	25	$3,056	$3,505	$109	$6,670
Less Optimistic	50	$17,777	$19,573	$275	$37,624

The effects of flooded businesses along the entire coast ripple outward to affect suppliers, employees, and consumers. In the 50-year, less optimistic environmental scenario, New Orleans will see losses equivalent to about 14% of annual labor productivity in the region.

Table 1.9: Incremental Lost Economic Activity Impacting New Orleans, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	25	$692	$1,680
Moderate	50	$1,059	$2,562
Less Optimistic	25	$931	$2,246
Less Optimistic	50	$3,748	$8,490

2 Baton Rouge Region

The Baton Rouge region is the second most populous region in the state. The Baton Rouge region is home to the state capital, flagship university Louisiana State University, and a large manufacturing center. It supports 25,000 businesses and over 430,000 jobs. The region includes the following parishes: Ascension, East Baton Rouge, East Feliciana, Iberville, Livingston, Pointe Coupee, St. Helena, Tangipahoa, Washington, West Baton Rouge, and West Feliciana. Major cities include Baton Rouge and Hammond. The top 5 industry sectors are as follows:

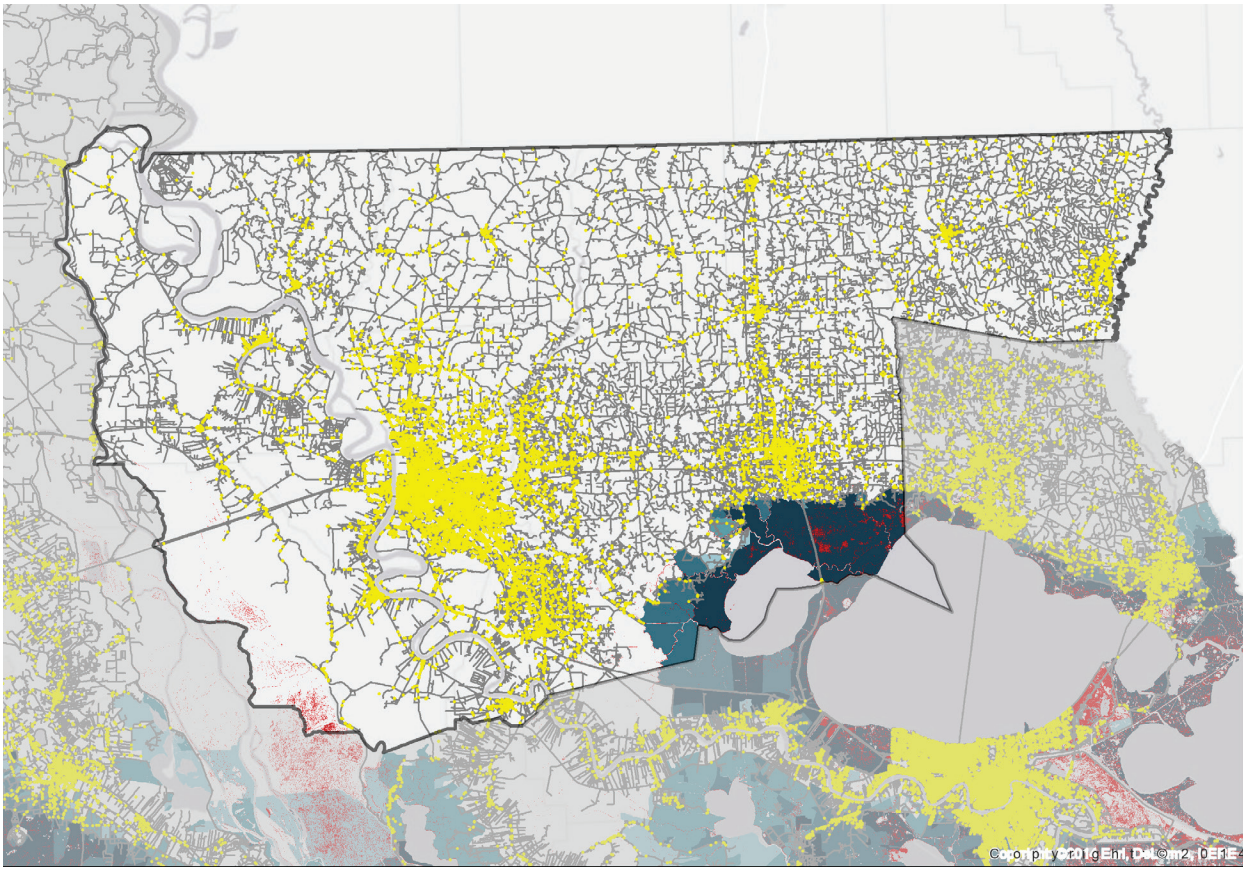
Table 2.1: Top Industries in Baton Rouge

Industry Sectors	Total Business Locations	Employment
Health care and social assistance	2,368	61,142
Construction	2,340	52,698
Retail trade	3,413	49,227
Educational services	334	41,524
Accommodation and food services	1,860	36,629

Source: Quarterly Census of Employment and Wages 2014.

The health of the construction industry in Baton Rouge is indicative of strong economic growth in the area. Population growth and growth in the number of businesses across all industries is one of the primary drivers of construction jobs, though it is also an important industry to in ongoing maintenance of existing manufacturing facilities. Manufacturing is another huge industry in the Baton Rouge region (sixth largest) because of the concentration of chemical plants, refineries, and other industry along the Mississippi River within this region. Approximately 8% of jobs in Baton Rouge are involved in manufacturing. Baton Rouge has more construction and manufacturing jobs than any other region, including New Orleans.

Baton Rouge is the furthest inland of the regions studied, with wetland areas in Livingston and Ascension connecting to the more protected Lake Maurepas and Tangipahoa resting on the northwestern portion of Lake Pontchartrain. However, it is important to understand the big picture and just how businesses and jobs in Baton Rouge will be hurt by massive storm surge in other parts of the state. Of all the people living in the Baton Rouge region, approximately 82,000 work outside of the region, mostly in the southern coastal regions. Approximately 100,000 people living outside the Baton Rouge region commute in for jobs, making coastal risks in other areas a direct concern for a significant portion of the area's workforce (U.S. Census Bureau 2014). Businesses have contracts with other businesses that may temporarily or permanently close in the aftermath of storms, professionals have clients that may evacuate or leave the state, plants have workers that cannot make it in, and suppliers may flood out.



May key: yellow represents current location of businesses, red represents land loss in 50 years from 2012 less optimistic scenario, and blue represents flooding from a 100-year storm after the land loss shown in red.

Land Loss Results (Red Map)

Total physical damage expected in the Baton Rouge Region in 25 years could total $52 million. In fifty years, physical damage could total $58 million. Table 2 presents the physical damage to the Baton Rouge region in terms of business and residence counts and replacement costs in several given scenarios and time horizons. Baton Rouge is expected to see relatively small amounts of physical damage when compared to other regions because it has very little coastline. In 50 years, Baton Rouge only accounts for about 2% of total damages.

Table 2.2: Physical Damage to Assets in Baton Rouge, Red Map

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$19	$8	$23	$50
Moderate	**50**	$23	$9	$23	$55
Less Optimistic	**25**	$19	$9	$25	$52
Less Optimistic	**50**	$23	$9	$25	$58

In comparison to the relatively small numbers of physical damage, Baton Rouge has a large risk of damage to economic activity. The loss of businesses in more vulnerable coastal areas leads to lower employment, wages, and output in other regions. The loss of these jobs and businesses in the New Orleans and Houma regions means fewer businesses are buying supplies and services from businesses in the capital region. Likewise, consumers are purchasing less. Table 2.3 presents the economic impact on Baton Rouge in terms of total lost jobs, wages, and output.

Table 2.3: Annual Economic Activity Lost Impacting Baton Rouge, Red Map

2012 Environmental Scenario	Time Horizon	Total Lost Jobs	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	2,910	$105	$478
Moderate	**50**	3,200	$119	$526
Less Optimistic	**25**	3,150	$114	$504
Less Optimistic	**50**	3,790	$144	$606

In 50 years, nearly 3,800 jobs and over half a billion in annual output could be lost in a future without action. This accounts for 17% of employment impacts across the coast. Even though there is very little physical damage in Baton Rouge, this region experiences the third greatest losses in terms of economic activity because of the size of the region's economy and economic linkages with businesses along the coast.

