Exploring the Implementation of Dike Building and the National Endowment for the Oceans Act to Support Coastal Restoration in Louisiana

Taylor Perrodin

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Exploring the Implementation of Dike Building and the National Endowment for the Oceans Act to Support Coastal Restoration in Louisiana

by

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Undergraduate honors thesis under the direction of

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Submitted to the LSU Roger Hadfield Ogden Honors College in partial fulfillment of the Upper Division Honors Program.

May, 2022

Louisiana State University

& Agricultural and Mechanical College

Baton Rouge, Louisiana
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I. Abstract

This research aims to explore the possibility and effects of dike building for land reclamation and the reintroduction of the National Endowment of the Oceans Act on the US Senate and House of Representatives floors. Following the Netherland’s model, this research tries to predict if dike building is a beneficial approach to revive coastal Louisiana. In order to identify that, interviews with industry professionals were conducted. This paper also explores literatures to determine if building dikes will be a beneficial approach for reclaiming land lost to erosion. Moreover, this paper reviews the National Endowment for the Oceans Act in detail as a potential funding source for coastal protection and restoration projects.
II. Acknowledgements

I would like to express my unwavering gratitude to my advisor, Dr. Trina Biswas, for guiding me through this research and writing process. She has been the best advisor and mentor I could have asked for. Without her patience, consistency, and support, this thesis would not have been possible.

I would also like to thank my family and friends for their continued support throughout my entire academic journey. Their unconditional love and faith in me have allowed me to persevere through everything life has thrown my way, and without them, I would not be as successful as I am. I am tremendously blessed to have a close family and friends who always believe in the best for me.

Lastly, I would like to thank my professors and instructors for equipping me with adequate knowledge to complete this thesis and my bachelor’s degree with college honors. It was their classes that inspired me to begin this research, and I will forever be grateful for my experiences at Louisiana State University.
1. Introduction

The erosion of Louisiana’s coast has been a pressing issue for as long as many people can remember. While there have been many numerous efforts to reduce land loss and its effects on coastal environments, Louisiana continues to lose about a football field of land every one-hundred minutes (Swenson, 2021). Without any proper action, the land loss will continue, and it is projected that about 1,750 additional square miles of land will be at risk of being lost to coastal erosion by 2060 (U.S Geological Survey, 2011; CPRA, 2012; Barnes et al., 2015).

Through my research, I hope to find a solution that reclaims land rather than continuing to slow the loss of it. This research aims to explore and discuss different programs and projects that can be implemented to contribute to the efforts of protecting and reviving coastal Louisiana’s natural and man-made capital stocks. The possibility of building dikes off of Louisiana’s coast, how to turn reclaimed land into useable land for multiple purposes, reintroducing the National Endowment for the Oceans Act, and how to better protect our coast from the effects of natural disasters and sea level rise are all areas to be explored further.

In a 2015 study, environmental scenarios were tested, and it was estimated that approximately $2.4 to $3.1 billion will be lost over the next fifty years in Louisiana’s annual output due to coastal erosion (Barnes, et al., 2015). Figure 1 shows the monetary value at risk with moderate and less optimistic scenarios tested for twenty-five- and fifty-year time periods. The sectors that are most directly affected by coastal erosion are oil and gas, navigation and transportation, commercial fishing, and recreational activity. These areas are important to the unique culture and seafood of Louisiana, and therefore should be protected.
The specific areas of interest listed above are important to preserving Louisiana and its economy because of the extensive damages done to not only the land, but also to the homes and lifestyles on the coast. This thesis focuses on the work of the Netherlands, a country with about 25% of its geographical area located below the sea level that has faced coastal land loss for centuries (Hillen, et al., 2010). This thesis discusses how the Netherlands, in which half the geographical area is only sitting above mean sea level by one meter (Hillen, et al., 2010), has used dikes to reclaim land from the water that surrounds their coast. Dike building in Louisiana has not been extensively explored and should continue to be studied to determine a definite opinion on the possibility of implementation. Hence, this thesis evaluates if the Netherlands model can be implemented to restore Louisiana’s coastline and whether it will be feasible both geographically and economically.
Given that adequate funding can always be a constraint while implementing policies, this thesis also explores the available resources to fund coastal restoration projects. In this thesis the National Endowment for the Oceans Act is explored in detail to identify its probable impacts. This act was implemented to create a stream of funding specifically to protect and conserve the US coast, ocean, and the Great Lakes ecosystem. The National Endowment of the Oceans Act would be beneficial to all coastal states’ restoration efforts but would need to be reviewed since it has been ten years since its introduction to the Senate floor.

The exploration of these two approaches will help to further the efforts of coastal restoration to save Louisiana’s coast from continuing to disappear, and the next section is an overview of how these two approaches are discussed in this thesis.

1.1 Overview

Coastal erosion can be costly to the economy. Along with the lands becoming uninhabitable, coastal erosion results in the loss of livelihoods and the outmigration of citizens. The land loss puts both man-made and natural assets at risk by disrupting economic activities and by disturbing ecosystem.

The motivation behind this thesis is to find a better solution to coastal restoration in Louisiana than the ones already in place.

This research initially discusses the impact of coastal erosion on Louisiana’s economy including land loss, loss of jobs, and outmigration of Louisiana natives. This thesis further explores the resources and discusses the course of actions to save the Louisiana coast.

This research paper is divided into two main sections, one explores the feasibility of building dikes to save coastal Louisiana, and the other focuses on the National Endowment for
the Oceans Act to discuss current and possible funding sources. The first section on dike building explores the economic and physical/geological impacts of building dikes in Louisiana and evaluates alternatives to dike building off of the coast to give some insight into other options that could be implemented so that the state will not be completely lost to erosion. Additionally, the impact of coastal erosion on Louisiana’s economy and the loss of livelihood resulting in outmigration are discussed within this first section. The second main section focuses on the National Endowment of the Oceans Act and the probable economic impacts of this act being signed into law. Also, the impact of similar regulations and agencies, and alternative options for the reintroduction of this act are discussed. Moreover, the questions asked in interviews with industry professionals that helped guide this research are discussed in the appendices. The conclusions drawn from the two main sections are evaluated to discuss a plan for the restoration of Louisiana’s coast that encompasses both approaches as well as other alternatives for a comprehensive conclusion of what should be done to ensure Louisiana will not be completely lost to erosion.

The next few sections present and evaluate the current state of Louisiana’s economy and the projects taking place in Louisiana and the Netherlands.

1.2 Economic Impact of Coastal Erosion on Louisiana’s Economy

In 1927, Louisiana experienced the Great Mississippi Flood, the largest river flood in history, in which ten thousand square miles and twenty parishes were submerged in water (Bradshaw, 2011). As a result, the construction of levees along the Mississippi River began, and the sediment build up process that the river current created was blocked; no new sediment was being transported from the northern parts of the Mississippi River to the delta region and creating more land. Before the 1930’s Louisiana was growing by three-fourths square miles each year,
which means that today, the state would be sixty square miles larger than it was then if this had continued. Instead, Louisiana is two thousand square miles smaller than it was in the 1930’s (CPRA, 2021). If this erosion would have taken place inland rather than on the coast, St. Charles, St. John the Baptist, St. James, Ascension, East Baton Rouge, and East Feliciana parishes would all be lost to the Gulf of Mexico, and if no restoration and protection projects would be taking place, an additional four thousand square miles of the coast would be lost fifty years from now.

