


2019

# PERCEPTIONS OF VULNERABILITY TO FLOODING, HURRICANES, AND CLIMATE CHANGE ON GRAND ISLE, LOUISIANA'S ONLY INHABITED BARRIER ISLAND

Lauren Miller  
*University of Montana*

Let us know how access to this document benefits you.

Follow this and additional works at: <https://scholarworks.umt.edu/etd>

 Part of the [Civic and Community Engagement Commons](#), [Civil Engineering Commons](#), [Demography, Population, and Ecology Commons](#), [Environmental Engineering Commons](#), [Environmental Studies Commons](#), [Nature and Society Relations Commons](#), [Other Civil and Environmental Engineering Commons](#), [Other Geography Commons](#), [Other Social and Behavioral Sciences Commons](#), [Other Sociology Commons](#), [Place and Environment Commons](#), [Rural Sociology Commons](#), [Structural Engineering Commons](#), and the [Tourism Commons](#)

## Recommended Citation

Miller, Lauren, "PERCEPTIONS OF VULNERABILITY TO FLOODING, HURRICANES, AND CLIMATE CHANGE ON GRAND ISLE, LOUISIANA'S ONLY INHABITED BARRIER ISLAND" (2019). *Graduate Student Theses, Dissertations, & Professional Papers*. 11286.

<https://scholarworks.umt.edu/etd/11286>

This Thesis is brought to you for free and open access by the Graduate School at ScholarWorks at University of Montana. It has been accepted for inclusion in Graduate Student Theses, Dissertations, & Professional Papers by an authorized administrator of ScholarWorks at University of Montana. For more information, please contact [scholarworks@mso.umt.edu](mailto:scholarworks@mso.umt.edu).

PERCEPTIONS OF VULNERABILITY TO FLOODING, HURRICANES, AND  
CLIMATE CHANGE ON GRAND ISLE, LOUISIANA'S ONLY INHABITED  
BARRIER ISLAND

By

LAUREN ANNE MILLER

B.A. Sociology, University of Louisiana at Lafayette, LA, 2015

Thesis

presented in partial fulfillment of the requirements  
for the degree of

Master of Arts  
in Sociology, Option Rural and Environmental Change

The University of Montana  
Missoula, MT

December 2018

Approved by:

Scott Whittenburg, Dean of The Graduate School  
Graduate School

Teresa Sobieszczyk, Chair  
Department of Sociology

Rayna Sage, Committee Member  
Department of Sociology

Sarah Halvorson, Committee Member  
Department of Geography

Miller, Lauren, M.A., December 2018

Sociology

Perceptions of Vulnerability to Flooding, Hurricanes, and Climate Change on Louisiana's Only Inhabited Barrier Island

Chairperson: Teresa Sobieszczyk

Committee Member: Rayna Sage

Committee Member: Sarah Halvorson

This study used in-depth interviews of permanent residents on Grand Isle, Louisiana, a remote barrier island, to better understand their perceptions of structural flood measures, non-structural responses to flooding and hurricanes, and perceptions of vulnerability to flooding, hurricanes, and climate change on a remote barrier island-Grand Isle, Louisiana. Residents' perceptions regarding the various structural measures implemented by the federal, state, and local government appeared mixed. Non-structural responses to flooding risks implemented at the household, community, state, and federal level continue to strengthen resiliency on Grand Isle. According to interviewees, aspects of environmental, rural, and economic vulnerability on Grand Isle impact islanders daily, yet residents continue to fight the environmental adversities as well as the flood management conflicts with government agencies. Findings from this study may be relevant to people and rural coastal communities in other parts of the United States and the world facing climate change-related storms and flooding.

## **Acknowledgments**

I would love to thank several people that have supported me throughout this thesis project. I am very grateful for my supportive and understanding thesis committee. Thank you, Teresa Sobieszczyk for your patience and dedication to my project and your sincere kindness throughout my time in Missoula, Montana. Thank you, Rayna Sage for mentoring me as a graduate student and research assistant. You inspire me to tackle challenges and enjoy the little things in life. Thank you, Sarah Halvorson for your great advice and positivity throughout my project.

I would also like to thank faculty and staff in the Sociology Department at the University of Montana for treating me like family and providing words of support throughout my graduate program. Our friendships will always be cherished. Also, many thanks to the UM Writing Center for being an amazing resource for me on and off campus. Thank you, Kim Brown Campbell, for getting me through several personal obstacles; I would not have gotten through graduate school without you.

Much thanks and appreciation, to my amazing loved ones who supported me in graduate school and in life. You all reminded me that hard work pays off, to never give up, and to take care of myself even when I felt that I did not have the time.

Finally, I would like to thank everyone on Grand Isle who helped make this project what it is today. Your willingness to help and share your personal stories with me will always be treasured.

## Table of Contents

Abstract.....	ii
Acknowledgments.....	iii
Table of Contents.....	iv
Chapter One -Introduction.....	1
Chapter Two -Literature Review.....	4
Chapter Three -Methodology.....	11
Chapter Four -Background.....	21
Chapter Five -Findings.....	38
Chapter Six -Analysis.....	87
Chapter Seven -Conclusion.....	103
Appendix A-Interview Script.....	108
Appendix B-Interview Questions.....	109
References.....	112

## **CHAPTER 1: INTRODUCTION**

During an interview, Mason, one of the oldest residents from Grand Isle, Louisiana, mentioned that in the late 1800s, before residents had official storm warnings, residents would go to the beach and observe the fiddler crabs as a way to forecast bad weather. If the crabs were busy stacking sand around their burrows, it was believed that bad weather was near because storm waves would wash over the sand mound, which would then plug the burrow to protect the crabs' homes flooding. Then he stated, "Animals have an instinct to protect where they stay." This sentence from Mason has echoed in my mind since our interview, and I think it is an overarching theme that describes what my project is all about--the ways people protect the vulnerable community on Grand Isle from flooding, hurricanes, and the impacts of climate change.

Climate change or the global increase in atmospheric and oceanic temperature will affect the probability of extreme weather events and hydrological cycles differently around the world (Smith et al. 2001). For instance, some regions like those along coastal areas will experience extreme floods, droughts, tropical cyclones, storms, and intense precipitation. Thirty-seven percent of the world's population lives in coastal communities, and about forty percent live within 60 miles of the coast (United Nations 2017). Coastal areas face environmental degradation from over-development, the effects of rising sea levels, and an increase in the number and severity of storm events, which together are leading to increased beach erosion, flooding, ecosystem destruction, and coastal vulnerability (Jones 2011). Notably, the impacts of sea level rise from climate change are not equal; islands and deltas are particularly vulnerable, especially those with coastal wetlands (Smith et al. 2001).

As sea levels rise, oceanic temperatures increase, and storms and hurricanes intensify, the effects of climate change will increase the impacts of wetland loss in Louisiana. Also, Louisiana's coastal wetlands are disappearing fast. Researchers estimate that by 2060, more than 37,884 yards of Louisiana's coastal lands will be lost due to natural and human-made factors like subsidence (sinking), the Mississippi River levee system, construction of oilfield canals for pipeline settlement, periodic storms, and new inlets and waterways (Bethel et al. 2011). One of the most vulnerable areas to climate change in Louisiana is Grand Isle—the last inhabited barrier island in the state. Over the past three hundred years, Grand Isle's sandy, low-lying landscape has provided a challenging space for human settlement, natural resource extraction, and tourism. However, the island is currently facing environmental degradation from the "combined effects of land subsidence, sea level rise, shoreline erosion, frequent hurricanes, and increased human activity and physical changes" (Meyer-Arendt 2011).

In this thesis, I use qualitative research methodology to explore Grand Isle's vulnerability to flooding and hurricanes historically and today as well as the capacity of Grand Isle residents to prepare, respond, and recover from the impacts of climate change. I also explore whether their capacity is shrinking or becoming reinforced via structural and non-structural measures. I do this by addressing the following research questions:

- (1) *What structural and non-structural measures have been implemented, and by whom, on Grand Isle to help protect from flooding and to mitigate risk from storms and hurricanes?*
- (2) *What are the residents' perceptions of vulnerability to the persistent risks of flooding and hurricanes from climate change as well as the efforts to mitigate such vulnerabilities?*

*(3) What conflicts have arisen between local residents and government officials as a result of responses to flooding or efforts to prepare for storms and floods related to climate change?*

In the following chapter, I discuss previous literature on structural measures, non-structural measures, citizens' perceptions of vulnerability to flooding, hurricanes, climate change, and conflicts arising from flood risk management decisions.



## **CHAPTER 2: LITERATURE REVIEW**

### **Introduction**

This chapter covers literature on structural measures, non-structural measures, citizens' perceptions of vulnerability to flooding, hurricanes, climate change, and conflicts arising from flood risk management decisions. In the first section, below, I will lay out the literature on structural and non-structural measures to climate-change related storms and flooding, and the implementation of such measures at the individual, state, and federal levels. This section also reviews people's levels of trust in such measures.

### **Structural Measures**

Structural measures are physical defenses built to reduce the probability of flooding and other environmental risks accompanying climate change and "range from large-scale infrastructure to local improvements that improve the resistance and resilience of individual homes or community;" structures also differ in economic cost and environmental impact (Shah, Rahman, and Chowdhury 2018; Sayers et al. 2013:25). Structural measures include levees, floodwalls, dams, embankments, storage basins, diversions (Vojinovic and Huang 2015) as well as drainage systems (Charlesworth and Booth 2016). Notably, in the U.S., economic losses due to flooding may increase despite structural measures like levees because they may experience physical issues with under-seepage, slope, instability, and subsidence (Dierauer, Punter, and Remo 2012:1). Moreover, structural measures also entail expenses involved with investment, construction, system operation, and periodic maintenance to prevent deterioration and failure (Baan and Klijn 2004; Sayers et al. 2013). Some studies argue that structural measures are harmful to floodplain ecosystems and are unsustainable for long-term flood events (Shah et al. 2018). For instance, structural design capacities may limit flood protection against

the increasing frequency and severity of flood incidents from climate change, especially as sea levels rise (Bradford et al. 2012; McNamee et al. 2014).