Incremental Storm Damage Results (Blue Map)

Baton Rouge has experienced wind damage and localized flooding due to rain, but historically the region has experienced minimal impacts due to storm surge. In the past ten years, Hurricanes Gustav and Isaac in particular had a harsh economic impact on the region although storm surge did not reach beyond lowland areas near Lake Maurepas. The analysis in this report captures only those impacts related to storm surge since that is the element of storm damage most directly tied to land loss. As such, the damage to assets resulting from increasing storm damage is relatively small. However, the region's economy has strong ties to the rest of the coast—especially New Orleans—creating sizeable risks due to economic disruptions from storms. Also, as land loss diminishes the land bridge protecting the opening to Lake Pontchartrain and Lake Maurepas, more of the Baton Rouge region may be exposed directly to storm surge.

Case study: Eastern, Katrina-Like Storm

If another storm similar to Hurricane Katrina hit the coast in 50 years, Baton Rouge would likely see very little physical damage, but normal trade flows would generate serious disruptions to the region because of the flooding in New Orleans. Table 2.4 presents the incremental damage to physical assets in Baton Rouge over what we would see with the current state of the coast.

Table 2.4: Incremental Physical Damage to Assets in Baton Rouge, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	25	$1	$38	$5	$44
Moderate	50	$3	$50	$6	$59
Less Optimistic	25	$2	$45	$5	$53
Less Optimistic	50	$5	$71	$10	$86

The effects of this storm would result in huge impacts on jobs, wages, and output in the New Orleans region. These damages will ripple out to affect other cities in the area, including Baton Rouge.

Another Katrina-like storm with levee failure would have catastrophic consequences across the coast. In Baton Rouge, residents could lose $1.3 billion in wages and businesses could lose $4.6 billion in output. Approximately 9% of the lost labor productivity (as measured by wages) after this Eastern storm would come from Baton Rouge.

Table 2.5: Incremental Lost Economic Activity Impacting Baton Rouge, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	25	$121	$396
Moderate	50	$158	$538
Less Optimistic	25	$152	$500
Less Optimistic	50	$1,308	$4,589

Case Study: Western, Rita-Like Storm

The next two tables display increases in storm damage from a storm hitting the western part of the state near Lake Charles. In this case, less than 1% of the physical damage comes from Baton Rouge but 10% of lost employment comes from the Baton Rouge region. Interestingly, the increase in damage is slightly larger than in the eastern-track storm. While total damage in the Baton Rouge area is larger for the eastern track storm than the western track storm at any given point in time, the figures in Table 2.6 and Table 2.7 represent increases in storm damage. The surprising finding that Baton Rouge would see larger increases in storm risk from a western track storm is more a reflection of the minimal risk the region faces from a western track storm under current conditions than an expectation that damage would somehow be worse in a future without action from a western track storm.

Table 2.6: Incremental Physical Damage to Assets in Baton Rouge, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	25	<$1	$57	$6	$63
Moderate	50	<$1	$77	$6	$84
Less Optimistic	25	<$1	$67	$6	$73
Less Optimistic	50	$13	$122	$6	$140

The bigger risks facing the Baton Rouge region are driven by the area's economic linkages to other parts of the coast. While not as large as the impacts from the eastern track storm, Baton Rouge could still see as much as a $1.9 billion increase in lost output due to a western track storm 50 years from now due to the region's linkages with heavily damaged areas in Lake Charles and flooding along other parts of the coast including severe impacts in Houma.

Table 2.7: Incremental Lost Economic Activity Impacting Baton Rouge, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	$203	$621
Moderate	**50**	$285	$927
Less Optimistic	**25**	$288	$957
Less Optimistic	**50**	$597	$1,887

100-Year Storm

In the 100-year storm, the physical damage in Baton Rouge ranges from about $68 million in 25 years to $103 million in 50 years. The 100-year storm in the less optimistic environmental scenario at a 50-year time horizon does predict some levee failure especially in Jefferson Parish, the Houma region, and other areas around the coast.

Table 2.8: Incremental Physical Damage to Assets in Baton Rouge, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	<$1	$52	$7	$59
Moderate	**50**	$4	$64	$8	$76
Less Optimistic	**25**	<$1	$60	$8	$68
Less Optimistic	**50**	$6	$89	$8	$103

The effects of flooded businesses along the entire coast ripples outward to affect suppliers, employees, and consumers. In the 50-year case, approximately 10% lost economic activity along the coast occurs in Baton Rouge. This means that about $760 million in wages, or 4% of total labor productivity in Baton Rouge is affected.

Table 2.9: Incremental Lost Economic Activity Impacting Baton Rouge, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	$216	$692
Moderate	**50**	$340	$1,081
Less Optimistic	**25**	$319	$1,011
Less Optimistic	**50**	$760	$2,595

3 Houma Region

The Houma region is the smallest region in southern Louisiana but contains a large amount of critical infrastructure that supports oil and gas jobs in the Gulf of Mexico. The region includes the following parishes: Assumption, Lafourche, and Terrebonne. The Houma region is home to the city of Houma, Thibodeaux, and Port Fourchon, a massive oil and gas port and base that services 90% of deepwater structures in the Gulf. The Houma region has about 5,700 businesses that support approximately 103,000 jobs. The top 5 industry sectors are as follows:

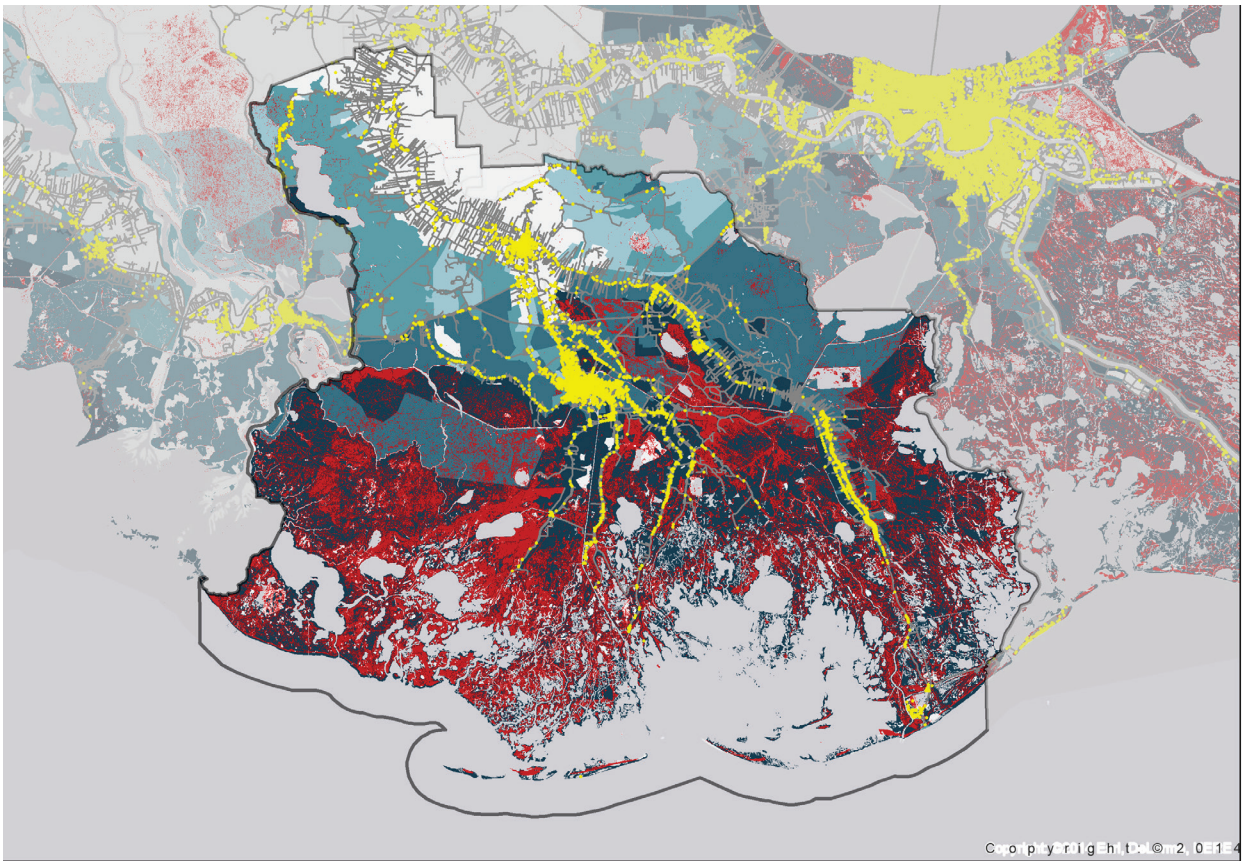
Table 3.1: Top Industries in Houma

Industry Sectors	Total Business Locations	Employment
Transportation and warehousing	405	14,213
Health care and social assistance	528	12,095
Manufacturing	314	11,782
Retail trade	808	11,425
Accommodation and food services	397	7,587

Source: Quarterly Census of Employment and Wages 2014.