![Image 1.](image.png)

**Image 1.** Louisiana’s coast in fifty years if no coastal protection/restoration efforts are implemented. Image source: Colten, 2021.

Also, contributing and unique to coastal erosion in Louisiana is the natural compacting and sinking of our marshes due to their muddy sediment makeup.

This erosion puts businesses, houses, infrastructure, and communities at risk of losing everything. If nothing is done to combat this land loss, flooding and infrastructure damage will result in the loss of residents, jobs, and the flow of commerce due to the outmigration of those residents to areas that are not directly affected by erosion (Barnes, et al., 2017). In 2017, it was estimated that there is $3.6 billion in infrastructure at risk from coastal land loss over the next fifty years (Cochran, 2017). The majority of this infrastructure is located at Port Fourchon, which
accounts for 20% of our nation’s oil and gas distribution supply, and where there is eight miles of highway level with the bayou, making it vulnerable to frequent flooding (CPRA, 2021). In addition to the $3.6 billion value of what will be lost, that infrastructure has supported $7.6 billion in national economic activity annually (Cochran, 2017). Louisiana is also a major trade hub. According to Barnes, et al. (2015), the coastal Louisiana parishes import $160 billion and export $156 billion annually. Coastal erosion will also affect Louisiana ports thereby adversely affecting domestic and international commodity trade volumes.

Louisiana will also continue to see trends of outmigration from the loss of land and the extreme effects of natural disasters felt by residents. For example, following hurricanes Katrina and Rita in 2005, 227,525 people moved out of Orleans Parish, 48,985 out of St. Bernard Parish, 8,488 out of Plaquemines Parish, and 2,587 out of Cameron Parish for storm related reasons (Hori, et al., 2008). Keeping residents in Louisiana is important to continue having a flow of commerce, but they are also the people who need to stay to continue spreading the culture of coastal Louisiana.

<table>
<thead>
<tr>
<th>Environmental Scenario</th>
<th>Time Horizon</th>
<th>Number of Structures</th>
<th>Total Replacement Costs($ millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>25 year</td>
<td>2,100</td>
<td>$310</td>
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<tr>
<td>Moderate</td>
<td>50 year</td>
<td>2,500</td>
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<tr>
<td>Less Optimistic</td>
<td>25 year</td>
<td>2,700</td>
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<tr>
<td>Less Optimistic</td>
<td>50 year</td>
<td>3,700</td>
<td>$510</td>
</tr>
</tbody>
</table>

*Table 1. Calculations made by the authors of Economic Evaluation of Coastal Land Loss in Louisiana of residual structures at risk from land loss based on estimated stock values All monetary values are presented in 2012 dollars. Figure source: Barnes, et al., 2015.*
Table 2. Calculations made by the authors of *Economic Evaluation of Coastal Land Loss in Louisiana* of the employment and annual payroll amounts at risk from land loss based data for business establishments. Government institutions were not. All monetary values are presented in 2012 dollars. Figure source: Barnes, et al., 2015.

Tables 1 and 2 show the results of the study conducted by Barnes, et al. In the study, scenarios with moderate and less optimistic conditions were evaluated for 25 years or 50 years from 2015. These scenario evaluations show the quantitative and monetary value of the buildings and employment at risk from land loss. If something is not done to save this coastal land, all of this economic activity will be lost, and that is why more research and funding should be utilized to explore dike building instead of just more coastal protection measures. The state and the federal government are already taking actions to restore Louisiana’s coast, and the next section discusses the projects and policies that are currently in place to revive Louisiana coast and the economy.

### 1.3 Current Projects and Policies

Louisiana is currently using small, temporary dikes in its efforts to slow coastal erosion through the rebuilding of a chain of barrier islands. Rebuilding these islands is important to slowing coastal erosion because they break wave energy and keep it away from coastal marshes. To do this, sand is brought to what is left of the island from offshore or dredged from the Mississippi River to build a sloping beach, then a dike is placed behind the island and sediment

<table>
<thead>
<tr>
<th>Environmental Scenario</th>
<th>Time Horizon</th>
<th>Employment</th>
<th>Total Payroll ($ millions)</th>
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<tbody>
<tr>
<td>Moderate</td>
<td>25 year</td>
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</tbody>
</table>
is pumped in between the beach and the dike to create a marsh. Since 2007, this project has resulted in the reclamation of seventy-four- and one-half square miles of barrier islands (CPRA How We Fight Video). This project is compiled of numerous smaller projects, and the Terrebonne area project currently has no potential federal funding source. The Coastal Protection and Restoration Authority fiscal year budget that goes into effect on July 1, 2022, allocates $845,542 for these projects, with the projected funding for 2024 and 2025 undetermined (CPRA Fiscal Year 2023 Annual Plan).

In addition to barrier island reclamation, improvements to the levee systems are also taking place across the state. Spillways, gates built into the sides of levees, have been implemented to allow for some sediment to be deposited in more areas across the state. The spillways allow for the top portion of the river to flow through and distribute the loose, freshwater materials elsewhere. There have also been numerous extensions, maintenance projects, and raising of the levees that have resulted in three hundred and twenty-seven miles of improvements to Louisiana’s levees (CPRA How We Fight Video). There are eight levee projects listed in the CPRA 2023 plan with only two having construction start dates and two others having no federal sponsor to fund the project.

Sediment diversions and dredging have been successful methods of restoring Louisiana’s marshes. According to the CPRA Mississippi River Mid-Basin Sediment Diversion Program, more than thirty million cubic yards of sand and sediment has been dredged from Mississippi River borrowing sites since 2008 to create, restore, and sustain four thousand acres of marsh, barrier islands, and ridge habitat. While dredging alone does not have the capability of collecting silt and clay from the water to build sustainable land, combining dredging with diversions yields better results for a longer period of time. Due to the success of these efforts, the CPRA has
dedicated $18 billion to marsh creation projects and plans to dredge fifty-five to sixty-five cubic yards of material over fifteen years (CPRA Mississippi River Mid-Basin Sediment Diversion Program).

On September 28, 2021, a construction contract was signed in the amount of $3,640,190.42 to begin the West Shore Levee Project (Robichaux, 2021). Test sections of a levee will be built along the West Shore of the Lake Pontchartrain levee alignment to provide information on what materials and methods are best for construction of the entire structure. The levee is expected to be completed in 2024 and stand eight and a half feet tall on the western side and twelve and a half feet tall on the eastern side. This design has been tweaked numerous times to ensure the levee will protect more than sixty thousand residents across three parishes, and these tweaks have resulted in the improvement of pumping station design to increase the water pumping capacity from two thousand one hundred and fifty to four thousand cubic feet per second (Robichaux, 2021).