### **Non-structural Measures**

Unlike structural measures, non-structural measures provide critical last lines of defense with communities in at-risk landscapes. They entail "knowledge, practice, or local agreements to reduce risks through policies and law, public awareness, training, and education" (Manning-Broome, Dubinin, and Jenkins 2015:3; Sayers et al. 2013). Non-structural measures also work toward reducing vulnerability through funding plans that reduce the exposure of people, the economy, and/or ecosystem to flooding (Baan and Klijn 2004:119; Sayers et al. 2013). Various non-structural measures include land-use planning policies for development and flood awareness, flood proofing homes and businesses, weather forecasts or flood and storm warnings, and insurance (Bradford et al. 2012), as well as laws for zoning and building permits, hazard mitigation grants, purchasing of homes (Manning-Broome et al. 2015), requirements for building alterations or codes, flood proofing kits, and evacuation plans (Fox-Rogers et al. 2016). Many researchers argue that non-structural measures are useful approaches for managing intense weather events related to climate change such as storms, cyclones, heavy precipitation patterns, and the resulting flood effects that may overwhelm existing structures (Hunt 1999; Kundzewicz 2009). Climate change will require local adoption of non-structural measures managed at the household level that can help protect individuals and their loved ones during emergencies (Fox-Rogers et al. 2016:331-337).

### **Structural and Non-structural Measures Implemented at Various Levels**

One key difference between structural and non-structural measures is that unlike non-structural measures, structural measures cannot be implemented at the individual level. Instead,

they can only be implemented at the community, state, and federal levels, which range from local levee districts to state decision makers to federal agencies (National Research Council 2012). For instance, in the early 20th century, the United States Army Corps of Engineers (USACE) began constructing levees in partnership with the local levee districts as coastal development in the US increased; Congress began to devote funds to upgrade existing levees and create new structures for counties to manage (Laska et al. 2005:109). In many communities, residents have established centralized levee districts to manage the structural upkeep of the local levees, although the cost for improvements may stress local budgets. Costs can include “construction, environmental impact assessments, erosion stabilization, endangered species surveys, and permit applications; state grants may be available to local levee districts, but often require privately matched funding” (McNamme et al. 2014:160).

Non-structural measures may be implemented at the household, community, state, or federal level. They aim to reduce exposure to flooding and other environmental risks. Non-structural measures implemented at the individual or household level include private measures and investments to protect the property or house like flood insurance and bulkheads<sup>1</sup> (Hung 2009; Scolobig, Marchi, and Borga 2012), information seeking on natural hazards (Dziakle, Biernacki, and Bokwa 2013), flood risk communication, using multiple sources of information, moving furniture upstairs (Kellens, Terpstra, and Demaeyer 2013), and evacuation (Sayers et al. 2013). At the community level, local communities may adopt programmatic non-structural measures from their recovery funds. At the state level, departments may initiate non-structural

---

<sup>1</sup> A bulkhead is a retaining structure of timber, steel, or reinforced concrete, used for shore protection and in harbor works.

programs to promote homeowner adaptations and preparedness information. National agencies offer grant and flood insurance programs to at-risk regions (Manning-Broome et al. 2015). For instance, the National Flood Insurance Policy (NFIP) limits flood losses by imposing construction standards in design or elevation for new buildings, which are then adopted and enforced by local governments (Burby 2006:177).

### **Level of Trust in Structural and Non-structural Measures and the Influences of Trust in Such Measures**

Interestingly, trust or faith in structural measures may cause residents to avoid taking non-structural measures before a hazardous event occurs (Scolobig et al. 2012). Levels of trust in flood structures may also influence citizens' perceptions of the potential for future flooding, which are inspired by their past observations of flood events whose impacts have been reduced by flood structures (Terpstra 2011). Moreover, individuals may be motivated to implement non-structural measures at the individual level if they feel highly exposed to risks. They may also be motivated if neighbors or local leaders expect them to take non-structural measures (Scolobig et al. 2012). Unlike structural measures, the "effectiveness of non-structural measures is difficult to observe because benefits are not immediately visible to the community until flooding occurs," which may also influence trust (Shah et al. 2018).

### **Vulnerability to Climate Change-related Flooding and Other Environmental Risk Impacts**

The section below will explore research on vulnerability to climate change impacts, including a definition of vulnerability and factors influencing people's perceptions of vulnerability to flooding and hurricanes related to climate change.

Vulnerability may be defined as "a combination of the inherent susceptibility of a particular group, people, property, and or natural feature to experience damage plus how the

harm experienced may be modified through actions that reduce susceptibility" (Sayers et al. 2013:26). Furthermore, vulnerability to climate change is expressed as "a function of exposure, adaptive capacity, and sensitivity threatened by future changes in climate" (Smith et al. 2001:926-928). Coastal regions, especially small, low-lying islands, are extremely vulnerable to climate change-related impacts such as sea flooding, sea level rise, intense storm surges, more frequent hurricanes, coastal erosion (Hall 2011), and high winds (Hilhorst 2004). Coastal areas also face many potential negative impacts on their environmental ecosystem, human settlements, and economic resource-based incomes like coastal fishing and tourism (Smith et al. 2001).

### **Perceptions of Vulnerability to Climate Change-Related Flooding and Other Risks**

The combination of potential climate change-related impacts on coastal communities affects people's perceptions of vulnerability to flooding, hurricanes, and climate change. First, perceptions of vulnerability depend on people's past experiences with flooding and other environmental risks (Collenteur 2015:374). Over time, some people living in low-lying areas may worry less about flooding before disasters strike because they feel experienced, better prepared, and less threatened; on the other hand, people who depend on the care of others may feel more vulnerable to flooding (Baan and Klijn 2004:114-115). Second, perceptions of vulnerability depend on people's subjective assessments of "shelter, distance from the projected point of impact, and the structural integrity of safety mechanisms" (Patterson et al. 2010:128). Third, perceptions of vulnerability may depend on how the individual or household interprets the threat and their ability to execute precautionary actions that mitigate their exposure to hazards (Fox-Rogers et al. 2016). People's perception of the effectiveness of the mitigation response and their self-efficacy or ability to implement a mitigation measure further influences how they protect their property against flooding (Fox-Rogers et al. 2016:338). Finally, it is interesting to

note that people in smaller communities often view vulnerability as a force of nature they cannot control, which significantly influences their evaluations of storms and their attempts to decrease losses from flooding (Dzialek and Bokwa 2012).

## **Government and Citizen Conflicts Regarding Roles and Interests with Flood Risk**

### **Management Decisions**

In this section, I discuss government and citizen conflicts regarding flood and storm risk management decisions. Flood risk management is recognized as an engineering pursuit as well as a social undertaking to mitigate the impacts of floods (Sayers et al. 2013). The roles and interests in flood risk management decisions differ between government entities and citizens. The government and its experts tend to have analytical views of flood risks, while the public tends to base their views of flood risks on feeling (Baan and Klijn 2004:116). Moreover, various land use interests cause conflict and disagreements between public and private stakeholders, including business owners, developers, conservationists, indigenous peoples, and government officials who manage coastal development through land use approval/refusals and applications for development within designated zones (Abel et al. 2011:283).

### **Conclusion**

Structural and non-structural measures taken to help prevent flooding and mitigate the impacts of climate change include both preventative and responsive efforts. While structural measures are taken at the community, state, or federal level, non-structural measures are taken at the individual, community, state, and federal level. People's level of trust in existing structural measures may influence their willingness to take non-structural measures, as well as the timing of such measures. Some researchers have looked at perceptions of flood risk to understand how individuals try to mitigate risks; some individuals felt limited in their flood mitigation practices.

Conflicts regarding flood management and land use decisions to deter the effects of sea level rise, coastal erosion, and loss of land area may exist between citizens and government entities and may increase over time, especially as environmental impacts increase uncertainty to people living in at-risk areas.

Based on this literature review, this thesis examines (1) individuals' assessments of the benefits and drawbacks of structural and non-structural measures to mitigate and respond to climate-change related storm surges and flooding, (2) people's perceptions of their vulnerability to flooding, hurricanes, and climate change, and (3) the conflicts that arise between government and citizens who have different roles and stakes in responding to climate change-related weather events.

## **CHAPTER 3: METHODOLOGY**

### **Site Selection**

Criteria for site selection included having a small rural population (fewer than 5,000 people) facing direct environmental impacts from climate change such as flooding, sea level rise, and frequent storms or hurricanes. I selected Louisiana as my general research site because of the many urgent environmental concerns there, such as significant wetland loss and climate related storms. Also, Louisiana is a place I call home. It was my wish to help protect it by bringing awareness to not only the serious environmental conditions, but also to the human-caused impacts of climate change.

Within Louisiana, I selected to focus on Grand Isle, the only inhabited barrier island in the state. It is consistently impacted by various weather events associated with climate change-- severe hurricanes, sea level rise, and flooding. It is a rural resort town with high levels of recreational activities and tourism that some full-time residents depend on for employment opportunities. In 2017, Grand Isle had an estimated population of 1,464 (Vintage 2017 Population Estimates), with 1,986 total housing units (American Community Survey 2013-2017). The gap likely indicates that some housing units are occupied by seasonal tourists who live on the island only seasonally or part-time residents who maintain or rent out the unit to tourists. In 2013, I visited the island for a family vacation. We rented a 'camp' for a weekend of swimming and sun bathing on the beach and fishing along the bay during sunset. As I learned more about the island and its environmental vulnerabilities related to climate change, I began contemplating on how it and other coastal communities in Louisiana are being affected and how parishes (counties) inland e.g. Lafayette will face the impacts of climate change as the state's coast is lost.