Here, the oil and gas industry is very important. Transportation and warehousing is the largest industry sector in the region. This sector includes offshore transportation and pipeline workers, among others. Approximately 14% of all jobs in Houma are in transportation and warehousing. Oil and gas extraction (the sixth largest industry sector) employs 7% of all jobs in the region. Of all the regions in south Louisiana, only Lafayette has a higher proportion of employment in oil and gas. While oil and gas activity in the region has slowed due to low oil prices, the industry is expected to recover gradually and will continue to be an important economic driver for the region. Manufacturing is also an important sector in Houma. These industry sectors are all full of high paying, skilled jobs, which draws economic activity to the area. Because of the abundance of these jobs, some 36% of people who work in Houma commute into the area to work (U.S. Census Bureau 2014).

Unfortunately, Houma is highly vulnerable to future land loss and storm damage. In a future without action, Houma is highly likely to see flooding both in the city of Houma and in surrounding areas like the towns of Larose, Cut Off, Galliano, and Golden Meadow inside the ring levee system. In addition, Highway 1, which leads to Port Fourchon and Grand Isle, is likely to be compromised in the next 25-50 years.



May key: yellow represents current location of businesses, red represents land loss in 50 years from 2012 less optimistic scenario, and blue represents flooding from a 100-year storm after the land loss shown in red.

Land Loss Results (Red Map)

Total physical damage in the Houma Region in 25 years could top $993 million in 25 years and $1.4 billion in 50 years. Table 2 presents the physical damage to the Houma region in terms of business and residence counts and replacement costs in several given scenarios and time horizons. Houma will be one of the hardest hit regions along with New Orleans, with approximately 38% of all physical damage coming from this region. This will be particularly damaging to Houma considering its smaller economic base.

Table 3.2: Physical Damage to Assets in Houma, Red Map

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$840	$11	$27	$879
Moderate	**50**	$925	$19	$63	$1,007
Less Optimistic	**25**	$922	$28	$44	$993
Less Optimistic	**50**	$1,140	$57	$207	$1,404

Houma also has a large risk of damage to economic activity. The loss of businesses in more vulnerable coastal areas leads to lower employment, wages, and output in other regions. The loss of these those jobs and businesses means fewer businesses are buying supplies and services from businesses in the Houma region. Likewise consumers are purchasing less. Table 3 presents the economic impact on Houma in terms of total lost jobs, wages, and output.

Table 3.3: Annual Economic Activity Lost Impacting Houma, Red Map

2012 Environmental Scenario	Time Horizon	Total Lost Jobs	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	4,340	$287	$1,130
Moderate	**50**	4,720	$321	$1,217
Less Optimistic	**25**	4,830	$317	$1,159
Less Optimistic	**50**	6,090	$406	$1,385

In 50 years, more than 6,000 jobs and $406 million in annual output could be lost. This accounts for about 27% of lost employment across the coast.

Incremental Storm Damage Results (Blue Map)

The Houma region is highly vulnerable to hurricane storm surge due to its forward position on the coast. While this region continues to invest its own money into storm protection, the city of Houma does not have a fully developed levee system like the city of New Orleans, so this area of relatively dense development will be more directly exposed to storm surge as land loss continues. Also of concern is the security of Port Fourchon and Highway 1, which extend further south into the Gulf than any other land infrastructure in Louisiana. Port Fourchon is a critical oil and gas port and supply base for the entire nation. Finally, the ring levee system around Larose, Cut Off, Galliano, and Golden Meadow is not expected to be entirely effective in 50 years if the land loss trends continue. In the storm surge mapping for all three storm events considered in this study, this levee system is predicted to fail in a future without action to maintain or expand that system. Current efforts to build the Morganza-to-the-Gulf levee system are expected to protect the region from a 100-year storm, but as land loss continues into the future, the city may become more vulnerable again. The Houma region, while relatively small in population compared to the other southern regions, contains a great deal of critical infrastructure for the state and the nation. In many of the cases studied, damage to the Houma region was comparable in size to the much larger and similarly coastal New Orleans.

Case study: Eastern, Katrina-Like Storm

If another storm similar to Hurricane Katrina hit the coast in 50 years, the damage could be even worse than it would be today. The loss of the wetlands that serve as a "buffer zone" to protect the coast from storm surge makes it more likely that the levees around the coast would fail and devastating flooding occur. Models predict that in the hypothetical "Eastern" (Katrina-like) storm, much of the Houma region will flood, including many of the homes and businesses around the city of Houma. The levee system around Larose, Cut Off, Galliano, and Golden Meadow is expected to fail, resulting in total losses in these towns. In other parts of the state, levees in the city of New Orleans would fail and the eastern part of the state would be hit hard.

Table 3.4 presents the incremental damage to physical assets in Houma over what we would see with the current state of the coast. Between 25 and 50 years, total replacement costs could increase from $5 billion to $8.2 billion. In the 25-year less optimistic scenario, Houma represents 32% of losses along the coast. In the 50-year scenario, flooding in the city of New Orleans dwarfs the $8.2 billion in losses here.

Table 3.4: Incremental Physical Damage to Assets in Houma, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$2,072	$1,048	$37	$3,157
Moderate	**50**	$3,149	$1,846	$56	$5,051
Less Optimistic	**25**	$3,168	$1,748	$54	$4,969
Less Optimistic	**50**	$4,738	$3,353	$96	$8,187

The effects of this storm would results in huge impacts on jobs, wages, and output in the Houma region. Up to 17% of annual labor productivity in Houma could be affected by the storm in 50 years.

Table 3.5: Incremental Lost Economic Activity Impacting Houma, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	$437	$1,049
Moderate	**50**	$546	$1,376
Less Optimistic	**25**	$583	$1,418
Less Optimistic	**50**	$990	$2,692

Case Study: Western, Rita-Like Storm

The next two tables display impacts of a storm like Hurricane Rita in a future without action, where the brunt of the impact is in the western part of Louisiana. A Western Rita-like storm would push higher storm surge to the east of the storm's path, thus causing more damage to Houma than the Eastern storm. In the 50-year, less optimistic scenario, this storm is projected to flood the whole southern part of the region, up to and including large parts of the city of Houma. Damage from that level of flooding would amount to approximately $19 billion in total replacement costs, which is approximately 45% of damage along the coast for this storm scenario.

Table 3.6: Incremental Physical Damage to Assets in Houma, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$3,573	$1,892	$37	$5,502
Moderate	**50**	$5,620	$3,197	$64	$8,881
Less Optimistic	**25**	$5,232	$3,195	$59	$8,486
Less Optimistic	**50**	$12,516	$6,319	$147	$18,982

This storm could result in a loss of $1.9 billion in labor productivity in the 50-year, less optimistic case. This is 32% of lost labor productivity of the entire coast coming from the Houma region, and 33% of annual labor productivity in the region.

Table 3.7: Incremental Lost Economic Activity Impacting Houma, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	25	$589	$1,427
Moderate	50	$827	$2,043
Less Optimistic	25	$849	$2,120
Less Optimistic	50	$1,903	$4,345

100-Year Storm

In the 100-year storm, the physical damage in Houma could be as much as $12.3 billion in 25 years and $20 billion in 50 years. The 100-year storm in the less optimistic scenario at a 50-year time horizon predicts large amounts of flooding in the Houma Region. In fact, the entire city of Houma and the ring levee system between Larose and Golden Meadow are predicted to flood, though Thibodaux will remain mostly dry. In other parts of the state, large parts of the New Orleans metropolitan region, particularly Jefferson Parish, are also predicted to flood.

Table 3.8: Incremental Physical Damage to Assets in Houma, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	25	$6,063	$2,707	$68	$8,837
Moderate	50	$8,715	$4,223	$105	$13,042
Less Optimistic	25	$8,237	$4,010	$95	$12,343
Less Optimistic	50	$13,238	$6,755	$159	$20,152

The effects of flooded businesses along the entire coast ripples outward to affect suppliers, employees, and consumers. In the 50-year, less optimistic environmental scenario, about 23% of the total impact occurs in the Houma region. Approximately 41% of total annual labor productivity in Houma will be impacted.