Following the devastating effects of Hurricane Katrina in 2005, the Louisiana Legislature restructured the Wetland Conservation and Restoration Authority to form the Coastal Protection and Restoration Authority (CPRA) through Act 8 of an extraordinary session used to expedite the passage of this act. It expanded the membership, duties, and responsibilities of the authority’s board including the responsibility of creating the coastal master plan every five years and an annual action plan with expenditures to be submitted to the legislature for approval. This expansion directed the CPRA to consider both hurricane protection and the protection, conservation, restoration, and enhancement of coastal wetlands and barrier shorelines when deciding on expenditures. It also broadened the definition of coastal area to include contiguous areas subject to storm and tidal surges. In 2009 and 2012, two more acts were passed to establish
the CPRA as a state entity and expand its duties further. The 2012 act also transferred additional protection and restoration responsibilities from other state entities to the authority (CPRA Structure).

The LSU Center for River Studies received a $9.3 million grant last year from the Army Corps of Engineers to explore how sea level rise and other impacts resulting from climate change will affect coastal military bases and ecosystems (LSU College of Engineering, 2021). This grant funding will be utilized to better understand the water cycle and ecological systems that influence how soil properties can change to better prepare for building coastal infrastructure in the future. While this research is not on dike building or coastal restoration specifically, it is important to furthering the exploration of implementing dikes on the coast because they are also large structures, similar to others, that the civil engineers on the project are used to working with. The results from this collaboration can be applied to how climate change and sea level rise would affect a coastal dike.

While all of these efforts have certainly benefited Louisiana’s coastal protection efforts, the coast is still suffering from coastal and loss. Simply slowing land loss is not enough to save Louisiana’s coast and culture. Without reclamation, Louisiana will continue to slowly disappear until there is nothing left, as numerous industry professionals noted in their interviews that we cannot stop coastal erosion, only slow it. That is why I am proposing the method of dike building that proved to be successful in the Netherlands. The Netherlands model, discussed in the next section, showed that dikes can be effective not only in slowing the inevitable erosion but also in reclaiming land. If this method is implemented in Louisiana and it is successful, Louisiana could be as large as it once was and continue to grow the industry and culture on the coast.

1.4 Success in the Netherlands
The Dutch people of the Netherlands have been building dikes for centuries as a way to reclaim and drain land from the water that surrounds their coast, and they are now the second largest agricultural exporter in the world, behind the U.S., with half the land area. A dike is a barrier that holds back water and is typically constructed of one large slab of rock cutting through another type of rock. The first dikes were low embankments only about a meter tall around crop fields to protect the crops from occasional flooding (Lenk, et al., 2017). Today, dikes are long walls built around a body of water to prevent the area from flooding, and there are over fifty dike systems in the country (Huizinga, 2012). Once the dike is fully built, windmills or electric pumps are placed on top of the wall to pump the water out until the area of land is uncovered. The uncovered land is then used to build new homes and businesses on, while the dike structure is constantly breaking wave energy, thus reducing negative effects on the coast. As time goes on, these dikes are raised until the point where the benefit of the increase in height from added protection is zero due to the costs associated with building on the dike; here the dike is at optimal height and protection levels. These dikes have been widely used to protect low lying areas in Vietnam, Bangladesh, Thailand, the Netherlands, and the U.S., and provide the cheapest, hard defense when the value of the land they are protecting is low (Brampton, 2002). This tidbit is important because Louisiana does not have a large amount of infrastructure to protect along the coast, keeping the value of the land lower in most coastal regions with the exception of the important coastal marshes.
**Image 2.** The shortening of the Netherlands coastline over time from the strategy of building dams and closing off estuaries, which has been regarded as an effective strategy for coastal protection. Image source: Kok, et al., 2008.

As shown in Image 2, these have brought the Netherlands a high degree of protection from flooding and erosion for low-lying areas.

Two cost benefit analyses, one in 1961 and one in 2003, show that the Delta Works, the largest flood protection system in the world located off of the west coast of the Netherlands, has a positive result, i.e., the level of benefit outweighed the cost of building and maintaining the dike (Huizinga, 2012). In addition to protection from dikes, the Netherlands has dredged rivers throughout the country which are important to carry sediment to low lying areas. Every year, between thirty and thirty-five million cubic meters of mud are dredged from the waterways for maintenance to keep the rivers navigable for the increasingly larger ships and then the dredged material is utilized in their coastal restoration efforts (Human Power, 2018). These efforts
resulted in the reclamation of two thousand and seven hundred square miles of land by 2017, and they are currently working on a project to restore an island chain that stretches one hundred square kilometers off the northwest coast of the continent, adjacent to the entirely reclaimed region of Flevoland (Wee, 2017). Image 3 shows the areas of land these projects protect throughout the country and how these systems are beneficial for the safety of the inland areas. Through this project, they have found that a salt marsh in front of a dike reduces the heights of waves crashing into the defense mechanisms, leading to less costs for maintaining and restructuring them. This is important because the current Louisiana projects in place already use this type of set up, but with a much smaller dikes, and placing the marsh behind the dike would cause it to sink and disappear.

**Image 3.** The Netherlands dike-rings and their corresponding safety measures. Image source: Hillen, et al., 2010

In 2017, the cost of construction for the two hundred-and fourteen-kilometer Delta Works in the Netherlands was calculated to be €750 million, but the benefits for safety, the agriculture
industry, savings on maintenance of other structures, and additional leisure activities on the reclaimed land were valued at €1,155 million (Bos, et al., 2017). According to a 2009 study, the amount of loss the country would suffer without any flood protection has a steady rate of increase of about €2.5 billion per half a meter of sea-level rise beginning at €1 billion for a half meter rise (Hallegatte, et al., 2010). Currently, the North Sea is rising at a rate of three millimeters per year and there is subsidence of up to eight millimeters per year around the coast, resulting in eleven millimeters of total land loss per year. Without the protection of dikes and hydraulic pumps, the rising sea level would have resulted in more extreme land loss and flood risk.

Protecting the land on the coast is highly important to the country because of the large amount of infrastructure near the coast that needs to be protected, as it is a vital source of benefitting their economy. The Netherlands is home to the world’s largest seaport in Rotterdam, every city has a well-developed public transportation and pipeline system, and the government has created a special fund to funnel money into improving transportation and infrastructure across the country. The country’s population has also been rapidly increasing, with one hundred and twenty-five thousand new inhabitants from 2018 to 2019 (Rozing, 2020). The Dutch must continue to protect their coast and livelihood through flood protection efforts, and dikes have proven to be a successful method.
The Afsluitdijk, a fundamental part of the Zuiderzee Works, that dams off the salt water Zuiderzee, part of the North Sea. Constructed between 1927 and 1932. Image source: researchgate.net.

The next section summarizes the views of experts who work on coastal restoration and also reviews the literature related to coastal restoration.