## **Research Approach**

I conducted a qualitative, interview-based research project, framed in accordance with Peter Berger and Thomas Luckmann's social construction of reality perspective. The two sociologists argue that people constantly create a shared reality through actions and interactions that are objectively factual and subjectively meaningful (Wallace and Wolf 2006:285). In addition, the theorists argue that people's everyday realities are socially constructed by past, present, and future decisions that impact their realities externally and objectively.

The social construction paradigm fits with my research topic as I intended to explore citizen and community adaptations to coastal flooding and storms. The subjective ideas of the importance and success of individual and structural protection measures with flood risks will depend on residents' own experiences and opinions. For example, actions taken by residents to elevate their homes in the past may affect their future decisions to evacuate, as they may no longer feel susceptible to home flooding. The social constructionist paradigm is a suitable framework for understanding how social interactions between community members contribute to individual-level decision-making as well as how individuals construct their own stories to explain or justify choices.

## **Research Methodology**

For this research project, I used in-depth interviews to explore how people in Grand Isle perceive government-provided flood interventions such as levees as well as their own individual and household adaptations to flood and storm risks. Interviews allowed for intimate discussions regarding various benefits and drawbacks of levees and other structural protections such as rock jetties. Given my limited resources, in-depth interviews proved to be a fairly easy data-gathering

technique appropriate to the overall research approach--social constructionism. According to qualitative research expert Berg (2007),

. . .interviewing provides maximum opportunities for complete and accurate communication of ideas between the researcher and respondent. It is an effective method for certain research questions that aim to understand the perceptions of participants. (p. 297)

Information from in-depth interviews enabled me to write rich, thick descriptions of the people's perceptions of vulnerability to floods, hurricanes, climate change, and their level of confidence in the performance of levees as well as other flood mitigation and prevention actions.

For this study, 14 out of 27 people who met my criteria for inclusion agreed to do an in-depth interview with me in person. Males and females who lived here full-time refused to sit down and do an interview with me, but they were happy to refer someone else that would be interested in talking. Some residents who refused to do the interview had plans for the holidays; older residents were unavailable because they planned a vacation out of hurricane and tourist season. Each of the 14 interviews I conducted lasted about 60 minutes (some lasted longer), and each took between two to five hours to transcribe. Audio-recording the interviews was a useful technique for capturing the highest quality information during the interviews; no one refused to be audio-recorded, although I found it helpful to take detailed notes during and immediately after the interviews as well.

To begin finding participants for this study, I reviewed news articles from the local paper, which was not that helpful with finding out how to get in contact with folks. However, searches for Grand Isle businesses on the Better Business Bureau website helped generate a list of businesses and agencies to cold call and to explain my study. During the call, I requested their assistance in identifying potential interview subjects. Some contacts eagerly volunteered to do the interviews themselves and we scheduled a date and time in advance over the telephone.

Additionally, I asked almost every participant interviewed to recommend other individuals for the study. This method of nonprobability snowball sampling worked well for gaining additional in-depth interview sessions through people’s community connections. The following table summarizes the selected characteristics of the interviewees.

**Table 1. Selected Characteristics of Interviewees**

<u>Characteristic</u>	<u>Number</u>	<u>Percentage</u>
<b>Source of Livelihood</b>		
Dependent on Grand Isle (GI)	10	72%
Partially Dependent on GI	1	7%
Not Dependent on GI	3	21%
<b>Geographic Location on GI</b>		
Center/Bayside	9	64%
Western/Bayside	2	14%
Mainland Chenier	2	14%
Beachside	1	8%
Participating in Home Elevation Program	9	64%
Not Participating in Home Elevation Program	5	36%
<b>Income Assessment</b>		
High	0	0%
Middle-High	7	50%
Low-Middle	4	29%
Retired	3	21%

### **Justification of Research Approach**

My research approach was suitable for this population size and community because of my time and financial restrictions as a graduate student. Conducting a study like this nationally or even across Louisiana would have required additional time and resources for gathering data from multiple target populations. The Grand Isle site was reasonable in size and complexity, so

the study could be completed within the available time and budget (Berg 2007:39). Choosing Grand Isle was also convenient because of its proximity to my family's home in Lafayette, Louisiana.

Because I collected interviews in December 2017 and January 2018, I had to be very flexible with scheduling interviews around Christmas and New Year's Eve celebrations. Although I had initially planned to conduct at least 15 interviews, an arctic cold front arrived in January that iced and closed down several bridges, making access to the site impossible, thus I could complete only 14 interviews. Also, I conducted two telephone follow up interviews in June 2018 with two local officials included in the group of 14. This follow up provided useful information on specific environmental projects done by the town within the past forty years that I included in the background and findings section.

### **Data Quality**

As noted earlier, every participant in this study agreed to be audio-recorded, and I used a special audio-recorder for clearer voice recordings, which I checked out from the Social Sciences Research Lab at the University of Montana. In addition to the recordings, I took detailed notes during and immediately after the interview. My notes corresponded well with the interview transcripts and were especially useful for reviewing specific details about several types of insurance coverage.

The quality of my data was not impacted by any interviewee's early withdrawal from the study. Only one participant became upset during our discussion about the personal effects of Hurricane Katrina. I debriefed the subject appropriately by asking them if they were okay; they agreed, and we continued the interview.

Although I collected 14 interviews, this was not enough to reach saturation. Further data collection and analyses should include more interviews and possibly include additional groups such as part-time residents, younger age groups, and federal government agents involved with flood protection projects on the island.

I used NVivo software to analyze the interview data. The software helped me to rigorously track and compare quotations and summarize the most important themes. NVivo was very helpful for classifying certain characteristics of participants and relating the main themes to those characteristics. Coding and later recoding the interviews allowed me to recognize and organize the most striking themes. I reported on the most striking themes by continuously reviewing my research questions and by launching report summaries within the software. The reports helped me to explore answers to my research questions by considering the data I wanted to select by filter (i.e. node, source, classification, number of times mentioned by source) and order (ascending or descending) to display the most striking themes. During analysis, Patton (1999) recommends:

. . .returning to the data over and over again to enable high quality analysis and real reflection of the phenomena. To ensure highest data quality collection and analysis, the researcher must search for rival explanations and keep data or meanings in context (p. 1198-1205).

During analysis, I returned to the interview transcriptions countless times with the NVivo software. This allowed me to reveal diverse explanations and behaviors among the participants while keeping those designated meanings in context.

### **Researcher Background and Credibility**

My hometown is Lafayette, Louisiana, roughly 170 miles (a 3-hour drive) from Grand Isle, Louisiana. I started this project with personal experience of climate change-related flooding and storms, which added to my credibility with research participants. Growing up in southwest

Louisiana, where flooding may occur at almost any time of the year, it was not unusual for schools and/or business to close when bad weather passed. When it came time for hurricane season, my parents prepared belongings and supplies to ride out the storm at home. Being an at-risk parish (county), Lafayette does not open evacuation shelters for hurricanes ranging from a category 3 to a category 5 since everyone is at risk (Lafayette Utilities System Hurricane Handbook 2018). The shelters only open for the lowest ranking category 1 (74-95 miles per hour winds) or category 2 (96-110 mph winds) hurricanes.

My family usually brought out the old gas ‘hurricane’ lanterns, placed new batteries in the radio, sheltered together in the living room, and stayed in touch with family and friends in the area if we could. In 2005 as Hurricane Katrina approached the Louisiana coastline, I remember my mom feeling really uncertain and wary of the expected damage that could potentially harm us. Our home is not in a designated flood zone, but some of our neighbors flooded because they lived next to the drainage canals that could not keep up with the flow of the floodwaters. We and other residents in our neighborhood could not leave in regular vehicles because the roads were also flooded and impassible. For hurricanes like Katrina, as well as for smaller storms, it usually took a few days for the water to subside and the roads to clear. Throughout my childhood, these behaviors and environmental impacts became a way of life and prepared us for survival.

Hurricane Katrina caused little harm to myself and my family that year. Although it happened over a decade ago, remembering Katrina’s disastrous impacts is emotional since it brought so much loss and tragedy to my home state and my country. The personal experiences with hurricanes interested me in identifying and observing human behaviors that plan, prepare, and respond to severe weather events and disasters. Also, the long-term effects of hurricanes and flooding on Louisianans made it easier to empathize with interviewees on Grand Isle.

An ice breaker for meeting people and gaining participants was mentioning that I am from Louisiana, had vacationed on Grand Isle, and have experience with and knowledge about levees, environmental hazards, cultural livelihoods, and common occupations in the state. This allowed me to gain trust with residents and thus eased my entry into the research site.

Participants seemed unconcerned about my gender, age, or ethnicity. However, some participants wanted me to further justify my interests as a researcher as a student with the University of Montana and explain my intentions for the study. Once I revealed that I was originally from southwest Louisiana, they trusted me more. In order to gain further trust, I took on a student learner role, which was very non-threatening and helped break the ice.

My credibility as a researcher includes the fact that I have studied quantitative and qualitative research methods in other classes. I have previous experience with identifying and formulating research problems, collecting data, and analyzing results to further understand social research problems. Biases and ideas about coastal flooding, cultural livelihoods, and community conflicts could have influenced me during data collection. This is why I prepared my mind to concentrate on what the participant was saying during the interview instead of asking irrelevant questions from my own (potentially different) perspective. In addition, I had to physically and mentally prepare for conducting interviews, especially if I had more than one during a site visit. In-person interviews take a lot of mental effort and concentration for both the participants and myself.

### **Ethical Issues**

As a sociological researcher, I had a responsibility to myself, the discipline of sociology, and to my participants to be ethical and responsible. The ethical research practices I employed

included obtaining informed consent of research participants, disguising individual identifiers, and securing the interview recordings, informed consent forms, and data.