Table 3.9: Incremental Lost Economic Activity Impacting Houma, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	25	$856	$1,913
Moderate	50	$1,226	$2,856
Less Optimistic	25	$1,180	$2,673
Less Optimistic	50	$2,377	$5,617

4 Lafayette Region

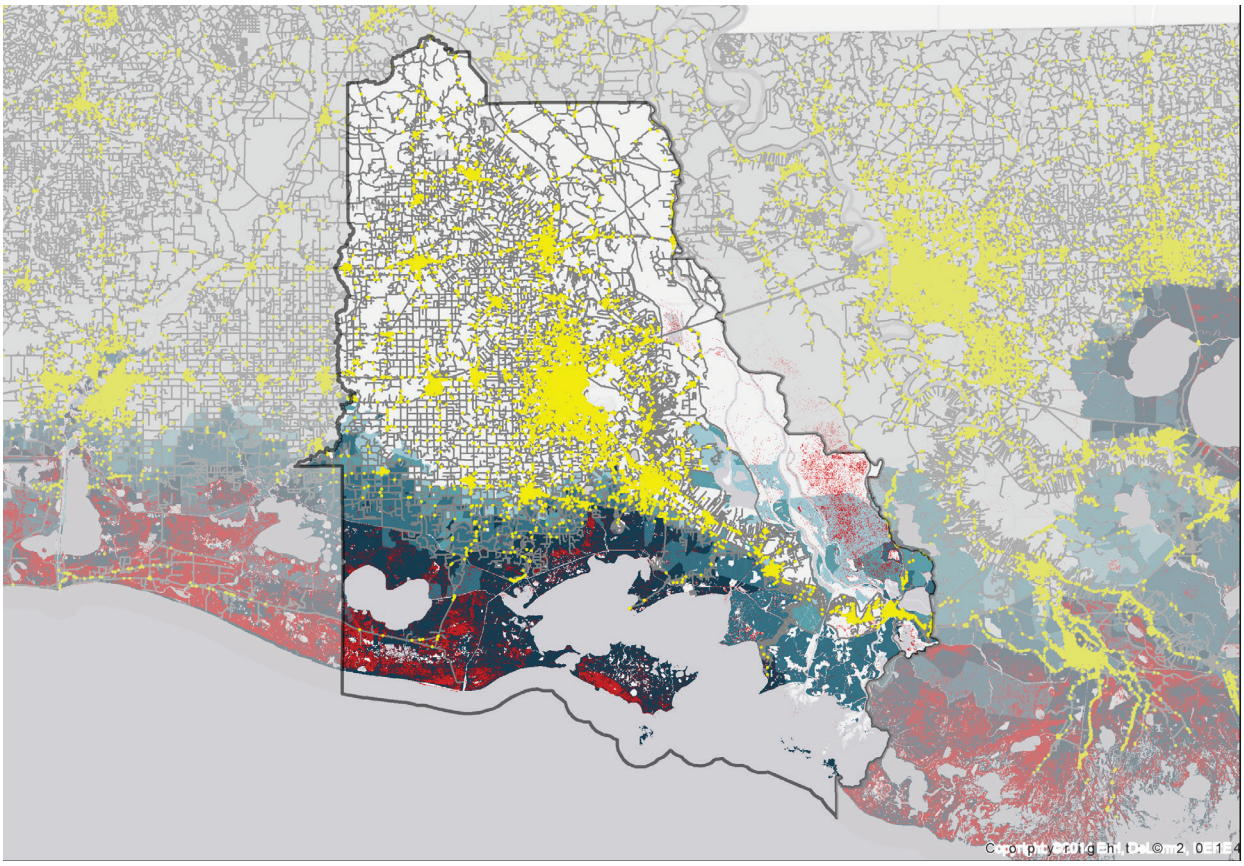
The Lafayette region is the third largest region in the state and includes the following parishes: Acadia, Evangeline, Iberia, Lafayette, St. Landry, St. Martin, St. Mary, and Vermilion. The Lafayette region is home to Lafayette, Morgan City, Franklin, and Opelousas. The Lafayette region supports 18,000 businesses and 277,000 jobs. The top 5 industries are as follows:

Table 4.1: Top Industries in Lafayette

Industry Sector	Total Business Locations	Employment
Health care and social assistance	2,058	40,377
Retail trade	2,568	34,213
Manufacturing	937	27,676
Mining, including oil and gas extraction	608	25,801
Accommodation and food services	1,128	22,595

Source: Quarterly Census of Employment and Wages 2014.

Lafayette has the largest concentration of oil and gas workers in the state. While employment has dropped off due to low oil prices, this industry is expected to remain an important economic driver for many years to come. Many of these workers live in Lafayette but go through Port Fourchon in the Houma region on their way to the Gulf. Though Lafayette is fairly well protected from coastal storm surge, devastating flooding in other regions of the state are likely to have large effects on the Lafayette region. More than 60,000 people are employed in Lafayette but live outside the region, and another 56,000 live in the Lafayette region but work elsewhere, many in the highly vulnerable New Orleans and Houma regions (U.S. Census Bureau 2014).



May key: yellow represents current location of businesses, red represents land loss in 50 years from 2012 less optimistic scenario, and blue represents flooding from a 100-year storm after the land loss shown in red.

Land Loss Results (Red Map)

Total physical damage expected in the Lafayette Region could be as high as $109 million in 25 years and $139 million in 50 years. Most of the land loss occurs in Vermilion Parish while some areas, particularly around the mouth of the Atchafalaya River are actually expected to gain ground. Table 4.2 presents the physical damage to the Lafayette region in terms of business and residence counts and replacement costs under several given scenarios and time horizons. Approximately 4% of coastal physical losses come from Lafayette.

Table 4.5: Physical Damage to Assets in Lafayette, Red Map

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$57	$4	$16	$78
Moderate	**50**	$67	$5	$16	$89
Less Optimistic	**25**	$79	$6	$23	$109
Less Optimistic	**50**	$94	$7	$38	$139

The loss of businesses in more vulnerable coastal areas leads to lower employment, wages, and output in other regions. The loss of these those jobs and businesses means fewer businesses are buying supplies and services from businesses in the Lafayette region. Likewise, consumers are purchasing less. Table 4.3 presents the economic impact on Lafayette in terms of total lost jobs, wages, and output.

Table 4.3: Annual Economic Activity Lost Impacting Lafayette, Red Map

2012 Environmental Scenario	Time Horizon	Total Lost Jobs	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	1,680	$64	$301
Moderate	**50**	1,880	$73	$336
Less Optimistic	**25**	1,850	$71	$319
Less Optimistic	**50**	2,240	$90	$385

In 50 years, more than 2200 jobs and $385 million in annual output could be lost. This accounts for 10% of lost employment across the coast.

Incremental Storm Damage Results (Blue Map)

The Lafayette region is often perceived as a region relatively safe from the effects of land loss; however, this region is not exempt from land loss in many of its coastal areas. Vermilion and Iberia Parishes, in particular, are expected to lose a great portion of their coastal wetlands, exposing Abbeville and New Iberia to stronger storm surge. In addition to the threat of storm surge, Lafayette is critically linked to storm surge impacts in the Gulf and the Houma region through Port Fourchon. Lafayette had almost 26,000 workers in oil and gas before the recent drop in oil prices, making the industry the fourth largest in the region. While it may take some time for employment to return to those heights, it continues to be an important industry for the region. Damage to other regions of the state produce an impact much larger than the initial physical damage would suggest.

Case study: Eastern, Katrina-Like Storm

Modeling predicts that in the Lafayette region, some flooding may occur in and around Franklin and Morgan City, but Lafayette and Abbeville are expected to remain dry in the hypothetical "Eastern" (Katrina-like) storm. Possible levee failure in New Orleans would cause flooding in the city of Lafayette and surrounding suburbs. Parts of the city of Houma and the entire swath of towns between Larose and Golden Meadow are predicted to see levee failure and flooding as well.

Table 4.4 presents the incremental damage to physical assets in Lafayette over what we would see with the current state of the coast. Total replacement costs could approach $1.8 billion in 50 years.

Table 4.4: Incremental Physical Damage to Assets in Lafayette, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$772	$408	$16	$1,196
Moderate	**50**	$1,024	$533	$18	$1,574
Less Optimistic	**25**	$872	$436	$18	$1,325
Less Optimistic	**50**	$1,112	$639	$20	$1,772

Even though less than 1% of the physical damage comes from Lafayette, the effects of this storm would results in huge impacts on jobs, wages, and output in throughout the entire coast. Due to the interconnectedness of all the regions, and in particular Lafayette's reliance on offshore jobs in oil and gas extraction, Lafayette could lose $885 million in wages and $3 billion in output. This accounts for 7% of the total coastal effect.

Table 4.5: Incremental Lost Economic Activity Impacting Lafayette, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	25	$178	$481
Moderate	50	$215	$613
Less Optimistic	25	$198	$549
Less Optimistic	50	$885	$2,987

Case Study: Western, Rita-Like Storm

The next tables display a case like Hurricane Rita, where the brunt of the impact is in the western part of the state. In the 50-year, less optimistic scenario, the storm surge is expected to reach as far north as Abbeville and New Iberia. In this case, about 13% of the physical damage and 15% of lost labor productivity across the coast comes from the Lafayette region. Of the cases studied, the western track storm produces more damage in Lafayette than the other storms at $5.2 billion in 50 years. However, even though $2.3 billion of output is lost in this case, more output is lost in the less damaging eastern-track storm. This idiosyncrasy happens because of the magnitude of the New Orleans regional economy compared to Lake Charles and Lafayette's economic connections with that region.