1.5 Interviews with Industry Professionals and Review of Literature

To understand the feasibility of building dikes to protect Louisiana’s coast, industry professionals were interviewed. During the interview a fixed set of questions were asked (see Appendix I for list of questions asked). Also, the floor was open to discuss the work and general views of these industry professionals who have a great understanding of the Louisiana coast, coastal restoration efforts in the U.S. and Louisiana, as well as about Louisiana’s economy.

In my interviews with industry professionals, there was a general consensus that more needs to be done for Louisiana’s coast and that dikes seem like a good method to utilize. It was stated that there will be people in strong opposition to dike building, such as those in the fishing
industry, and that their reasons for the opposition should also be taken into consideration. Each person I interviewed also stated that the National Endowment for the Oceans Act is a reasonable political approach to coastal restoration funding and should therefore be reevaluated for introduction to the U.S. Senate or House of Representatives. However, there are thousands of individuals and some groups who disagree with the broader legislation that previously encompassed the endowment and so they aided in urging lawmakers to fail the bill. While the endowment itself has been widely accepted as a good solution, its failure has been noted as collateral damage for the purpose of failing the Water Resources Development Act (WRDA) due to an amendment that would have prohibited the U.S. Army Corps of Engineers from coordinating with coastal states, federal agencies, and the public for ocean planning (Merwin, 2014).

The individuals who focus on coastal restoration efforts and research explained that Louisiana’s coast has a muddy makeup that lacks an abundant source of sand to easily relocate to fit our restoration needs. They also all concluded that the leveeing of the Mississippi River was not beneficial to coastal restoration and protection because it ended the constant diversion and accumulation of sediment throughout the U.S. and onto Louisiana’s coast, and engineers have been arguing this point for centuries (Hersher, 2018). However, the levee system in Louisiana, composed of levees, floodwalls, and other control structures, protects over four million citizens, one and a half million homes, thirty-three thousand farms, and countless transportation routes that are vital to U.S. trade operations (Mississippi Valley Division, U.S. Army Corps of Engineers). When speaking with economists, I directed my questions towards the economic impacts of the two approaches on Louisiana’s economy and the livelihood of the people living in coastal communities. In their experience, more money is a good thing and the amount of funding
available, how spending will be prioritized, and the people involved in helping make allocation decisions will play important roles in how effective the endowment would be. When considering the individuals involved in making the allocation decisions, commercial and recreational fishermen are one of the most important public groups of people to have at the table. Despite the potential benefits to the fishing industry that come from National Ocean Policy, fishermen have been slow to accept it, feeling their voices were not well represented during the policy’s development, which has made it difficult to get them on board with the policy and its amendments since (Conathan, 2013). While it was brought up by multiple interviewees that Louisiana’s goal is to protect the existing land and the Netherland’s goal is to gain more land, it was also an understanding that simply protecting the coast as it is will ultimately lead to the disappearance of Louisiana and coastal culture. However, it is important that new projects be evaluated from all angles, including the study and quantification of social and cultural processes on the coast. While these have been noted as important matters when deciding on projects to implement, they have yet to be measured by the CPRA and used for deciding which projects to implement (Colten, 2021). All of the professionals I interviewed agree that dike building, and the National Endowment for the Oceans Act would be beneficial, but both need to be further explored to better understand the scope of the benefits and costs before implementation.

Louisiana’s coast gets a direct hurricane hit once every three years, making these areas particularly vulnerable to extreme flooding and erosion from large amounts of saltwater destroying the vegetation (Frankson, 2017). With extremely dramatic hurricanes, such as category five Katrina in 2005, Louisiana has gained national attention, and it is well-known that something must be done to restore and defend the coast in order to preserve the state. A study done by Stark, et al. in 2016 explores combining nature-based and engineering approaches to
model the effects of marsh sizes and dike placement surrounding the wetland areas by performing scenario analyses in which the shape of the marsh and location of the dike are changed and the reduction on high water level is evaluated. This study stems from the increase in attention being brought to create strategies for protecting coastal and estuarine areas from flood hazards and the recent research into the negative effects of dike building alone. They found that placing the dike too close to the seaward marsh edge, and thus making the marsh shorter, does not have much if any effect on reducing the effects of high-water levels, but that placing the dike in a position to extend the platform of the marsh by just one kilometer decreased the water level by 7-10 centimeters (Stark, et al., 2016). However, this same reduction in water level did not occur when the platform of the marsh was increased by 5 kilometers due to dike placement. This study is beneficial to making progress on coastal restoration and dike use in Louisiana since many parts of the state’s coast do not support the development of rock dikes (Handley, et al., 2015).

RISC-KIT has weighed the advantages and disadvantages, costs, and the difference shape plays in the role of implementing dikes. The article mention that dike building is advantageous because it is less expensive than some civil engineering techniques for flood protection, such as dam building, and that dikes with a slope are more effective than vertical dikes. The latter is because adding a slope to the dike will cause the waves to break, reducing their energy and the damage it could cause to the shoreline (RISC-KIT, Sea Dikes). The disadvantages discussed for dike building are expenses of extensive construction and maintenance, and prevention of land use during construction. With dikes being so large in size, the amount of materials that must be used and stored on land including sand, clay, and asphalt is also large and takes up a lot of land surrounding the construction site. This results in high input costs for the dikes and a large
amount of land needed for storing materials, meaning that land cannot be used for other things such as tourism and fishing on the coast. It is also stated that permanent structures made from significant construction negatively affect the natural processes of the coastline and ecosystem. The building of a dike in the United States would cost anywhere from $9 to $29.2 million per meter rise in height for each kilometer in length (RISC-KIT, Sea Dikes). These numbers are derived from land availability and cost, design of the dike, anticipated wave strength, stages of construction needed, and availability and cost of materials and labor. The article also points out that there are alternative dike designs that can be built with local efforts and at a cheaper cost, but that the science and technology are sure to be sound and that extreme caution should be used when paying less attention to the building of the dike to meet the accurate needs of the environment for that cheaper cost. They also touch on what the previous literature piece was focused on and mentioned that dikes can be constructed to complement other coastal protection methods stating that this will address the negative impacts of dike building while allowing the benefits of the method to still be realized.

2. Exploring the Feasibility of Dike Building in Louisiana

Coastal erosion in Louisiana is caused by adverse weather conditions, sea level rise, and human behavior. In the past year alone, the state has experienced numerous direct hurricane hits, massive flooding, and unusual freezing temperatures. Erosion resulting from these conditions significantly affects the oil and gas, commercial fishing, recreation, and navigation and transportation industries. Sea level is rising all over the globe, but Louisiana faces a unique rise due to subsidence, the gradual sinking of land. While interviewing Dr. John White, Associate Dean of Research for the LSU Department of Oceanography and Coastal Sciences, he stated that sea level is rising about three millimeters per year and Louisiana’s coast in sinking at a rate of
ten millimeters per year, resulting in thirteen millimeters of sea level rise for Louisiana. Human activities have contributed to 53% of deltaic plain loss in the past century caused by sediment disposition being restricted from the raising of levees. Also, from the 1960’s to the 1980’s, navigation channels, waterfront properties, and marinas were built, which led to coastal excavation all along the coastline, leaving our coast exposed and more vulnerable than before (Dardis, 2010). Netherlands’s erosion is similar to this as it is also sinking and has eroding barrier islands, and they focused heavily on dike building to restore that coast and revive their economy. In the next section, their success story and methodology are elaborately discussed and examined.