Prior to beginning the interviews, this project was reviewed by the University of Montana's Institutional Review Board. Based on the planned protocol, I started each interview by explaining the purpose and scope of the study. In addition, I requested consent for interviews to be audio-recorded. During the informed consent process, I noted that the study did not include the possibility of serious risk of harm, injury, or death. The risks to participants were low. Research participants voluntarily consented to be a part of the study. I obtained written informed consent forms from each participant before interviewing them. (The informed consent form and the form for consent to be audio-recorded are displayed in Appendix A). I informed each participant that all personal information would be kept confidential by removing any elements from the research records that might reveal subjects' identities. I also explained to participants that they could refuse to participate in the study or skip specific questions during interviews.

Carrying out qualitative in-depth interviews using the interview guide (displayed in Appendix B) involved the need to probe deeply into participants' experiences at times when they may have felt vulnerable or distressed, like during time of evacuation or returning to the island to assess flood damages. To protect the participants from harm, I stopped the interview at any sign of distress and began to debrief them by asking whether they needed help and if they were okay. Only when and if the participant had recovered and was willing to continue did I resume the interview. Of course, participants had the right to stop the interview at any time or not answer any questions. Instead of stopping or refusing to answer one or more questions, some simply stated “No” to indicate that they wished to continue to the next question.



I stored the audio-recordings on a personal storage device, transcribed them, and then deleted them from the recorder. I protected the anonymity of participants by assigning pseudonyms to each within the interview transcriptions and the thesis. I also redacted personal information from the transcripts.

In the interview transcriptions and thesis, I changed participants' real names to pseudonyms. I also labeled audio reports and notes by using pseudonyms to identify each participant and/or location that may make it possible to discover the participant's identity (Berg 2007:79). To ensure anonymity, I stored identifying records and lists of participant names and locations in my locked office, separate from the data and audio-recordings. All informed consent documents obtained for each participant were stored securely.

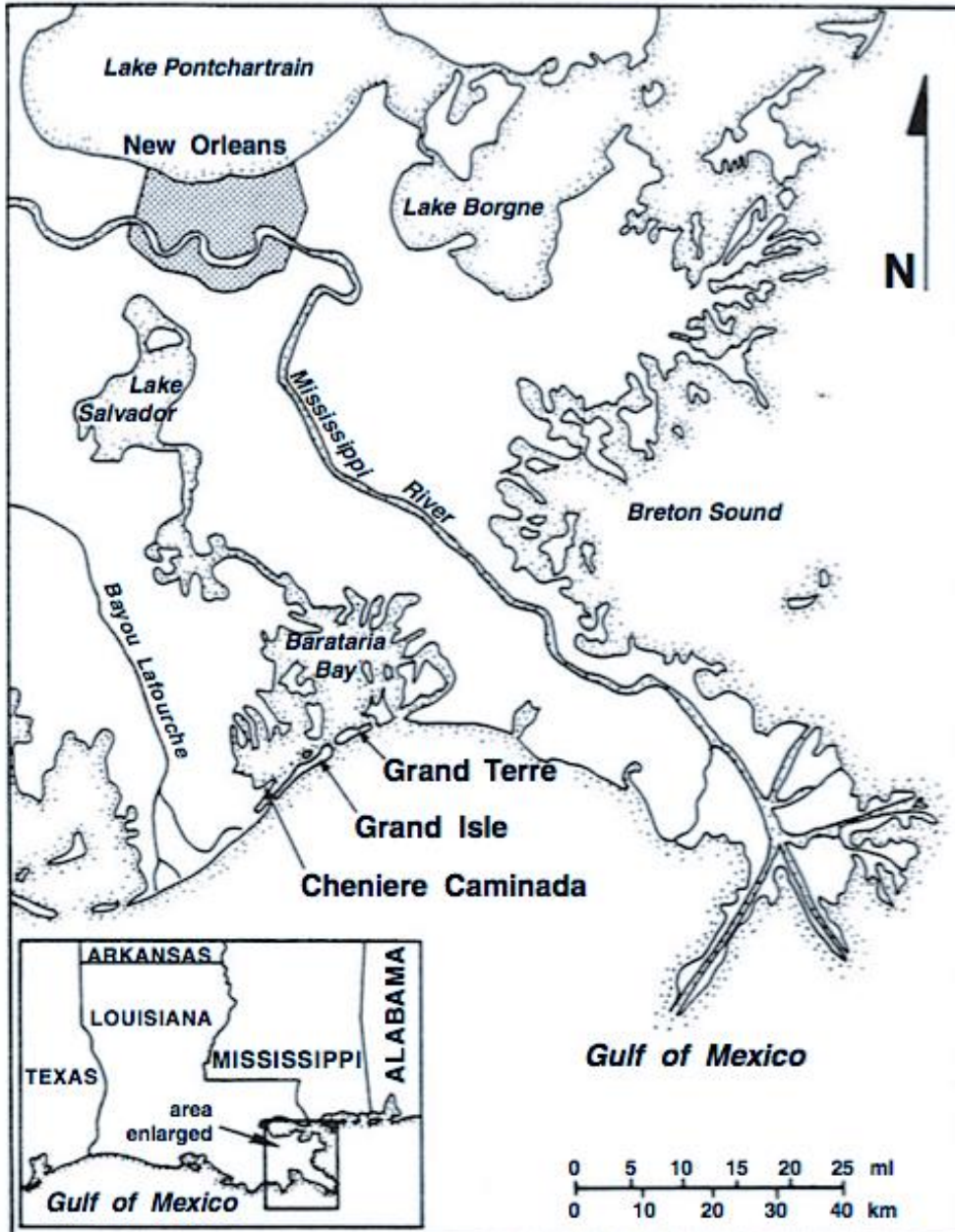
### **Possible Limitations**

The interview guide covered evacuation for storms, but it did not include topics regarding emergency kits or controlling environmental effects to utility connections like breakers, fuse boxes, and gasoline valves. I later wished that I would have asked about these issues to get a sense of how vulnerable the utility systems can be to coastal risks here. If floodwaters entered the homes or businesses of residents at some point in time, none of them were present or decided not to mention the experience. My study also is limited because of its focus on a single community in Louisiana, the last island community in the state. Nonetheless, I expect my findings to be applicable to other island communities with similar attributes facing climate change-related storms and hurricanes, flooding, and sea level rise.

The next chapter provides a brief description of Grand Isle and the environmental and historical factors and processes that have influenced risk and vulnerability to coastal hazards there.

## **CHAPTER 4: BACKGROUND ON GRAND ISLE**

Finding background information for this thesis involved evaluating several textual sources online. First, I examined online information from the USACE and the Louisiana Department of Natural Resources to get a comprehensive timeline of all of the structural projects implemented on Grand Isle. Second, I researched Census Bureau records to find past and current records of populations and housing units here. Third, I examined several e-books and articles that mentioned significant environmental and historical factors and processes that have influenced risk and vulnerability to coastal hazards on Grand Isle. Fourth, I included several images and maps for readers to better understand the overall environmental vulnerability of the island. Finally, I evaluated and quoted other documents to provide context that assisted in the interpretation of the interview data.



Map A: Regional Setting of Grand Isle, LA.  
 Source: Meyer-Arendt 2011:204.

Native American hunting and gathering activities at what is now Louisiana's coastal landscape began over 10,000 years ago (Laska et al. 2005). See Map A above for reference. According to Wall et al. (2014:19), "at the time of European contact, seven different tribes of Native Americans from the Muskogean linguistic family lived on the river delta below what is now New Orleans." Other ethnic groups arrived in Louisiana's coastal lands after forced relocations only three centuries ago (Colten 2018). In 1719, the first massive importation of Africans occurred, bringing slaves from "Guinea, the Gold Coast, Ghana, Angola, Senegal, Gambia, Nigeria, Benin, and the Caribbean" (Wall et al. 2014). During the mid-to-late 18<sup>th</sup> century, Louisiana received thousands of Acadians from what is now Nova Scotia after the British expelled those who refused to swear allegiance to Great Britain (Wall et al. 2014:86). In 1777, Spain ordered several hundred Ileños (Canary Islanders) to move to Louisiana; they began fishing and hunting along the coast soon after they arrived (Wall et al. 2014:88). The lower coasts of Louisiana became a place peopled by "fishermen, trappers, and smugglers of every hue and color" (Stielow 1982:249). The precedent industries formed Grand Islanders original livelihood base.

### **Environmental and Historical Factors Influencing Risk and Vulnerability to Coastal Hazards on Grand Isle**

Louisiana's geological coast results from the Mississippi River's deltaic cycle which builds and withdraws sedimentation from watershed deposits over time (LDNR 2007:56). Humans have hunted and fished on Grand Isle for at least 2,000 years; the earliest recorded Native Americans to span the island were the Chitimacha tribe whose main village was on Bayou Lafourche (near present day Chenier Caminada) and the Ouacha tribe (occupying present day Barataria) (Evans, Stielow, Swanson 1979). Early European exploration began in the early

16<sup>th</sup> century; in 1787 four men of French descent whose Spanish land grants allowed ownership officially settled on Grand Isle (Evans et al. 1979). Plantation owners would later begin growing sugarcane and cotton on the island, which continued into the early 19<sup>th</sup> century (Meyer-Arendt 2011:207).

### *The Early 1800s*

In 1803, Louisiana came to the United States as part of the Louisiana Purchase (Wall et al. 2014), and in 1812, Louisiana officially became the eighteenth state of the union. Commercial fishing also began this year. Between 1810 to 1890, Grand Isle's population increased from 63 to 301 residents, which resulted in multiple changes in land ownership and opportunities to live off of the land via hunting and fishing, planting, and ranching (Evans et al. 1979).

Louisiana's sub-tropical climate involves frequent precipitation throughout the year as well as tropical cyclones and significant hurricanes that particularly impact the low lands. Because of these conditions, beginning in the 1800s, people on Grand Isle began using several methods to prevent or mitigate possible storm damage. For example, residents "built levees and drainage ditches to control bayside flooding," and they built elevated homes and businesses from cypress (Meyer-Arendt 2011:207). Cypress timber is known for its ability to absorb wind and water energy from hurricanes and its rot resistance (Allen 1997). Also, structures built near the naturally occurring beach ridges or sand deposits helped protect against wind and wave action (Meyer-Arendt 1985).