Table 4.6: Incremental Physical Damage to Assets in Lafayette, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	25	$939	$564	$12	$1,516
Moderate	50	$1,801	$1,045	$20	$2,866
Less Optimistic	25	$1,346	$850	$19	$2,214
Less Optimistic	50	$3,554	$1,650	$39	$5,242

Table 4.7: Incremental Lost Economic Activity Impacting Lafayette, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	25	$291	$783
Moderate	50	$445	$1,207
Less Optimistic	25	$375	$1,048
Less Optimistic	50	$873	$2,268

100-Year Storm

In the 100-year storm, the estimated physical damage in Lafayette could total $2.6 billion in 25 years and $4.2 billion in 50 years. The 100-year storm in the less optimistic scenario at a 50-year time horizon predicts flooding in Abbeville and New Iberia. In other parts of the state, levees in Jefferson parish and other areas around New Orleans (not in the city proper) are predicted by the model to fail and cause flooding. In the Houma region, the city of Houma and everything south of it, including the ring levee around Larose, Cut Off, Galliano, and Golden Meadow, are expected to flood. In the 100-year storm, around 7% of physical damage occurs in the Lafayette region.

Table 4.8: Incremental Physical Damage to Assets in Lafayette, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$634	$415	$12	$1,061
Moderate	**50**	$1,843	$848	$24	$2,715
Less Optimistic	**25**	$1,739	$804	$25	$2,568
Less Optimistic	**50**	$2,646	$1,538	$32	$4,217

The effects of flooded businesses along the entire coast ripples outward to affect suppliers, employees, and consumers. In the 50-year, less optimistic environmental scenario, about 11% of this impact occurs in the Lafayette region.

Table 4.9: Incremental Lost Economic Activity Impacting Lafayette, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	$240	$741
Moderate	**50**	$499	$1,473
Less Optimistic	**25**	$480	$1,407
Less Optimistic	**50**	$907	$2,827

5 Lake Charles Region

The Lake Charles region is an up-and-coming manufacturing center in southern Louisiana. The region includes the following parishes: Allen, Beauregard, Calcasieu, Cameron, and Jefferson Davis. Besides the city of Lake Charles, Jennings and DeRidder are located in the region. The region supports 7,000 businesses and 120,000 jobs. The top 5 industries are as follows:

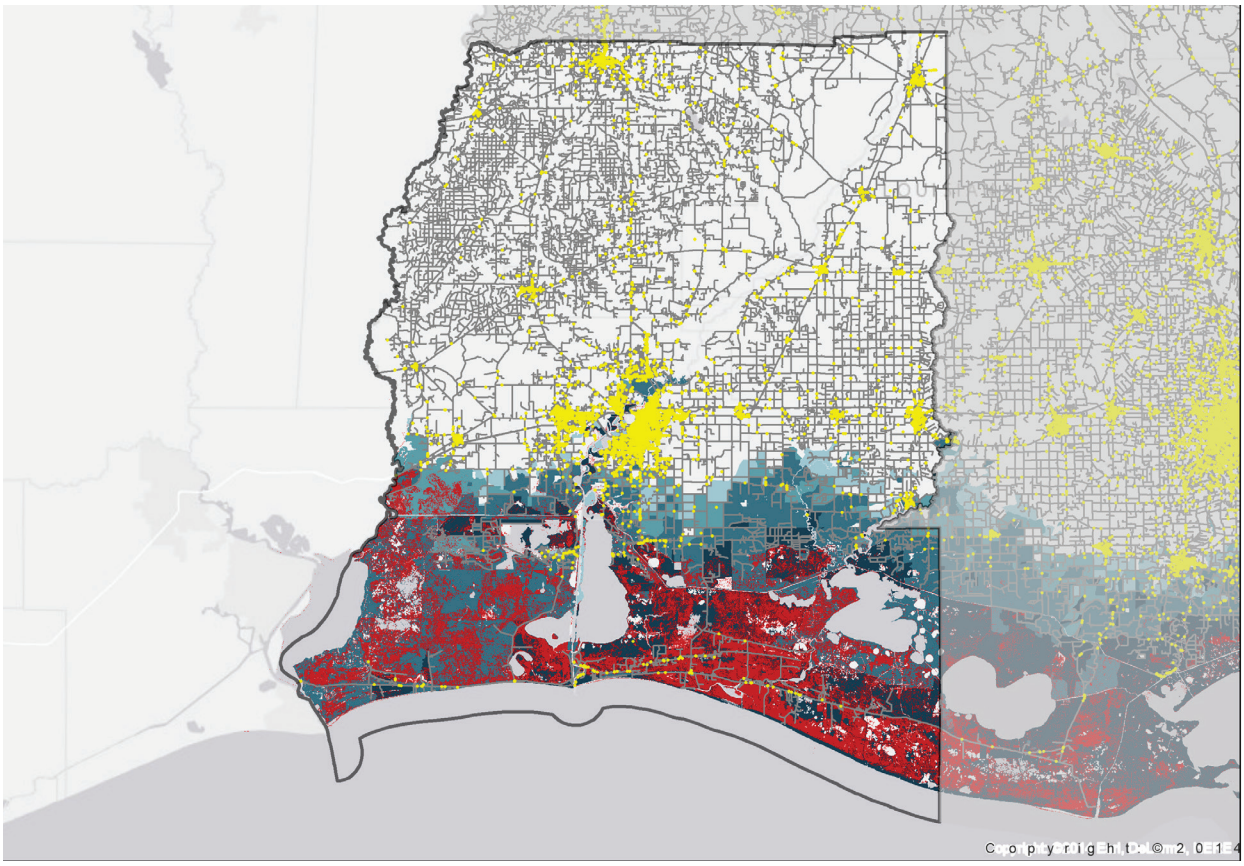
Table 5.1: Top Industries in Lake Charles

Industry Sectors	Total Business Locations	Employment
Health care and social assistance	724	16,863
Construction	664	16,476
Retail trade	1,081	13,479
Accommodation and food services	515	13,183
Manufacturing	225	11,155

Source: Quarterly Census of Employment and Wages 2014.

Note that construction is a very strong sector in Lake Charles, indicative of recent and continuing economic growth, and manufacturing is very high on the list. Approximately 9% of the working population is engaged in manufacturing jobs. However, a forward-looking assessment of the Lake Charles economy reveals clearly that protecting the Port of Lake Charles and other trade-supporting infrastructure will be essential. Over $100 billion of investment projects have been announced in the last several years alone, much of which depends on the Port for Liquefied Natural Gas export. Construction in support of these activities has already been deemed a game-changer for the region. Protecting the vulnerable infrastructure that makes this rapid growth possible is crucial to the future health of the region.

These large investments have included some site-specific measures to increase structural resiliency in order to reduce the risk of storm damage. However, as expectations about the pace and extent of land loss shift toward a more rapid deterioration of the coast, the risk facing these new investments also grows. At this stage, the actual risk facing these new facilities is unclear and has not been included in the damage estimates below, but could lead to substantially larger risks if they too become vulnerable to the effects of land loss.



May key: yellow represents current location of businesses, red represents land loss in 50 years from 2012 less optimistic scenario, and blue represents flooding from a 100-year storm after the land loss shown in red.

Land Loss Results (Red Map)

Total physical damage expected in the Lake Charles Region could be as high as $253 million in 25 years and $423 million in 50 years. Table 5.2 presents the physical damage to the Lake Charles region in terms of business and residence counts and replacement costs in several given scenarios and time horizons. Approximately 7% of coastal business replacement costs come from the Lake Charles region, but 27% of the infrastructure damage comes from this region.

Table 5.2: Physical Damage to Assets in Lake Charles, Red Map

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$56	$12	$46	$114
Moderate	**50**	$101	$18	$58	$176
Less Optimistic	**25**	$123	$29	$101	$253
Less Optimistic	**50**	$168	$56	$199	$423

The loss of businesses in more vulnerable coastal areas leads to lower employment, wages, and output in other regions. The loss of these those jobs and businesses means fewer businesses are buying supplies and services from businesses in the Lake Charles region. Likewise consumers are purchasing less. Table 3 presents the economic impact on Lake Charles in terms of total lost jobs, wages, and output.