2.1 Economic Impact of Coastal Restoration Projects

The current projects in place in the coastal master plan account for 7,800-10,500 jobs, $460-$620 million in wages, $590-$785 million value added to the state economy, and $1.1-$1.5 billion in output each year (Cochran, 2017). Currently, there are 726,795 properties in Louisiana (32% of all properties in the state) that have a probability greater than 26% of being severely affected by flooding over the next thirty years (Flood Factor). That’s 726,795 homes and businesses that would be misplaced, and many forced to shut down as the 2020 COVID-19 outbreak proved just how difficult it could be for some of these smaller Louisiana businesses to recover from financial hardship with nearly 60% of small businesses at risk just one month after the pandemic had reached the U.S. (WAFB, 2020).

The estimated cost of a new sea dike in 2018 in the United States was $28.8 million per kilometer and Louisiana’s coast is about 635.2 kilometers long, which is about $18.2 billion if we would build a constant dike around the entire coast, however some research has suggested that a ring of dikes might be a better approach, so the costs would be slightly higher for the
construction of multiple dikes covering this same area (Aerts, 2018). This cost has most likely increased since then due to the increase in the rate of sea level rise and strength of the major storms that struck the coast in the past few years. Many factors affect this cost estimate including land availability and cost, the design of the dike, anticipated loading sizes, time construction will take, proximity to and availability of materials, and availability and cost of expertise for planning and supervision (UN Climate Technology Centre & Network). The exact number of individuals to be employed for the construction of a dike is undeterminable, as it varies based on dike size and the people involved in the construction. Generally, there will be engineers, ecologists, scientists, economists, and construction managers and crew all needed to construct a dike, so there will be an abundance of workers necessary for this type of project (Lenk, et al., 2016). In 2017, an international team of scientists concluded that the economic and long-term benefits of building dikes to reduce flood damage outweigh their initial cost on a global scale. Their results showed that, while economic damages from floods are expected to increase, flood damages for the year 2080 could be reduced to below their estimate today through effective investments in dikes taking places from 2020 to 2050 (Ward, et al., 2017). As part of the Louisiana Coastal Protection and Restoration planning and technical effort a team of experts from the Netherlands conducted a study to estimate the costs of a sea dike in Louisiana from the Dutch perspective. Based on their results, the estimated cost per kilometer for a dike in New Orleans was €5 to 8 million in 2007 (Hillen, et al., 2010). This cost is relatively high because the dike would be unbreachable from the use of a flexible asphalt protective layer placed on its top.

Even though exact economic impact of building dikes is currently immeasurable, like Netherlands and other coastal Louisiana restoration projects, building dikes in these coastal parishes will create jobs close to people’s homes, hopefully incentivizing them to stay there and
keeping the flow of money in the area constant. However, it is necessary that the company hired to construct the dike be required to hire residents of these parishes rather than bringing out of state/country employees. If that is the case, outmigration will still lessen due to lower flood risk, but those who leave looking for work or are displaced by the area needed for construction being taken over will still out-migrate.

2.2 Physical and Geographical Impact of Building Dikes on Louisiana’s Coast

A dike is a massive structure that takes up a lot of coastal space. During construction, the entire area where the dike will sit and space for the material to be stationed will have to be dedicated to the construction site and cannot be used for anything else. Also, there are typically camp areas built for the laborers near the construction site, so a large amount of land would be taken from the coastal community during this time. These communities account for 2.3 million of the 4.6 million residents, and $45.9 billion in annual wages in Louisiana for 2021 (National Oceanic and Atmospheric Administration Office for Coastal Management). However, Louisiana does not have a lot of infrastructure or a heavy population density sitting on the coast, so the land that would be taken will most likely be what is currently used for recreation activities such as fishing. Also, building a large dike off of the coast would get rid of any marshland, ecosystems, and species inhabiting the shoreline, shallow Gulf front, and construction zone. The extent of these damages would depend on the length of and time it takes to build the dike because all the organisms living where the dike would be placed would need to relocate and their ecosystem would fall apart. The benefit of dikes to levees for organisms is that they would not be confined within the walls of the levee and can continue to move freely just within the space beyond the shore. Since outdoor recreation is a large part of Louisiana’s economy and the fishing industry would strongly oppose dike construction, ring dikes have been brought up in conversations as a
different type of dike to build. Recreational fishing in Louisiana accounts for $1.96 billion in sales and supports about seventeen thousand jobs statewide, so it is important to consider ring dikes and listen to people from the industry’s concerns (Garcia, 2017). A dike ring is a continuous line of flood protection that includes dunes and dikes to enclose an area, like a circle. This has not been explored much in Louisiana but has allowed for better management of flood protection structures in the Netherlands because teams and individual managers can be in charge of an entire ring instead of multiple teams trying to work together with numerous individual dikes (Stomp, et al., 2016).

A major concern about the physical make up of Louisiana’s coast is that it is very muddy and that is why dredging would be an important component of dike construction. A 2005 study explored design options for barrier island and coastal structures listed the ability of existing soil to support rock placement as a component that would make coastal structures most likely to succeed. This study noted that of five experimental structures built on the coast in 1990, only the two ends of the system had experienced sand accumulation and that the beach behind the remaining structures continued to erode while behind these two areas remained (Campbell, et al. 2005). They also noted that most of the construction templates they based their restoration research on contained sediment mixtures as the base for the structures. In order for these mixtures to exist and the dike not to subside just like the coast, dredging and transportation of materials to the construction site would need to take place. This can be very costly, which will be discussed further in the next section, and adds time and labor that needs to go into the construction of the dike.

2.3 Alternative Approaches
Instead of beginning construction on these large structures with little research into the results, there are other successful methods of land protection that can be used to protect Louisiana’s coast from erosion such as dikes adjacent to marshes, ring levees, sand motor, and conducting more research projects into the probability and successfulness of a dike in Louisiana. In a 2013 study by Smale and Hoonhout, models were used to investigate the effects of a salt marsh zone beyond the Wadden sea dikes north of the Netherlands. It was found that by including a six-hundred-meter marsh zone, the need for future dike reinforcements was reduced from fifty kilometers of dike heightening to twenty-five kilometers in 2050. This is because a salt marsh zone that can keep up with the pace of rising sea level restricts the amount of rise against the dike and breaks down wave action to keep it at a constant rate so that no one portion of the dike is deteriorating at a faster rate than the rest of it. Another study in 2014 expanded on the 2013 study and evaluated the change in results from widening the marsh zone. It was found that waves were dampened in the first one thousand meters of the marsh zone, but that additional width beyond that point did not yield any additional benefits (van Loon-Steensma, 2015). This is good news for Louisiana because the abundant saltwater marshes in the state are a vital part of the state’s history, culture, and fishing industry, so knowing that they can be beneficial for coastal restoration beyond our current efforts provides a new avenue for research.