### *1850 to 1893*

In the mid-nineteenth century, Grand Isle's tourism industry began when wealthy plantation owners and residents of New Orleans traveled by steamboat to visit the sub-tropical island during the summer months (Meyer-Arendt 2011:207; Stielow 1982). At this time, Grand

Isle plantation owners were growing sugarcane and cotton, both of which were dependent on slave labor. Economic gains from sugarcane and cotton plantations ended for two significant reasons: soil salinization and the end of slavery after the Civil War (Meyer-Arendt 2011). As the agricultural industry declined, commercial fishing continued and tourism increased. For example, two wealthy New Orleanians converted one of the sugarcane plantations into the Grand Isle Hotel for visitors (Stielow 1982:242-243). In 1890, sections of the New Orleans and Grand Isle Railroad traveled along the lower Mississippi with steamship connections to Grand Isle, which further attracted tourists to the island (Stielow 1982; Meyer-Arendt 2011). Unfortunately, the 1893 Chênrière Caminada hurricane destroyed most of the island's developed infrastructure (Meyer-Arendt 1985). Recovery from the hurricane of 1893 demonstrates the beginning of Grand Isle's cultural response to rebuild settlements and continue natural resource practices for economic support in this rural community.

### *The Early 1900s*

In the early twentieth century, the National Weather Service agency began sending warnings to local Grand Isle officials about approaching storms. Based on these warnings, fishers and residents "secured their equipment, while some residents evacuated to New Orleans" (Colten 2010:21). Two severe hurricanes in 1909 and 1915 destroyed much of the emerging tourism infrastructure which had been rebuilt after Hurricane Chênrière Caminada (Meyer-Arendt 2011:207).

During the 1930s, the number of vacation homes on Grand Isle increased as "many islanders were forced to sell their property by the Great Depression" (Meyer-Arendt 2011:208). In 1934, the completion of Louisiana Highway 1, with a bridge to the island, further improved visitor access (Meyer-Arendt 1985:208). In that same year, the town removed driftwood from

Grand Isle's shoreline as well as several natural beach ridges to provide space for automobile access on the beach, summer beachfront homes, and hotels and rental cottages (Meyer-Arendt 1985:208). It was also during this time that exploration and production activities for oil and gas began within the Gulf region (Theriot 2014).

#### *1945 to 1965*

After World War II ended in 1945, more and more U.S. citizens had the money and freedom to travel the United States and take summer vacations to resort communities (Smith 1998). By 1948, offshore drilling for oil took place off of the Louisiana coast which expanded employment opportunities for current residents and attracted labor migrants to the community (Burley 2007). A few years later, recreational development as well as the demand for petroleum and natural gas heightened (Theriot 2014). Large hotels and rental cottages emerged on Grand Isle, and up to 10,000 visitors spent time recreating during the weekends (Meyer-Arendt 2011).

The island has endured geological shoreline changes before human settlement began (Meyer-Arendt 1985). But, without the driftwood and beach ridges to act as soft-shore protections by trapping sediment and absorbing wave energy, shoreline erosion increased (Simmons 2016). Thus, during the post-WWII era, public concerns for protection from erosion and flooding emerged. In 1951, the government of Louisiana responded by constructing fourteen timber groins<sup>2</sup> both at the west end of the island and near the center, but unfortunately these structures were ineffective as they interrupted natural land build-up and increased beach erosion (Meyer-Arendt 1985:208-210).

---

<sup>2</sup> A groin is a rigid structure built out from a shore to protect the shore from erosion, to trap sand, or to direct a current for scouring a channel; a groin is also known as a jetty.

By 1960, the oil and gas industry had become the dominant industry in coastal Louisiana, while traditional agriculture and commercial fishing in this region dropped to some extent (Theriot 2014). Between 1950 and 1960, oil and gas employment grew by over 12,000 people in the state (US Census 1950; U.S. Census 1960), with most of this growth occurring in coastal Louisiana where interstate pipelines transferred oil and gas through wetlands ecosystems, prompting some local fisherman, officials, and resource managers to question the ecological changes such as wetland removal (Theriot 2014:50). The oil, gas, and commercial fishing industries provided economic livelihood for most people on Grand Isle. The town's economy was stable, and tourism was at its peak (Meyer-Arendt 2011).

Naturally, the positioning of the Grand Isle on a river delta means that it experiences frequent hurricanes and storm surges, which contribute to the damaging erosion. Human mitigation projects to combat the environmental degradation of the island's shoreline took place regularly during this period. For example, a jetty<sup>3</sup> that had been built before 1960 on the eastern end of the island required multiple extensions and repairs by the Louisiana Department of Public Works and the U.S. Coast Guard (LDNR 2007).

In 1965, a significant storm wrecked the island--Hurricane Betsy. This hurricane made landfall as a Category 3<sup>4</sup> at Grand Isle and devastated several local tourist attractions and businesses, causing a 9 foot high storm surge that crossed the island and severely eroded the

---

<sup>3</sup> A jetty is a long narrow structure built as a barrier to protect the coastline from erosive currents, tides, and waves. It stretches from the shore into the body of water.

<sup>4</sup> The Saffir-Simpson Hurricane Wind Scale categorizes hurricanes from 1 through 5 based on sustained wind speed and estimates potential property damage.



western beach up to Louisiana Highway 1 (Meyer-Arendt 1985:209). (See Image 1, below, for Saffir-Simpson Hurricane Scale.) According to Colten (2010:34-35), “Betsy reshaped public policy towards hurricanes in Louisiana and the United States as a whole by creating national discussions about disaster response”, and in 1968 the U.S. Congress created the National Flood Insurance Program (NFIP) (Manning-Broome et al. 2015). This national program tries:

. . .to reduce losses from flood damage caused by insufficient flood works and programs; to share the risk of flood losses and encourage preventative and protective measures; to create economic cooperation between the Federal Government and the private insurance industry; to encourage sound land use via state and local governments by minimizing developmental exposure to flood losses; and to base flood insurance on pooling risks, minimizing costs, and distributing burdens equitably among those who will be protected by flood insurance and the general public (U.S. Congress 968: 1-2).

Flood insurance in Louisiana offered through the NFIP is available to homeowners, renters, and business owners. Coverage is not federally required, but mortgage lenders do require borrowers to have flood coverage if the property is in a flood zone (Manning-Broome et al. 2015). The goals of the program include covering certain damage costs to buildings and their contents.

<p>The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures. In the western North Pacific, the term "super typhoon" is used for tropical cyclones with sustained winds exceeding 150 mph.</p>		
<b>Category</b>	<b>Sustained Winds</b>	<b>Types of Damage Due to Hurricane Winds</b>
1	74-95 mph 64-82 kt 119-153 km/h	<b>Very dangerous winds will produce some damage:</b> Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 kt 154-177 km/h	<b>Extremely dangerous winds will cause extensive damage:</b> Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph 96-112 kt 178-208 km/h	<b>Devastating damage will occur:</b> Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph 113-136 kt 209-251 km/h	<b>Catastrophic damage will occur:</b> Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	157 mph or higher 137 kt or higher 252 km/h or higher	<b>Catastrophic damage will occur:</b> A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
<p><b>Image 1: Saffir-Simpson Hurricane Wind Scale. It does not cover potential damage from storm surge, rainfall-induced floods, and tornadoes. Wind damage somewhat depends on the local building codes enforced or in effect. Source: Schott et al. 2012.</b></p>		

*1970 to 1999*

Coastal engineering efforts continued after Hurricane Betsy. In 1971, the United States Army Corps of Engineers (USACE) suggested that the Louisiana Department of Public Works construct a jetty to stabilize the western end of Grand Isle, which also eventually resulted in significant shoreline build-up and retreat (Louisiana Department of Natural Resources 2007). A concrete retaining wall built by Corps of Engineers stabilized the coastal highway on the western end, but later caused erosion near homes further down the beach (Meyer-Arendt 1985:209).

During the early eighties, noticeable sea level rise and continued shoreline erosion on the island influenced a change in the structural approaches to erosion and flooding by the USACE and the town of Grand Isle. To combat sea level rise from the Gulf of Mexico, the USACE decided to construct the western jetty and offshore breakwater system, as well as an artificial dune along the entire length of the island's shoreline; the dune is eleven and a half feet above sea level, built with sand dredged from 2,500 to 4,000 feet offshore (LDNR 2007). The Corps completed the dune project and beach restoration in early 1985, and tourist development began to increase. But later in 1985, the dune suffered damage from Hurricanes Danny in August, Elena in September, and Juan in October (Meyer-Arendt 2011:209). Later, in 1989, then mayor Andy Vallance ordered a rock project involving a breakwater and jetty system in the Gulf of Mexico near the shoreline, which succeeded in capturing sediment but was utterly landlocked by 2003; the project ultimately changed the morphology of the shoreline by building land between the beach and the breakwaters (LDNR 2007:8).

Until 1990, beach nourishments also increased Grand Isle's beach width. From 1990-1991, one beach nourishment project contained 600,000 cubic yards of material, and three additional nourishment projects were completed in 1991 (LDNR 2007:8). Since the mid-1990s,

“the Louisiana Gulf Coast has experienced increased shoreline erosion” because of hurricanes and elevated Gulf of Mexico waters (Meyer-Arendt 1985:203). From 1994 to 1995, the USACE “constructed twenty-three detached offshore breakwaters with the aim of mitigating shoreline erosion on Grand Isle” (LDNR 2007:9). The breakwaters start at the center of the island and continue east to Grand Isle State Park, where the Louisiana Department of Transportation and Development constructed thirteen more breakwaters in 1999 (LDNR 2007). The various structural projects were meant to help protect the island from shoreline erosion and sea level rise by obstructing wave action in the Gulf of Mexico before reaching the shoreline.