Table 5.3: Annual Economic Activity Lost Impacting Lake Charles, Red Map

2012 Environmental Scenario	Time Horizon	Total Lost Jobs	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	790	$26	$384
Moderate	**50**	970	$40	$437
Less Optimistic	**25**	930	$37	$428
Less Optimistic	**50**	1,210	$54	$494

In 50 years, more than 1,200 jobs and $494 million in annual output could be impacted.

Incremental Storm Damage Results (Blue Map)

For the Lake Charles region, the hurricane season of 2005 brought not only the notorious Hurricane Katrina, but also a second blow in the form of Hurricane Rita, which made landfall at the Louisiana-Texas border and hit the region hard. This hurricane devastated Cameron Parish, and pushed up through the Calcasieu River into the city of Lake Charles. Millions of dollars have been invested since then to rebuild the shoreline of Cameron Parish as the first line of defense against storm surge. In addition, funds from the BP oil spill fines will be used to reduce wetland losses caused by saltwater intrusion with the Calcasieu Ship Channel Salinity Control Project. However, the inexorable processes of erosion and sea level rise will fight to erase these gains over the next 50 years, and business and residential buildings will become increasingly vulnerable as land loss reduces the natural storm defenses of the region.

Case study: Eastern, Katrina-Like Storm

If another storm similar to Hurricane Katrina hit the coast in 50 years, the damage would be even worse than it would be today. In the Lake Charles region, damages will not be as catastrophic as around New Orleans and Houma, where levee failure and city flooding is expected to cause severe damage. Because Lake Charles is on the eastern, calmer side of the hurricane's path, it will not bear the brunt of the storm, but that is not to say it will escape unscathed. Table 4 presents the incremental damage to physical assets in Lake Charles over what we would see with the current state of the coast. Total replacement costs could be as high as $875 million in 50 years.

Table 5.4: Incremental Physical Damage to Assets in Lake Charles, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$347	$64	$16	$427
Moderate	**50**	$414	$89	$19	$522
Less Optimistic	**25**	$440	$90	$27	$557
Less Optimistic	**50**	$569	$232	$74	$875

Another Katrina-like storm with levee failure in New Orleans would have catastrophic consequences across the coast. The effects of this storm would result in large impacts on jobs, wages, and output in the Lake Charles region. Approximately $303 million in labor productivity could be lost and businesses could lose $1.1 billion in output.

Table 5.5: Incremental Lost Economic Activity Impacting Lake Charles, Blue Map — Eastern Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	$92	$280
Moderate	**50**	$99	$312
Less Optimistic	**25**	$99	$302
Less Optimistic	**50**	$303	$1,122

Case Study: Western, Rita-Like Storm

The next two tables display a case like Hurricane Rita, where the brunt of the impact is in the western part of the state. This storm is the worst case studied in the Lake Charles region. In this case, about 18% of the physical damage and 19% of the labor productivity comes from the Lake Charles region. Relative to the Houma area, where 45% of the damage comes from, most of the economic activity in Lake Charles region is on higher and better protected land. However, there are still many businesses and residences that are vulnerable, to a tune of up to $8.6 billion in replacement costs.

Table 5.6: Incremental Physical Damage to Assets in Lake Charles, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$1,113	$502	$21	$1,636
Moderate	**50**	$1,821	$960	$31	$2,812
Less Optimistic	**25**	$2,789	$1,389	$51	$4,229
Less Optimistic	**50**	$5,898	$2,608	$92	$8,598

The western track storm could result in $960 million in lost labor productivity, equivalent to approximately 18% of total annual wages in the region. The western track storm could also cause up to $2.3 billion of lost output.

Table 5.7: Incremental Lost Economic Activity Impacting Lake Charles, Blue Map — Western Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	$247	$645
Moderate	**50**	$360	$1,027
Less Optimistic	**25**	$458	$1,276
Less Optimistic	**50**	$960	$2,356

100-Year Storm

In the 100-year storm, the physical damage in Lake Charles could total $1.3 billion in 25 years and $2.2 billion in 50 years. The 100-year storm in the less optimistic environmental scenario at a 50-year time horizon does predict some levee failure around the coast, particularly around Houma and in areas around New Orleans. In this case, around 3% of damage to businesses occurs in the Lake Charles region.

Table 5.8: Incremental Physical Damage to Assets in Lake Charles, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Business Replacement Costs (millions)	Residence Replacement Costs (millions)	Infrastructure Replacement Costs (millions)	Total Replacement Costs (millions)
Moderate	**25**	$471	$433	$19	$924
Moderate	**50**	$618	$635	$25	$1,277
Less Optimistic	**25**	$644	$664	$36	$1,344
Less Optimistic	**50**	$1,049	$1,127	$63	$2,238

The effects of flooded businesses along the entire coast ripples outward to affect suppliers, employees, and consumers. In the 50-year, less optimistic environmental scenario, about 5% of this impact on labor productivity occurs in the Lake Charles region.

Table 5.9: Incremental Lost Economic Activity Impacting Lake Charles, Blue Map — 100-Year Storm

2012 Environmental Scenario	Time Horizon	Total Lost Wages (millions)	Total Lost Output (millions)
Moderate	**25**	$99	$341
Moderate	**50**	$137	$550
Less Optimistic	**25**	$140	$553
Less Optimistic	**50**	$414	$1,511

III. Economic Opportunities to Protect and Restore the Coast

While the economic risks of land loss reverberate across southern Louisiana, these regions also have the most to gain from a robust protection and restoration program as billions of dollars are invested in Louisiana's coast. Over the coming years, the state of Louisiana will be spending unprecedented amounts on coastal restoration and protection projects as the state accelerates implementation of its ambitious Coastal Master Plan.

These plans, including levees, locks, river diversions, and other initiatives, are cutting-edge projects that attempt to rebuild land and engineer solutions to natural and man-made environmental problems across the coast. Louisiana is poised on the forefront of what could be a global trend toward massive civil engineering projects to combat environmental change in coastal cities around the world. These storm protection and restoration investments in Louisiana bring a large opportunity for local businesses to expand and will bring professionals and experts from all over the world to the state. Experience in the civil construction projects and the critical mass of skilled labor and water management professionals will also open opportunities beyond the borders of Louisiana and the United States.

To estimate the economic impact coastal restoration spending will have on Louisiana, it is important to understand the magnitude and timing of the spending. The next sections will explain the sources of funding for coastal restoration projects and discuss the project phases and timing, as well as how we use this information to project future opportunities in Louisiana.

Review of Sources of Funding

Since the inception of the Coastal Protection and Restoration Authority in 2008, Louisiana has worked to harness a changing mix of revenues. This section lays out major sources of funding for coastal restoration in Louisiana. All of these sources will extend beyond the 10-year period considered in this report for these projections.

GOMESA

The Gulf of Mexico Energy Security Act of 2006 (GOMESA) created a revenue sharing arrangement for the four Gulf Producing States and their eligible coastal political subdivisions to share some of the qualified revenues from the Outer Continental Shelf oil and gas leases. Beginning in fiscal year 2017, so long as the price of oil continues to be above $49 per barrel, the cap will be reached and Louisiana will receive the maximum payment of approximately $176 million per year to the state and parishes. The funds must be dedicated primarily to coastal restoration, mitigation, and conservation management, or mitigation of the impact of outer Continental Shelf activities through the funding of onshore infrastructure projects. The funding is now constitutionally protected for the Coastal Protection and Restoration Trust Fund and the state intends that the vast majority of the money will go to coastal work outlined in the Coastal Master Plan (Stafford 2016).

Deepwater Horizon NRDA

Penalties and damage assessments from the Deepwater Horizon oil spill in 2010 will provide a large source of funding for coastal restoration in Louisiana. One of the largest sources of oil spill funding is the settlement of natural resource damages claims, which were identified through the Natural Resource Damage Assessment (NRDA). The overall NRDA settlement was $8.8 billion, with slightly over $5 billion dedicated to Louisiana (Trustee Council 2016). Of this, the majority ($4.3 billion) will be spent to restore and conserve habitat along the coast, and the remainder to restore water quality, replenish and protect living coastal and marine resources, provide and enhance recreational opportunities, and monitor and manage activities. Some of this money has already been committed by BP as early restoration funds, and the remaining is expected to come in annual payments of approximately $319 million.

National Fish and Wildlife Foundation

Another source of oil spill-related funding is the $2.544 billion in criminal penalties that was directed to the National Fish and Wildlife Foundation (NFWF), of which $1.272 billion will be spent in Louisiana. These funds are administered by NFWF, and in Louisiana, can only be utilized for barrier island and river diversion projects. Proposals must be approved by both the CPRA Board and the NFWF Board. As of November 2016, $465 million have been approved on 12 projects, including planning and engineer and design work on an Atchafalaya River Diversion and multiple Mississippi River diversions (National Fish and Wildlife Foundation).