One of the ways the Netherlands has protected their coast from land loss is through a sand motor. A sand motor involved dumping of sand along the coast and allowing nature to spread it out. A few years ago, the Dutch government dropped about twenty-eight million cubic yards of sand dredged from the seafloor off the thirteen-mile southern coast of the Netherlands, forming a lagoon, pushing the beach into the North Sea by a half mile, and adding about three thousand five hundred acres of new beach and dunes (Baurick, et al., 2020). This area now
attracts thousands of walkers, tanners, and surfers to the area during the summer, which in return brings more consumers and cash flow to the economy. The sand has moved much faster than initially anticipated and is now expected to last a total of forty years before needing more material to be dumped, up from the previous expectation of twenty years (Baurick, et al., 2020). Louisiana has implemented similar projects, but at a much higher cost than the Netherlands. Louisiana moved almost twenty-five million cubic yards of sand for two restoration projects for a cost of $334 million, whereas the Netherlands was able to transport about twenty-eight million cubic yards of sand for only $55.5 million (Baurick, et al., 2020). When asked why these projects cost significantly more in Louisiana than in the Netherlands, Greg Gandy, CPRA Deputy Director and former Manager of Island Restoration Projects, stated that the answer is not yet clear, but that the additional cost could be due to the greater distance the dredged material had to be transported for the Louisiana project sites in comparison to Dutch ones. However, there was only less than a four-square mile difference in the distance traveled between Louisiana’s Whiskey Bay project and the sand motor (Baurick, et al., 2020). It is important for Louisiana to begin collaborating with the Netherlands to learn how to improve our protection and restoration efforts, since they have had much research and project success.

2.4 Conclusion of Exploring the Feasibility of Dike Building in Louisiana

Dike building is a tried and successful method in the Netherlands, Vietnam, and Canada, and I believe their effectiveness and the possibility of them being implemented in Louisiana needs to be further explored through experimentation. Dikes would provide a great deal of protection for coastal communities and culture and would allow Louisiana to reclaim the land it has lost due to erosion and subsidence. In order for dike experimentation and implementation to be the most effective, a diverse group of professionals should be involved in making decisions
(politicians, ecologists, economists, environmentalists, scientists, engineers, and people who have worked on a successful dike before) to ensure many viewpoints, benefits, and drawbacks are considered. It is also important that the company hired to construct the dike be required to hire local residents as a way to better combat out-migration that results from the drawbacks of coastal erosion. While the protection measures currently in place in Louisiana are beneficial for creating marshes and slowing the effects of erosion, they are not stopping the inevitable: Louisiana is disappearing. Barrier island reclamation is also not enough to keep Louisiana thriving for centuries to come. Dikes will provide land that can be used for more than just protection, and the businesses and residents that eventually inhabit the reclaimed land will contribute to Louisiana’s economy. Louisiana’s marshes are unique and important, but the people who live here are the ones that will continue to share the stories and culture that make Louisiana so special, so they need a place to reside and building is a way to do that.

The next main section explains and discusses the reintroduction of the National Endowment for the Oceans Act at the federal level. Similar funding implementations for Louisiana and the probable impact that would result from passing this act into law are also discussed in this section.

3. National Endowment for the Oceans Act

Any coastal restoration project requires adequate sources of funding. By working with large organizations that can supply a strong foundation in science and technology, the effectiveness of these structures can be significantly improved. Construction of sea dikes at a local level is possible, but they are likely to utilize local materials and traditional methods which may not constitute the most effective approach and result in more improvements to be made to the structures in the future. For example, dikes built in Vietnam before there was sufficient
funding and design provided poor levels of protection than was initially intended (Mai, et al., 2008). While there are some sources of funding for coastal restoration activities, this available funding is not enough to implement all the projects in the coastal master plan. Recent dikes in the Netherlands were possible because the Dutch government budgeted to provide €160 million for climate-relevant projects through the Dutch Fund for Climate Development (DFCD) from 2019-2022, and private investments contributed additional funding beyond that throughout the years (Government of the Netherlands, 2018). The National Endowment for the Oceans Act would provide a reliable source of funding at the federal level for coastal restoration activities across the U.S., making it easier to conduct large projects and ensure they are effective.

3.1 What is the National Endowment for the Oceans Act?

In 2010, senators Sheldon Whitehouse and Olympia Snowe introduced the National Endowment for the Oceans Act to the U.S. Senate floor. The purpose of the endowment was to be, “a dedicated, off-budget funding stream that would fund state, regional, and federal priorities including coastal restoration activities” (National Endowment for the Oceans Act. S. 646.). The act was included in the version of the RESTORE Act that was passed in the Senate during the 2012 legislative session, but it was not included in the final version that President Obama signed into law (Conathan, et al., 2014). It was not signed into law due to many senators’ reservations about an amendment made by the Committee on Environment and Public Works that allowed the use of some of the endowment funds in the Great Lakes area. Senators opposed this amendment because they felt it went against the initial intent of the RESTORE Act. Senator Marco Rubio of Florida stated “What started as a genuine bipartisan effort to dedicate as much BP fine money as possible towards Gulf Coast restoration has now turned into a raw deal that increases taxes, creates a new environmental bureaucracy, and could steer money to places like the Great Lakes
and West Coast that had nothing to do with the oil spill” when asked why he changed his mind from being in favor the original bill (Sherman, 2012).

The senators thoroughly outlined where the funding for this endowment would come from in their formal proposal. The Oil Spill Liability Trust Fund serves as source to pay costs and damages that result from oil spills and the substantial threats of oil spills; this fund is a large part of what has made our current coastal restoration projects possible following the BP oil spill in 2010. The bill stated that any amount credited to the fund after the 2011 fiscal year when the balance is $1,500,000,000 or more would be transferred into the endowment. 12.5% of the revenue generated from section 8 of the Outer Continental Shelf Lands Act\(^1\), which provides jurisdiction of the United States over submerged pieces of land that belong to the outer continental shelf and gives authorization to lease those lands, would also be deposited into the endowment. About two-thirds of the annual disbursements made from the endowment would go directly to supporting the projects undertaken by coastal states in proportion to the length of their shorelines and size of their coastal populations. All other disbursements would be distributed through grants to strengthen roads, bridges, and other infrastructure such as spillways and levees critical to coastal economies and protection (S. 36411: National Endowment for the Oceans Act).