#### *2000 to 2018*

From the early 2000s to 2018, Louisiana state and the USACE projects have put in place various structural measures such as “sediment diversions into regions experiencing wetland loss, additional breakwaters to combat erosion, rock retaining walls, additional beach nourishments”, as well as various non-structural measures planned mostly for unpopulated coastal areas, but including Grand Isle (Meyer-Arendt 2011:210). For instance, in 2005, a beach nourishment project placed more than 850,000 cubic yards of sand extending 6,500 feet from the center to west side of the beach (LDNR 2007). Later that year the federal government funded additional breakwaters offshore along the north-east Gulf side and the bayside (Meyer-Arendt 2011:210).

Unfortunately, such efforts did little good. Later in 2005, Grand Isle residents experienced one of the worst environmental events in United States’ history: Hurricane Katrina, a Category 3 storm that made landfall on Louisiana’s eastern coastline with winds of 110 knots, a storm surge between approximately 15 and 19 feet, and between 8 and 10 inches of rain total; for the US as a whole, total damages from this hurricane were estimated at \$108 billion dollars (Knabb, Rhome, and Brown 2005). Fortunately, Grand Isle residents had enough time to evacuate the island

before Katrina flooded the island and washed away entire homes and businesses as well as the Grand Isle Public Library (Dawson and McCook 2006). Unfortunately, Katrina extensively damaged Louisiana Highway 1 built over Caminada Bay, which temporarily impeded residents' ability to return home after their storms as well as their access to services and their jobs. The storm surge caused deck movement and scouring to the coastal highway, and the estimated cost to repair the damage was \$500,000 (Padgett, Nielson, Yashinsky, Kwon, Burdette, and Tavera 2008).

Because of this damage, most residents were unable to begin damage assessment and recovery efforts for several weeks. About a month after Katrina, Hurricane Rita, also a Category 3 hurricane at landfall, brought over 12 billion dollars' worth of property damage for Louisiana (Knabb et al. 2006).



Image 2: Pre-Katrina construction of twenty-two-foot elevated highway LA 1 using the environmentally preferred construction method that eliminates the need for dredging a canal to accommodate heavy-lift cranes. Source: Theriot 2014.

Post-Katrina and Rita, Congress appropriated \$13.41 billion to Louisiana for disaster-related housing needs through the state's new Homeowners Assistance Program under the Road Home recovery initiative (Love 2008). Road Home provided funding options for affected homeowners in certain parishes of Louisiana and involved funding for compensation for damages, home elevation, additional compensation grants for relocation, as well as individual mitigation funds (i.e., for purchasing new storm windows) (The Road Home Homeowners Assistance 2012). Some homeowners on Grand Isle applied to the program, but other residents on the island did not have this option because their homes were still mortgaged (thus they were not considered to be home owners). As of 2017, there were 1,986 housing units on the island (American Fact Finder 2017), and 226 of them had been elevated through the Road Home program (Investments in Residential Construction 2018). Road Home's core funding through the Community Development Block Grant managed by the Department of Housing and Urban Development covered the full cost of home elevation. The program lasted from 2006 to 2016. Even in 2018, some people on Grand Isle have homes that are only at the older, lower elevation standards. Some residents may have preferred not to elevate to the newer standards because of the risk of subsequent increases in their homeowner's insurance due to increased exposure to storm winds. The Federal Emergency Management Agency (FEMA) sets the base flood elevation standard or BFE through Flood Insurance Rate Maps (FIRMs)<sup>5</sup>. FEMA designates BFE levels for a home up to or above a calculated one percent chance annual flood or according to the

---

<sup>5</sup> A Flood Insurance Rate Map (FIRM) is the official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community.

historical flood of record. According to Manning-Broome and coauthors (2015:25), “the relationship between the BFE and a structure’s elevation determines the flood insurance premium.” The National Flood Insurance Program relies on FIRMS to designate which communities are at risk to flooding.

As of 2015, despite the availability of Road Home funding to relocate, “more than 90 percent of homeowners in coastal Louisiana chose to stay put and mitigate the damage to their homes and businesses rather than relocating or selling” (Manning-Broome et al. 2015:41). In Grand Isle, many residents chose to rebuild with help from the community, their relatives, out-of-state nonprofit organizations, and FEMA; many sold their homes and moved away.

To try to prevent future damage from storms such as Katrina, in late 2005 the Louisiana State Legislature created the Coastal Protection and Restoration Authority (CPRA), which released the Coastal Master Plan for a Sustainable Coast in 2007. In 2008, the USACE was finishing repairs to Grand Isle's structural protection systems due to damage from Katrina and Rita. Repairs included an 8,000 linear foot section of the dune, rock jetties, breakwaters, and pedestrian crosswalks over the dune to and from the beach (Grand Isle Hurricane Protection 2009). Unfortunately, in September 2008, when repairs were nearly complete, Hurricane Gustav caused numerous breaches to the Gulf side dune as sand washed across the island (Meyer-Arendt 2011). That same month, another hurricane – Ike – threatened Grand Isle, initiating a flood fighting effort by the USACE to prevent residential flooding, especially on the western side of the town where the dune significantly breached from Gustav. Prior to the landfall of Hurricane Ike, the USACE led an eight-day effort to fill the breaches from Gustav with sandbags and install a 1,000-foot "burrito" core, which reconstructed 5.7 miles of the dune with a geotextile tube core filled with sand, clay, and capped off with additional sand. Lastly, the effort included an

additional beach nourishment project involving one million cubic yards of sand dredged from offshore (Grand Isle Hurricane Protection 2009). This flood fighting effort was completed before Ike made landfall, and it successfully mitigated damages from Ike. However, this episode showed the vulnerability of the hurricane protection dune to hurricanes and just how frequently the island may be impacted during hurricane season.

In 2010, the town of Grand Isle and other coastal states experienced a devastating environmental disaster, the Deepwater Horizon offshore oil spill. A drilling unit owned by British Petroleum (BP) exploded fewer than seventy miles from Grand Isle, leaking 3.19 million barrels of gallons of oil and several thousand tons of hydrocarbon gases into the Gulf over a period of four months (Meyer-Arendt 2011:216; Pallardy 2018; Beyer, Trannum, Bakke, Hodson, and Collier 2016). Oil spread to a depth of between 3,600 and 4,265 meters, contaminating and affecting deep water sea life habitats (Beyer et al. 2016). After the oil spill, BP funded a cleanup of the damaged coast, with a total of 9,810,133 pounds of oil residue collected in Louisiana alone (Amadeo 2018). Grand Isle's beach and wetland areas were a part of the BP-funded cleanup, but despite cleanup efforts, the island is still recovering from the extensive contamination of salt marshes, seabirds, estuaries, and wildlife nursery areas. Furthermore, the devastating environmental impacts of the oil spill also economically damaged employment opportunities in coastal Louisiana, especially for rural residents working in the fishing and tourism industries, like many on Grand Isle. Furthermore, "changing technologies, international competition, and rising fuel prices have also spawned additional adaptations among shrimpers in coastal Louisiana, many of whom have had to find other jobs" (Colten 2018:375).

Later in 2012, the Coastal Protection and Restoration Authority announced its planned priorities for coastal land restoration, structural protection projects, and non-structural strategies

for coastal Louisiana for the next fifty years (Manning-Broome et al. 2015:6). Other preparation efforts by the state of Louisiana include: creating community planning boards along the coast, having various state agencies like the Department of Transportation and Development and the Department of Natural Resources administer non-structural risk reduction programs, and adopting the International Building Code (IBC) and the State Uniform Construction Code (UCC) (Manning-Broome et al. 2015:6-60). Adopting these codes requires new changes for rebuilding. For example, new wall installations must break-away during flood events, and new homes must include hurricane straps<sup>6</sup> to make the roof more resistant to high winds, uplift, overturning, and sliding (Simpson Strong House Tips 2017). According to a 2012 FEMA report, *Best Practices: Promoting Successful Mitigation Post Hurricane Katrina* (2012:23-25), since Katrina, “Grand Isle residents have elevated 111 existing homes and rebuilt 261 homes following IBC and FEMA Code of Federal Regulations.” Most of the island’s homes had been seriously damaged or destroyed by Katrina and Rita, hence the higher number of rebuilt homes.

In 2015 and 2016, “low oil prices and the consequent shrinking of the oil and gas industry have limited opportunities, especially for youthful islanders seeking to enter the labor force” (Colten 2018:380). Also, opportunities to purchase or build homes in coastal Louisiana are limited because mortgages require flood insurance, which raises the cost beyond the means of many who might like to remain on Grand Isle and “inhibits certain property owners from selling or transferring land titles” (Colten 2018:379).

The 2017 hurricane season brought three major weather events. In June, Hurricane Cindy

---

<sup>6</sup> Hurricane straps are installed to new homes and help the homes to withstand winds of more than 100 miles per hour.



brought significant erosion to the dune on the western end of Grand Isle and exposed several hundred feet of the geo-tube, which is the base of the dune. Flooding up to five feet also occurred, which may have affected residential homes below base flood elevation standards (Berg 2018). In the remaining summer months, riprap repairs (loads of loose rocks) were placed against the western end of the dune to control for erosion. As Hurricane Harvey approached Grand Isle, workers rushed to bring in additional rock loads to protect the damaged dune from rising tides and incoming storm surge (Blake and Zelinsky 2018). These efforts were successful, but additional work is still needed. In October 2017, Hurricane Nate inundated the island's roadways with between three and five feet of water (Beven and Berg 2018). As with all flood events, the water from Nate was removed via the town's drainage system. The amount of time it takes to remove floodwaters from the island depends on multiple factors such as the direction of the storm, breaching of the dune or bayside levee, level of storm surge washing over the island, the amount of rainfall, as well as technical difficulties to the pumps such as power outages.

The 2018 hurricane season began June 1st, and while the summer season brought recreational tourists to the island for the 4<sup>th</sup> of July and the annual Grand Isle Tarpon Rodeo, the uncertainty of when the next storm will arrive was likely on everyone's mind.