RESTORE Revenues

The RESTORE Act (Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act) was created in July 2012 to establish the distribution of civil penalties related to the Deepwater Horizon spill. The RESTORE Act created the Gulf Coast Ecosystem Restoration Council to administer the distribution of funds and dedicates 80% of the penalties to a Gulf Restoration Trust Fund. Total spill-related penalties are $6.7 billion from Transocean, Anadarko, and BP. The penalties are to be split through three allocations between the five Gulf States and federal agency efforts in the Gulf. In total, $993 million is already dedicated to Louisiana, with more to come as specific restoration projects are chosen by the Gulf Coast Ecosystem Restoration Council (Barnes & Bankston 2016).

CWPPRA

The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) is federal legislation enacted in 1990 that is designed to identify, prepare, and fund construction of coastal wetlands restoration projects. Federal funds to Louisiana have ranged between approximately $30 million per year to about $80 million per year in the past (Costal Protection and Restoration Authority, 2016). The underlying taxes and duties are heavily tied to the price of fuel. While that price was up over the last couple of years, it has fallen and could potentially fall further in the future.

CPR Trust Fund

The state created the Coastal Protection and Restoration Trust Fund (CPR Trust Fund) to house a portion of state mineral revenues dedicated to coastal restoration in accordance with the Louisiana Constitution on. The Trust Fund can also accept funds from other sources, including but not limited to CIAP, GOMESA, RESTORE, and NRDA dollars, and serves to help carry coastal protection and restoration dollars across fiscal years and manage cash flow. However, the mineral revenues deposited into the CPR Trust Fund represent an additional recurring source of revenue for coastal projects. The amount of mineral revenues is tied to oil and gas production on state lands, and has ranged from $55 million in 2009 (Coastal Protection and Restoration Authority, 2009) to approximately $15 million in 2017 (Coastal Protection and Restoration Authority, 2016).

Potential Future Opportunities

In addition to these more concrete sources of funding, there will need to be additional opportunities to harness resources for coastal restoration in the future. Other sources of funds in the past have included targeted federal programs like the Coastal Impact Assistance Program (CIAP), as well as ongoing federal funding mechanisms that have provided opportunities in the past to supplement the state's protection and restoration dollars such as disaster recovery grants through the Community Development Block Grants program and hazard mitigation dollars from the Federal Emergency Management Agency (FEMA). There may also be new innovative funding streams for restoration from both public and private sources. For example, Louisiana may be able to use mitigation banking and carbon crediting to funnel restoration dollars to the coast. The Coastal Master Plan includes a number of proposed projects to protect and restore the coast that may become more feasible with additional funds. Because of the uncertainty of these revenue sources, they are not included in projections for this report, but they would offer additional opportunities to businesses engaged in coastal protection and restoration work.

Methodology

Spending on coastal restoration projects creates direct output and jobs in the state, which ripple outward into indirect and induced output. Businesses with contracts for coastal restoration buy what they need from other companies in Louisiana (indirect output), and so forth. Employees from firms hired to complete restoration projects create another round of sales (induced output) when they spend their wages. The software IMPLAN and statewide multipliers are used to measure the effect of these indirect and induced output from a given amount of direct spending on coastal restoration projects in Louisiana. IMPLAN draws from historical trade flow patterns to measure how increases and decreases in activity in one industry impact other industries.

To obtain a reasonable estimate of revenue and expenditures on coastal restoration work in Louisiana, we reviewed CPRA's Annual and Master Plans and publicly available summaries of oil spill-related funding. The 2017 Annual Plan lays out a very specific three-year projection of revenues and expenditures. After this point, there is much less certainty on a year-to-year basis, though as discussed in the previous section, there are some known revenue sources. To confirm our figures, we met with CPRA to review background related to historical funding streams to aid in developing realistic scenarios of future revenue streams. Table 6.1 provides a range of reasonable values from the various funding sources, from which a "low" and "high" revenue year can be modeled.

Table 6.1: Louisiana Annual Revenue Outlook 2017-2026

Revenue Sources	Low	High
GOMESA	$100,000,000	$140,000,000
Deepwater Horizon NRDA	$319,000,000	$319,000,000
NFWF	$45,000,000	$85,000,000
RESTORE	$35,000,000	$75,000,000
CWPPRA Federal Funds	$35,000,000	$90,000,000
CPR Trust Fund Annual Revenue	$15,000,000	$35,000,000
Other	$45,000,000	$56,000,000
Total Projected Revenue (CPRA)	$594,000,000	$800,000,000
Parish Coastal Restoration Revenue	$36,000,000	$40,000,000
Total Louisiana Coastal Restoration Revenue	$630,000,000	$840,000,000

The revenue picture shows approximately how much money the state has to spend on coastal restoration, but does not capture the type of work (mix of industries) or exact timing. For instance, according to the 2017 Annual Plan, the total projected expenditures for the 2017 fiscal year is $735 million. Construction and maintenance constitute the largest portion of the budget at 75% and engineering and design captures 14% of the budget. The following year, construction and maintenance is expected to step back to 61% of the budget, and engineering and design ***rise*** to 20%. The distribution of work can result in a slightly different mix of job creation, wages, and indirect and induced output. However, to provide a general picture of the economic activity generated by spending on the state's coastal protection and restoration program, a typical construction-heavy year with 75% construction, 14% engineering and design and 11% general business and administrative support is used for economic impact modeling.

There are several major projects on the horizon that will bring a surge in spending, including the Mid Barataria and Mid Breton Mississippi River sediment diversions. As these two projects move forward, it is expected that they will significantly influence the timing of expenditures relative to annual revenue flows as well as the distribution of expense category. For instance, CPRA may spend less than total available revenues in some years to save up for construction costs on the

diversions, or may bond GOMESA funds to bring an influx of cash that can be paid back over time. Because the timing of expenditures is uncertain, this model assumes the low- and high-revenue estimates are similar to the rate of expenditures over time.

Results

The state has already begun investing in storm protection and restoration projects, so there are many people already employed in these restoration-related occupations. The number of these jobs varies from year to year, but this steady stream of money from the oil spill settlements and GOMESA represents a much larger and more stable, long-term revenue source and job creation.

This report focuses on the next 10 years, where revenues are most certain. While actual revenues in each year will vary somewhat and the timing of expenditure will also vary from year to year as the state aligns available dollars with specific projects, this report produces a range of annual spending to characterize the overall level of spending we expect for at least the next 10 years. At the lower end of the range of future spending, coastal protection and restoration will directly support 4,500 jobs annually. After considering the indirect and induced economic effects, coastal protection and restoration spending is expected to support a total of 7,800 jobs and $463 million in wages are supported annually. At the higher end, 6,000 direct jobs are supported annually; in total, 10,500 jobs and $618 million in wages are supported annually. Total annual value added ranges from $589 million to $785 million and output ranges from $1.1 billion to $1.5 billion, representing a tremendous opportunity to Louisiana firms to compete for this work.

Table 6.2 Low Revenue Year

Impact Type	Employment	Labor Income (millions)	Value Added (millions)	Output (millions)
Direct Effect	4,500	$306	$314	$630
Indirect Effect	1,200	$70	$113	$195
Induced Effect	2,100	$87	$161	$263
Total Effect	7,800	$463	$589	$1,088

Table 6.3 High Revenue Year

Impact Type	Employment	Labor Income (millions)	Value Added (millions)	Output (millions)
Direct Effect	6,000	$408	$419	$840
Indirect Effect	1,600	$93	$151	$260
Induced Effect	2,800	$117	$215	$351
Total Effect	10,500	$618	$785	$1,451

Historically, some coastal restoration and protection work was absorbed by Louisiana firms while some of the work went to out-of-state contractors. Because Louisiana is now looking ahead to a more sustained flow of projects, there is likely to be a renewed interest among Louisiana-based contractors to bid and capture a larger share of the work. As Louisiana firms continue to undertake coastal projects, professionals and skilled workers in Louisiana may have more opportunities for jobs in coastal work, and Louisiana residents may increase demand for training in these high-demand occupations.

The average wage for jobs of all kinds created by this spending, including planning and engineering, construction, and other jobs, is $59,000 annually, much higher than Louisiana's average wage of $41,000 (Bureau of Labor Statistics). These jobs will attract professional and skilled labor from many places as well as provide opportunity for local residents to enter high-paying career paths.

Most jobs added will be construction jobs, with a significant number in engineering and design and administrative and professional support position. Occupations directly associated with coastal restoration include construction laborers, dredge operators, carpenters, plumbers and pipefitters, drafters, engineers and architects, project managers, computer analysts and programmers, accountants and auditors (Hobor, Plyer, & Horwitz 2014; Louisiana Workforce Commission 2011). Many of these jobs only require a high school diploma. Table 6.4 shows the breakout of industries that will most benefit from restoration spending during the high-revenue year in Table 6.3.