3.2 Similar Implementations

The Gulf of Mexico Energy Security Act (GOMESA) was signed into law in 2006 and provides revenue sharing provisions for the four Gulf oil and gas producing states: Alabama, Louisiana, Mississippi, and Texas. The funds from this act are to be used for conservation, restoration, and protection through two phases of implementation. According to the Bureau of

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\(^1\) Total revenue for the Outer Continental Shelf Lands Act is not available to calculate the 12.5% that would be annually deposited into the National Endowment for the Oceans.
Ocean Energy Management (BOEM), phase one began with the 2007 fiscal year and dedicated 37.5% of outer continental shelf (OCS) revenues from royalties, rents, inspection fees, civil penalties, and other revenues to be shared amongst the four states, and an additional 12.5% from those revenues was dedicated to the Land and Water Conservation Fund (LWCF). The second phase began with the 2017 fiscal year and expanded the type of revenues that were qualified to be accounted for in the 37.5% of OCS revenues. The revenue sharing maximum that GOMESA can obtain was also $500 million per year for the states and LWCF combined from fiscal year 2016 to 2055 (BOEM, 2020). For the 2021 fiscal year, Louisiana received $109,948,762 in disbursements from the $9,632,767,364 that was collected (Office of Natural Resources Revenue).

The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) was authorized in 1990 and provides funding for the planning and implementation of wetland restoration and protection projects in coastal Louisiana. According to the Mississippi River Delta’s Community Guide to Coastal Restoration, the Sport Fish Restoration and Boating Safety Trust Fund supplies CWPPRA with $30-80 million each year in coast sharing to cover 85% of each project’s cost.

3.3 Probable Economic Impact

Money from the endowment can be used for the exploration and understanding of marine ecosystems on the coast. This research could lead to new species being discovered and lessening the number of endangered species among aquatic and coastal animals (S. 36411: National Endowment for the Oceans Act). This research could also better inform the scientific community on how coastal ecosystems would be affected by dike construction and mitigation of negative effects. Having less endangered species would benefit Louisiana’s ecosystems, tourism, and
agriculture. Millions of people visit natural areas across the United States each year, resulting in a multi-billion-dollar industry (Endangered Species Coalition). This could also lead to a new market for the internalization of costs from the implementation of dike building because the negative effects to the coastal environment can be offset by the funding from the endowment.

The act could also provide immediate for dike building. Money today is worth more than money in the future, and this is true for Louisiana’s coastal land. It is important that this money be acquired sooner rather than later so the reclaimed land and increased protection can be realized before it is too late. The Oil Spill Liability Trust Fund’s balance, where a portion of the funding for the act comes from, has been steadily increasing with total receipts for fiscal year 2019-2020 totaling over $3.7 billion, and is expected to continue receiving $76 million annually through 2031 (Congressional Research Service, 2019). Remember, the threshold for disbursements of funds from the trust into the National Endowment for the Oceans is $1.5 billion, so $2.2 billion would have been deposited into the endowment during this period alone. A continuation of this trend would allow for construction of dikes to be fully funded in eight years or less when combined with other revenues received in the endowment.

With more funds being available, it is possible that costs for landowners to protect their own land could be offset. One Houma resident told their story about attempting to save historic oak trees on the edge of their property adjacent to marshland, but due to extensive permit requirements, associated costs, and drawn-out timeline, the oaks were gone before any protective measures could be put in place. With increased funding available, governmental agencies could streamline permitting, making the entire process easier. Also, the increased funding could lead to some people’s land being included in demonstration projects, taking the burden off landowners.

3.4 Alternative Approaches and Funding Sources
However, there are alternative approaches that can be taken to increase the amount of allocated funds to Louisiana’s coastal protection efforts. The disbursements made to the four states covered under GOMESA were $250 million out of the $9.6 billion collected for the 2021 fiscal year (Office of Natural Resources Revenue, 2021). If this act were amended to require a fixed dollar amount of funding to be dedicated to dike building, other sources of funding would not be necessary. By writing into the act that this funding be set aside specifically for dike building, states will not have to go through the process of applying to lease the land first, and the Secretary of State could ensure the funding is distributed properly based on current CPRA project sites.

Another political approach to coastal restoration would be to allow foreign dredging businesses to offer their services in the U.S. at a less expensive cost with more efficient, long-term results. The Foreign Dredge Act of 1906 and the Jones Act of 1920 banned foreign companies from dredging in the U.S. in an effort to protect U.S. employees and businesses in the shipping and dredging industry. The problem is that it can be up to three times more expensive to use U.S. built ships than foreign ones, consumers are forced to pay higher costs for goods, and the U.S. is paying significantly more than countries such as the Netherlands for the same type of projects, as discussed in section 2.6. Exporting knowledge in water management and coastal protection generates about $9 billion annually for the Netherlands, about 2% of total exports, and it is a widely established market with seasoned businesses and individuals (Baurick, et al., 2020). By allowing these businesses to educate U.S. dredgers and coastal planners, the U.S. can allocate funding more efficiently and implement more projects for all coastal states, creating long-term partnerships with other countries for coastal restoration.

3.5 Conclusion for the National Endowment for the Oceans Act
Reintroducing this bill in the U.S. Senate again and signing it into law could provide a much-needed source of funding to explore more options for saving Louisiana’s coast. Just as the legislature cannot amend CPRA’s master plan because it is created by experts in the field of coastal restoration, the intent of the act should not be corrupted by political factors. The endowment’s funding could make large scale projects, such as dike building, a more feasible option. With large scale projects being implemented, more jobs would become available for Louisiana residents, helping Louisiana’s economy by allowing consumers to have more disposable income to put back into their local and state economies. It has been the consensus of all the industry professionals interviewed that more funding is always good for Louisiana’s coastal restoration efforts, but the timing and amount of that funding are crucial in determining how effective the additional funding will be. Louisiana needs funding sooner rather than later, with a strategic plan for prioritizing projects with the most coastal protection benefits. Well-funded National Endowment for the Oceans Act would go a long way towards making that possible.

4. Conclusion

Dike building and the National Endowment for the Oceans Act need to be further evaluated and put into action through experimentation and expert consultation so that their effectiveness for Louisiana can be determined. None of the professionals interviewed or literature explored mentioned that Louisiana should not try to reclaim land, only that protection and restoration of marshes have been the main goal.

Based on the available research and information, Louisiana might cease to complete erosion. However, after reviewing the literature related to coastal erosion, it does not seem that dikes should be the only thing implemented to save the coast. Adequate funding for dike building
and other projects could be more easily provided if the National Endowment for the Oceans Act were reintroduced to the U.S. Senate or House of Representatives. Through well thought out allocations of the endowment with priority given to projects that provide the most benefits in the shortest time frame, the additional funding would allow for dike building to be implemented more easily while the current projects can continue without the risk of losing funding.

Combating coastal erosion in Louisiana cannot be fixed with one type of project; it will take a comprehensive approach of multiple types of projects, funding, and policies to reclaim land and keep Louisiana’s culture and economy alive.