Image 3: Grand Isle, Louisiana (top) surrounded by the Gulf of Mexico (left) and several bays (right). Isle Grand Terre (bottom) lays east of Grand Isle.  
Source: Welcome to Grand Isle website 2018.

## **CHAPTER 5: FINDINGS**

### **Introduction**

This chapter discusses the main research findings for this study explaining: (1) the structural measures implemented for the community of Grand Isle to reduce flooding and mitigate environmental risks from climate change, (2) the non-structural measures implemented to reduce flood impacts on residences and businesses and mitigate environmental risks from climate change, (3) the local perceptions of vulnerability to flooding, hurricanes, and climate change and, (4) the conflicts arising as a result of local roles and responses to flooding and environmental risks from climate change.

### **Structural Measures**

This section explores local opinions regarding the various structural measures implemented on Grand Isle: the hurricane protection dune, the tidal surge protection levee, breakwater systems or rock jetties, and stationary drainage pumps. These structural measures emerged as the most common themes for discussing flood resistance on the island.

#### *Hurricane Protection Dune*

Every respondent in the study mentioned the hurricane protection dune (HPD) as a way to reduce flooding. Built and managed by the USACE, it stands as one crucial structural intervention used for flood protection. Over half of the respondents mentioned the HPD working well. For example, Justin, a 62-year-old public official, discussed how the barrier stops storm surge that comes towards the island from the Gulf of Mexico:

If a ten-foot storm surge comes in and the sand [dune] breaks down, the levee stops [the surge] a little bit. We never flood from the Gulf side. I do not care what comes, we never flood.

Even though Justin expressed the HPD's tendency to erode from storm surge,<sup>7</sup> he believed the structure performs well enough to impede breaching; the artificial dune is 11.5 feet above sea level, but the island has a history of receiving even higher levels of storm surge. Rising sea levels from storm surge combine with environmental risks of sea level rise and land subsidence.

Veronica, a 42-year-old county clerk, mentioned similar benefits of having the HPD as a flood barrier:

The levee protects [the town] from storm surges and high tides. The only time we really have an issue with high tides on the front end [of the island] is when a storm is in the Gulf of Mexico. The water comes creeping up in some places, and then it will stop. If [the structure] is built well enough, [the water level] won't go any further.

Interestingly, almost half of the respondents felt a need for the USACE to improve the design and oversight of the structure so damages will not continue. Furthermore, the majority of respondents mentioned various drawbacks to HPD, the main one being erosion, especially at the western end of the structure. For this reason, the HPD is armored with vegetation to reduce erosion and scouring<sup>8</sup> from storm surge, storm winds, and wave action. Once the structure begins to erode, it becomes susceptible to further deterioration until repairs are completed either by the town, which repairs damages from Category 1 or 2 storms, or the USACE, which repairs damages from Category 3 storms or above. Ava, a 62-year-old town official, expressed the following views about the dune:

It has to be constantly replenished because, truly, my opinion is poor planning. The levee [on the beach side] failed quite a few times. The town and the Corps just finished a project on the west end of the island for a few thousand feet, and it washed away. Normal tides and things can get to it. I think the Corps [design] it to fail.

---

<sup>7</sup> A storm surge is an abnormal rise in the level of the sea along a coast caused by the onshore winds of a severe cyclone.

<sup>8</sup> Scouring is the erosive force of moving water, as in a river or sea.

This comment was one of several instances where a resident felt dissatisfied with the USACE's design and oversight of the HPD. Similarly, Bernie, a recreation guide on the island, expressed her mixed views of the HPD as a barrier to flooding:

We live by the Gulf of Mexico, and [the levees] separates our homes from the Gulf and the bays because if the water does not get us from the north, it will get us from the south. We have no chance of not getting water. A levee is the best possible solution [officials] could come up with to stop Mother Nature and all of her fury, but she has invited herself down our street [before]. The benefits [of the levees] are to help us from flooding, but the crappy part is, it does not always work.

Regardless of the levees on Grand Isle, residents like Bernie experience “no chance of not getting water.” The USACE worked on the riprap<sup>9</sup> on the HPD last winter. Justin, the public official mentioned earlier, brought up the riprap repair after the most recent storm damage to the structure.

The waves were so big that it kept on slicing the levee. The levee [HPD] was falling into the Gulf of Mexico, and the geo-tube became exposed. The town finally put some rocks against the levee as a temporary fix...they had no choice but to hurry and cover up the levee.

Residents also referred to the geotextile-tube as the “burrito,” which performs as a structural reinforcement mechanism within the HPD to combat erosion and scouring. Originally, the USACE pumped sand into the “burrito,” covered it with additional sand loads and planted grasses for reinforcement; it extends for 5.7 miles of the HPD system. In addition, riprap, sand deposits onto the dune, also known as nourishment, were funded by the federal government after town officials’ lobbied for funding.

---

<sup>9</sup> Riprap is loose stone used to form a foundation for a breakwater or other structure.



Image 4: HPD and shoreline erosion on the west end of the beach caused waves from the Gulf to come up to this boardwalk. The town placed emergency riprap at this section to halt erosion. Source: Miller, Lauren 2018.



Image 5: Additional rip rap on the western end of the hurricane protection dune with houses built behind the structure. Source: Miller, Lauren 2018.

Nourishments became vital for protecting the HPD from breaching, but sand also had drawbacks.

Veronica, a 42-year-old county clerk, explained a situation when the dune lost significant amounts of sand after strong winds:

Any time that winds are strong enough to move sand, it will move [sand] onto the road and under people's houses that live on the beach side. A lot of residents' [land] elevations have built up in certain areas where the levee breached.

Interestingly, the HPD's breaches have unintentionally impacted home owner's properties.

Bernie, a 59-year-old recreation guide, echoes the impact of dune failure when she said:

There are times when the water [retreated], but it brought all the sand into some of the yards. I've seen it from a lot of hurricanes and storms. People struggled to hire equipment and to get their family to shovel it. It's dangerous because if a storm comes and they're only seven feet in the air, they're going to [flood] because the water's going to rise faster.

Bernie's comment reveals how the HPD made some residents more vulnerable to flooding.

Noah, a 65-year-old local seaboard member, described the HDP's performance and failures in the past.

It can be a blessing and a curse. It is always a maintenance issue. It is never a done deal, particularly after a storm [where] we had breaches, and we lost a lot [of sand]. Levees do not always work, mainly if it is the first most barrier to the weather. It also depends on the severity of the storm and from what direction it comes. It [the HPD] can help the majority of the time. It is probably a wise thing to have, but there are times when it was not.

Respondents provided a range of benefits and drawbacks about the hurricane protection dune along the beach. The next section discusses the tidal surge protection levee built partially on the bayside of the island.

#### *Tidal Surge Protection Levee*

The Grand Isle Independent Levee District (ca. 1992) manages the tidal surge protection levee (TSPL) located at the bayside of the island. The Grand Isle district builds levees to protect



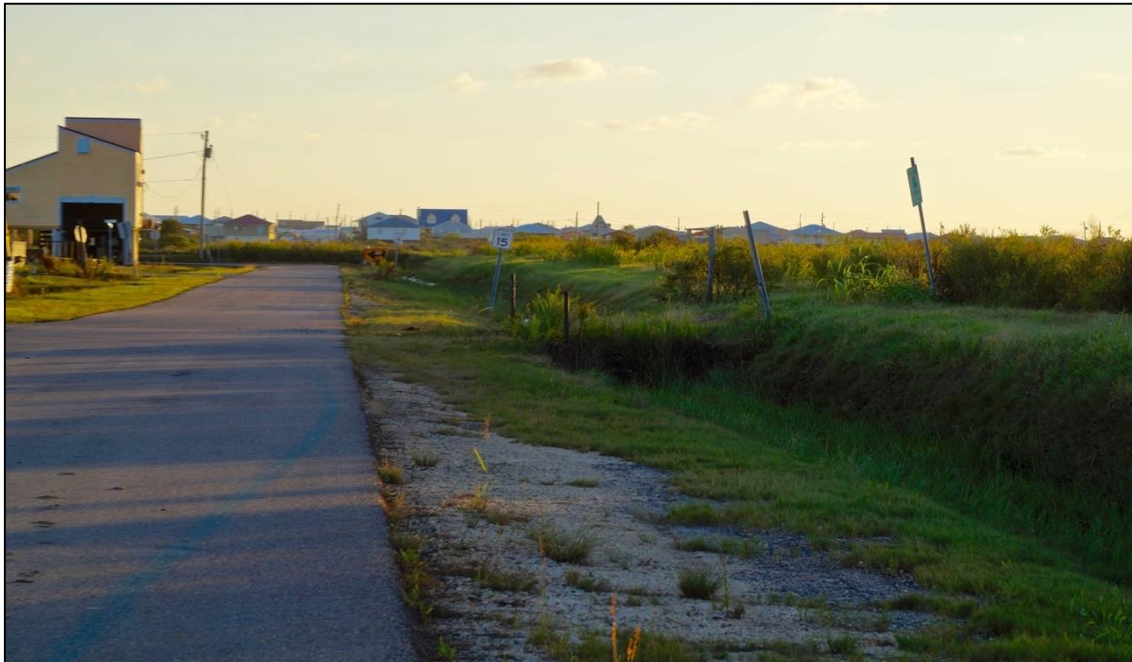


Image 6: The tidal surge protection levee at the center of the bayside of the island with drainage ditch directly next to it. Source: Miller, Lauren 2018.

people and property in and around Grand Isle. Less than half of the respondents felt that the tidal surge protection levee worked well to protect developments from flooding. The town built the TSPL with objectives to protect residential homes and businesses from incoming high tides and storm surges. Ben, a 55-year-old equipment supervisor, mentioned positive views about the tidal surge protection levee's performance:

The back levee is a tidal surge protection levee, and it keeps the high tides from coming in, especially in the town hall area [center of the island]. We cannot do without our levee. Especially during storm seasons, abnormal tides, and little tropical storms. It's what protects our homes, our vehicles, our lives, [and] our animals. Cannot do without it.