Table 6.4: Top Industries in Protection and Restoration Economy

Sector Number	Description	Employment	Labor Income (millions)	Value Added (millions)	Output (millions)
35	Construction of new nonresidential structures	4,200	$276	$291	$630
384	Office administrative services	1,100	$61	$56	$97
369	Architectural, engineering, and related services	1,000	$88	$89	$141
413	Food services and drinking places	460	$11	$15	$28
382	Employment services	240	$7	$8	$10
319	Wholesale trade businesses	190	$15	$27	$40
360	Real estate establishments	190	$2	$18	$24
394	Offices of physicians, dentists, and other health practitioners	160	$14	$14	$22
397	Private hospitals	150	$11	$12	$23
426	Private household operations	140	< $1	< $1	< $1

Discussion

Clearly, the dollars coming into Louisiana for coastal restoration will have a multiplying effect on the economy as more Louisiana jobs are added and economic growth stimulated in the economy. In the case of the high-revenue, construction-heavy year, the indirect and induced output is almost 58% of the direct spending injected into the economy by CPRA and local governments.

In addition to the short-run economic activity generated from this spending, this spending provides a base of work that will position Louisiana-based businesses for long-term growth. For instance, investment in coastal restoration provides diversification and new opportunities for well-established firms that traditionally serve oil and gas companies, helping Louisiana weather periods of poor oil and gas production (Lowe, Stokes, & Gereffi 2011). Another anticipated benefit of the large expenditures on coastal restoration is the expertise and skilled labor gained by local firms. The concentration of jobs in those industries that support protection and restoration work will help Louisiana in its efforts to develop a "water management cluster" of innovation and collaboration and a critical mass of professional and skilled labor. Expertise and resources gained from major marine construction and coastal restoration projects can help Louisiana firms compete for large contracts outside of the state and export knowledge to other regions, resulting in new jobs in Louisiana (Hobor, Plyer, & Horwitz, 2015).

IV. Summary and Conclusion

All of southern Louisiana will be impacted by future land loss and coastal restoration in the state, even those regions that are not on the "front lines." Louisiana businesses are connected to other businesses, government, and people, both consumers and employees. These economic linkages mean that when one area of the coast is damaged by hurricanes or land loss, other parts of the state are also impacted with lost output and labor productivity. This means that the large investments in coastal restoration and protection by the state ripple out into the economy and create more widespread and beneficial economic impacts and opportunities.

Each region is affected by storms, but to different degrees. In New Orleans, there are significant vulnerabilities in the levee system as surrounding marsh is depleted and the Gulf gets closer to the region's dense population and economic center. In Baton Rouge, it is not the direct impact of a storm, but the indirect and induced impacts that ripple in to the region that hits jobs and businesses in the event of the storm. In Houma, land loss is increasingly exposing the city to storm surge from storms of any trajectory. Future levee protection systems and LA-1 improvements will help, but these are not failsafe and continued investments in coastal restoration activities will be needed to mitigate these risks. Regions like Lafayette and New Orleans, with a large number of oil and gas related jobs, have a particular interest in keeping the Houma area secure because impacts there will ripple through the state's economy to neighboring regions. In the Lafayette region, some of the more coastal communities like Morgan City, Franklin, Abbeville, and New Iberia are becoming increasingly vulnerable to storm surge. Also, damage to cities like New Orleans, Houma, and Lake Charles have lasting economic repercussions in Lafayette. And finally in Lake Charles, many of the same storm surge vulnerabilities will affect business interests in the strong economy there.

Continued investments in coastal restoration and storm protection infrastructure are essential to ameliorating the potential damage caused by land loss and storm surge in a future without action. The opportunities that these investments will open up in the construction, engineering, and "water management" related industries provide a significant incentive to support restoration work along Louisiana's coast, in addition to the long-term land-building benefits of a robust protection and restoration program.

References

Barnes, C. & Bankston, M. Governor's Office for Coastal Activities. (2016). Oil Spill Funding: Focus on Louisiana [PowerPoint slides]. Presentation to St. John the Baptist Coastal Zone Management Advisory Committee.

Barnes, S., Bond, C., Burger, N., Anania, K., Strong, A., Weilant, S., & Virgets, S. LSU Economics and Policy Research Group & RAND Corporation. *Economic Evaluation of Costal Land Loss in Louisiana*. (2015). Available from http://coastal.la.gov/economic-evaluation-of-land-loss-in-louisiana/

Bureau of Labor Statistics, U.S. Department of Labor. *Occupational Employment Statistics*. Accessed Nov 8, 2016. http://www.bls.gov/oes/current/oes_la.htm#00-0000

Coastal Protection and Restoration Authority, State of Louisiana. *Louisiana's Comprehensive Master Plan for a Sustainable Coast*. (2012). Baton Rouge, LA.

Coastal Protection and Restoration Authority, State of Louisiana. *Integrated Ecosystem Restoration & Hurricane Protection in Coastal Louisiana: Fiscal Year 2017 Annual Plan*. (2016). Baton Rouge, LA.

Coastal Protection and Restoration Authority, State of Louisiana. I*ntegrated Ecosystem Restoration & Hurricane Protection in Coastal Louisiana: Fiscal Year 2010 Annual Plan*. (2009). Baton Rouge, LA.

Federal Emergency Management Agency, HAZUS-MH database version 2.1 data years 2000 and forward.

Hobor, G., Plyer, A., & Horwitz, B. The Data Center. *The Coastal Index: the Problem and Possibility of Our Coast*. (2014). Retrieved from http://www.datacenterresearch.org/reports_analysis/the-coastal-index/.

Infogroup and ESRI Business Analyst, Info-USA Business Geodatabase Version 10.1.

International Commission for the Protection of the Rhine. 2015. Rhine Atlas. Retrieved from http://geoportal.bafg.de/mapapps/resources/apps/ICPR_EN/index.html?lang=en.

Kellermann, P., A. Schöbel, G. Kundela, and A. H. Thieken. "Estimating flood damage to railway infrastructure – the case study of the March River flood in 2006 at the Austrian Northern Railway." Natural Hazards and Earth Systems Sciences. 3, 2629–2663, 2015.

Lowe, M., Stokes, S., & Gereffi, G. Duke Center on Globalization, Governance, & Competitiveness. Restoring the Gulf Coast: New Markets for Established Firms. (2011). Retrieved from https://www.edf.org/ecosystems/restoring-mississippi-river-delta

Louisiana Department of Transportation and Development (2013). Base Map Road Feature (10_0) [Geodatabase]. Retrieved from http://www.dotd.la.gov.

Louisiana State University AgCenter. 2014. Ag Summary. Retrieved from http://apps.lsuagcenter.com/agsummary/Overview.html

Louisiana Workforce Commission. (2011). The Greening of Louisiana's Economy: Career Pathways. Retrieved from https://business.lsu.edu/Economics-and-Policy-Research-Group/Pages/Green-Jobs-Study-Archive.aspx

Louisiana Workforce Commission. Quarterly Census of Employment and Wages. 2014. Retrieved from http://www.laworks.net/LaborMarketInfo/LMI_WageDataAnnual2002toPresent.asp?year=2014

LSU Division of Economic Development. (2013). 2011 Louisiana Tourism Satellite Account: An Update. Available from http://www.crt.state.la.us/tourism/louisiana-research/archived-research/index

Meselhe, E., White, E. D., & Reed, D. J., (2016). 2017 Coastal Master Plan: Appendix C: Modeling Chapter 2 – Future Scenarios. Version I. (p. 32). Baton Rouge, Louisiana: Coastal Protection and Restoration Authority.

National Fish and Wildlife Foundation. (2016). NFWF Approves Nearly $370 Million for New Restoration Projects on the Gulf Coast. Retrieved from http://www.nfwf.org/whoweare/mediacenter/pr/Pages/gebf_16-1115.aspx

U.S. Census Bureau. 2013. TIGER/line [Geodatabase]. Retrieved from https://www.census.gov/geo/maps-data/data/tiger-line.html.

U.S. Census Bureau. 2014. OnTheMap Application. Longitudinal-Employer Household Dynamics Program. http://onthemap.ces.census.gov/

U.S. Census Bureau, American Community Survey (ACS) data. 2010. As of July 24, 2015: http://www.census.gov/acs/www/data/data-tables-and-tools/index.php

U.S. Department of Agriculture, National Agricultural Statistics Service. 2013. CropScape [Geodatabase]. Retrieved from http://nassgeodata.gmu.edu/CropScape/index.jsp?state=LA.

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