Since this study was confined to the academic year, there are many questions that are yet to be answered from this research. During one of my interviews, it was mentioned that there are plans to build a ring levee at Port Fourchon to protect the infrastructure and trade there. I was not able to find any news articles or research projects confirming this project is going to be put in the works, but it should be explored extensively before implementation. Diversions were discussed as a method that has been beneficial for coastal protection practices and they have less severe effects on coastal ecosystems than a dike would. More dredging would allow for more experimental work to be done in regard to dike building while keeping coastal organisms and ecosystems intact. When asked what more they wanted to see done to protect Louisiana’s coast, one interviewee’s answer was different from all the others in that they did not say any specific type of project to be done. Instead, the interviewee stated that they wanted to see Louisiana’s parishes work together on projects that will benefit residents rather than each project site simply doing their own projects simultaneously. It was also brought up that there should be more transparency about projects, planning, and allocations from the CPRA and government agencies.
If people were made known of what is going on to protect the coast, they might be more inclined to help and be more accepting to the projects and policies put in place.
III. References


Appendix I - Questionnaire for Industry Professionals

1. What are the current impacts of coastal erosion on Louisiana’s economy?
2. How are Louisiana’s current efforts to combat coastal erosion effecting the economy?
3. How effective are Louisiana’s current coastal restoration efforts?
4. Do you think the National Endowment for the Oceans Act would benefit Louisiana’s economy, and if so, why?
5. What are the current research and field projects aimed at combating land loss?
6. What would you like to see done to better the coastal restoration efforts in Louisiana?
7. How does Louisiana’s coast and resources differ from the Netherlands?
8. Are there any projects currently in place that focus on land reclamation rather than land protection?
9. Do you think dike building off of the coast to reclaim land loss would benefit Louisiana? What about building dikes adjacent marshes?
Appendix II - Explanation of Why Industry Professionals Were Chosen

Dr. Stephen Barnes is an associate professor and the director of the Kathleen Blanco Public Policy Center at the University of Louisiana at Lafayette with his Bachelor of Science, Master of Science and Ph.D. in economics. I interviewed him because he is a former professor for LSU, and I used his 2017 paper titled “Economic Evaluation of Coastal Land Loss in Louisiana” for my research. With his direct experience quantifying coastal land loss and numerous research projects funded by the U.S. Environmental Protection Agency, I knew he could provide me with information and advice for my two economic impact sections and better explaining why certain economic and environmental benefits are so important.

Dr. James “Luke” Boutwell is a Special Projects Manager for Mather Economics in Atlanta, Georgia and holds a Ph. D. and Master of Science in Agricultural Economics from Louisiana State University, and a Bachelor of Science in Geography from the University of Alabama. As a student at LSU, Dr. Boutwell has numerous publications for his research on wetland loss in Louisiana. After using one of these papers to conduct my research, it seemed fitting to reach out to him for an interview to discuss the results of his studies and his thoughts on how this research would further benefit Louisiana’s coastal restoration efforts.

Dr. Rex Caffey is a professor in the department of Agricultural Economics and Agribusiness at Louisiana State University and holds a Ph. D. in Wildlife and Fisheries Science, a Master of Science in Agricultural Economics, and a Bachelor of Science in Agricultural Business. While at LSU, he has conducted and aided students with research related to the economic and policy challenges faced by fisheries and coastal wetlands in the northern Gulf of Mexico region and is the founding director of the LSU Center for Natural Resource Economics and Policy (CNREP). Dr. Caffey was able to provide more answers about how coastal land loss
effects Louisiana’s economy and how the National Endowment for the Oceans Act would benefit more research efforts off the coast.

Dr. Matthew Fannin is a professor in the department of Agricultural Economics and Agribusiness at Louisiana State University with a Ph. D and Master of Science in Agricultural Economics and a Bachelor of Science in Food and Resource Economics. He is exceptionally experienced in the areas of rural development and regional economics with previous experience with the Rural Policy Research Institute. Dr. Fannin was able to provide insight into how the construction of a dike would affect coastal communities in the short and long run. He also provided me with some thought provoking questions to help guide my research further into the economic aspect of the effects.

Senator Michael “Big Mike” Fesi is a Louisiana state senator representing the twentieth district located in Lafourche and Terrebonne parishes along the Gulf of Mexico and a native of Houma, Louisiana. He has been serving as a senator since 2020 and worked as an oil and gas businessman prior to winning that election. As a Houma native, Senator Fesi gave a first-hand perspective on the devastation that occurs from land loss to coastal communities. He also provided a well thought out position on the National Endowment for the Oceans Act, as someone working in the legislature with over two years of experience in his current position and heavy political involvement prior to being elected.

Dr. Daniel Petrolia is a Louisiana native and professor in the Mississippi State University Department of Agricultural Economics, specifically teaching graduate courses on environmental and quantitative economics. He also received two Bachelors of Art and a Master of Science from LSU. I interviewed him because the majority of his research focuses on the economics of coastal resources and natural hazards, including his paper published in 2009 titled “A Cost Analysis of
Rapid Land-Building Technologies for Coastal Restoration in Louisiana”. With his direct experience in quantifying the economic impact coastal restoration has in Louisiana, Dr. Petrolia was able to elaborate on his own research and journal publications to help me better understand and estimate the economic impact of dike building in Louisiana.

Dr. Gregory Upton is an associate research professor at Louisiana State University in the Center for Energy Studies. He holds a Ph. D, Master of Science, and Bachelor of Science in Economics from LSU and is a member of numerous national professional organizations for economists. During his time at LSU, he has conducted research and given presentations on many energy issues that are significant to Louisiana’s economic circumstances and has been quoted or cited about one hundred times in media. Dr. Upton provided an economist’s perspective on current coastal restoration projects and an educated opinion on the possible implementation of dikes and the National Endowment for the Oceans Act.

Dr. John White is the Associate Dean of Research and a professor in the Department of Oceanography and Coastal Sciences at Louisiana State University with a Ph. D. in Soil and Water Science, Master of Science in Geological Oceanography and Coastal Zone Management, and a Bachelor of Science in Geology. His most recent publication is a study on the impacts of a Mississippi River freshwater diversion, and this is something I looked into since the leveeing of the river was viewed so negatively by the other interviewees. Dr. White was able to expand on the things I have learned about the construction of the ocean floor and the materials needed to construct dikes.

Dr. Clint Wilson is a professor at Louisiana State University in the school of Civil and Environmental Engineering and the Director of the LSU Center for River Studies, which houses the nation’s largest working model of the lower Mississippi River. At the center, he oversees the
ten thousand square foot river model on which student workers replicate the flow and sediment diversion of the Mississippi River for research. One year in real time can be demonstrated in just one hour on the model. With experience in coastal restoration research and engineering, Dr. Wilson provided me with information on the past, present, and future of the Mississippi River and coastal restoration in Louisiana as well as an educated opinion on the possibility of dike construction. He also invited me to tour the river center where I was able to study maps, charts, and models of the river and coastal projects to better understand how Louisiana’s coast has changed over time.

David Mornout is a masters student studying International Land and Water Management at Wageningen University in the Netherlands. David and I communicated via email about David’s studies and how we could help aid my research with what he is currently working on. He shared some files with me from the Netherlands government and explained what research he has going on at the university. Since David is currently working on two of the dike systems in the Netherlands, I knew he could provide information related to hands-on experiences and had access to data that may not be widely available.