Ben explicitly stated that the town cannot “do” or function without the bay TSPL. Ava, a 62-year-old resident, also mentioned the town's need for the structure, but from a geological perspective:

I know we need them. Most of the people that live here and own property here want the levees and breakwaters. We need them to help. Grand Isle is a barrier island. Barrier islands are supposed to move and shift, and without the levees and breakwaters holding



them together, the island would be a constantly changing barrier island. Being [that it is] populated with things here, you cannot let that [shifting] happen.

Indeed, the TSPL, HPD, and breakwaters (discussed later) are human mechanisms built to try to control coastal flooding onto the island, but controlling nature oftentimes involves unwanted consequences. Thus, it is interesting to reveal that more than half of the respondents held negative assessments of the TSPL's performance. For instance, Ronald, a 70-year-old business owner, mentioned how the limited length of the tidal surge protection levee on Grand Isle has failed to prevent flooding:

The levee is at the middle section of Grand Isle. It does not cover all of Grand Isle. When we have a little disturbance, high tides [occur], and [the TSPL] is not going to stop the water from coming in. When the last hurricane hit, we could see the water coming over the road.

The tidal surge protection levee only extends for a specific portion along the bayside of Grand Isle. Its limited length may explain why residents feel dissatisfied or mixed about the performance of the structure to mitigate flooding. The Grand Isle Levee District was in the process of extending the TSPL during the time where interviews were collected. Rose, a 73-year-old curator, explained her observations of the ineffectiveness of the town's recent addition to the TSPL:

A lot of hurricanes come in from the bayside, which has virtually no protection. The town needs to rethink the whole engineering plan because building that dirt levee out there, that's not going to do any good. The system they are using right now, I am not even sure if that is doable here on the island. I don't think it is effective. That water rolls right over that levee. It rolled over the levee the last time. I think the Mayor and our local people are doing the best they can do under the circumstance, but I think that this is a state if not, a federal issue.

The Grand Isle Independent Levee District used dirt or clay for the TSPL's addition since the material helps with structural stability, unlike sand.

On a different note, William, a 54-year-old housing technician, was the only resident that felt that the tidal surge protection levee *and* the hurricane protection dune were unnecessary flood systems. A few others commented on the structures' effects on drainage:

Well, [drainage] was better without the levees. Grand Isle would get a hurricane, and the water would come in, then the water [would] leave. Simple. No pumps, no nothing. Now, we got a levee in the front, a levee in the back, and the water cannot get out. [Water] comes and it stays there. It was better without the levees on the beach, and it was better without the levees in the back. Now, we have to pump all of the water out.

As with the hurricane protection dune, a majority of residents also felt mixed about the TSPL's performance to mitigate flooding and the consequences on drainage. For example, Justin predicted that the recent additions to the TSPL will help with future storm scenarios, but not if the structure is breached:

The town is building a four-foot levee right now, just for a major category 1 or 2 [hurricane] that passes east to west of Grand Isle. It could also [block] a lot of debris coming in. If it is a category 3 [hurricane moving in the same direction], there is nothing we can do. [The water] is going to come over [the levee] and get trapped.

Justin's comment, "there is nothing we can do," demonstrates the town's vulnerability to the TSPL's limitations. Oscar, an 81-year-old retired resident, discussed a similar opinion about the TSPL and the island's dependence on the stationary pump stations to remove floodwaters:

The town enhanced the levee behind the island. It helped out. The only problem is when you live in a fishbowl, it holds the water out, but it holds the water in until they can get the pumps to pump it out. So, we have the mercy of the pumps to pump the water out when it comes in.

While some respondents benefited from the TSPL, others held mixed opinions of it.

Nevertheless, several respondents I interviewed live in areas that are not protected by the TSPL, yet they felt that the structure was important for the community. The next section discusses the breakwater systems or rock jetties placed along both sides of the island's shorelines.

### *Breakwater Systems or Rock Jetties*

Half of the interview respondents felt that the breakwaters<sup>10</sup> or rock jetties surrounding Grand Isle worked well. For instance, Justin provided a positive assessment of the breakwaters around the island help to prevent shoreline erosion:

Our experience over the years is the need to put rocks in the Gulf and work with Mother Nature. When [the weather] gets rough, the wind blows from the southeast, and it stirs up the Gulf and throws [sand] and water on the other side of the rocks, and then it settles. The rocks stop the wave energy from coming against the shoreline, and it builds up the island. It's what we have to do here. Once we run out of money for rocks, that is when [areas of the shoreline] starts cowering. [Breakwaters] are the most helpful measure to fight coastal erosion.

Like with the levee system on the bayside of the island, additional breakwater systems are needed to protect the island. When asked about other projects on the island that reduce coastal flooding, Ronald responded:

We have rock jetties. Our first rock jetty was [built] in 1963. The east end of Grand Isle was eroding badly. When they put that rock jetty, it started building up Grand Isle on that end. Then several years ago, they started putting those breakwaters in there, and that helped out a great deal as far as the erosion goes because it is building up the beach.

It's clear from interviews that the breakwater systems alleviate shoreline and coastal erosion.

Only a few respondents mentioned negative views of the rock systems. Mason was particularly critical:

The engineers will design something, and they have never seen Grand Isle [in person]. There are some big rock jetties [in the Gulf]...that is a joke. That is a waste of money. Six million dollars thrown out. Wasted! I worked with those engineers at times. I asked them to tell me what good it does. They said, 'Oh, well it's going to prevent the north windstorm from hitting Grand Isle.' No, it won't! They built it too far! I told them, 'The only good that did, maybe y'all thought of that...the pelicans and the seagulls have a place to land.'

---

<sup>10</sup> A breakwater is an offshore structure protecting a harbor or beach from the force of waves.



Image 7: Breakwater on the bayside of the island. This wetland or saltwater marsh area rests next to the Barataria bay. Source: Miller, Lauren 2018.



Image 8: Multiple breakwater segments situated in the Gulf of Mexico along Grand Isle's beach. Source: Miller, Lauren 2017.

Mason's opinion reflects on the USACE's decision to place the breakwaters in certain areas of the Gulf of Mexico before actually visiting the site. Oscar likewise mentioned a negative view of the placement of the rock jetties and the effect on the western end of the HPD:

What caused the problem over there is the way the rock jetties are set up and the way the currents are running. For years, [the HPD] just kept slowly eating away and eating away, and Tropical Storm Cindy just escalated the erosion. It was a slow process. You could see a little bit of it gone every day. The town is going to have to do some major surgery to repair it, and that's going to [involve] putting some rocks out into the Gulf to stop the erosion and to stop the island from eroding away.

One section in the Gulf of Mexico near the western end of the island has no breakwater system at this time, although during a follow up interview, Ben, a community supervisor, revealed that the mayor of Grand Isle lobbied to the federal government for funds to complete the breakwater system and received fifteen million dollars to do so.

A little more than half of the respondents mentioned mixed opinions about the rock jetties or breakwater systems. For instance, when asked about other systems that helped with the most recent storm, Noah, a local storm responder, mentioned the rock jetties around the island:

Well, they help with every storm. It just slows down the speed and intensity of the water and knocks the wave height down. We have got the majority of the island covered. Of course, there are spaces in between each pile, so we still get some erosion form where these spaces are, but in general, it helps everywhere. We are missing some down towards the west end and a few in the back. It is an ongoing project. Every year, we try to get some more money to put more rocks.

The "ongoing project" and efforts to fund the breakwaters likewise frame Rose's mixed response of the breakwater systems:

In some areas of the island, they have put breakwaters to break the wave action. If we have a hurricane coming in from the bayside of the island, that is not going to do a whole lot of good. The rock jetties on the bayside are not nearly high enough. The ones on the Gulf side, are much taller, and it will break the water action to some degree, depending on the severity of the storm. If you are talking about a [category] 1 or a 2, it will probably keep most of the water out. If you are talking anything above a [category] 2, no.

Rose's point on the severity of the storm is important for determining how much the breakwaters will impede future flooding. As discussed, the main purposes of the systems are to strengthen the shorelines and disrupt wave action. Somewhat like the HPD and the TSPL, the stationary drainage pumps, discussed next, require constant maintenance by the town's workers.

### *Stationary Drainage Pumps*

Interestingly, less than half of the respondents mentioned drainage pumps as a way of handling flooding. This may be due to some of the pumps' automatic settings to remove floodwater. Although, if the TSPL breaches and waves continue to flood in, the pumps may not be able to keep up or the equipment may succumb to technical issues. Respondents who mentioned the pumps felt mixed about their overall performance. Initially, Ben, a 55-year-old supervisor, reported a positive assessment of the system's performance, but later in the interview, he brought up a mixed assessment:

When all the rainwater [floods the back of the island], the pumps kick on automatically and pump out into the bay. The town makes sure that nobody floods out the best they can. Just for rain anyhow. Sometimes, the town has to call a rental company to rent more pumps because we need bigger motors and bigger pumps. If the town can ever get the money [for bigger pumps], I would sleep better at night. When we lost all our pumps for Katrina, FEMA replaced what we had. There were five pumps on Grand Isle that pumped twice as much water than any other pump, eighteen thousand gallons a minute. Now, the [stations] pump less water, but it gets us out of a bind.





Image 9: Electric drainage pump (left) and diesel pump (right) at the bayside of Grand Isle, Louisiana. Each pump works to pump floodwaters away from the community and over the tidal surge protection levee during storms and other events. Source: Miller, Lauren 2018.



Image 10: A second pump on the tidal surge protection levee pumps floodwaters from the canal over the levee and back into the bay. Source: Miller, Lauren 2018.



Image 11: Drainage canal (left), tidal surge protection levee (center), and drainage pumps (right). Source: Miller, Lauren 2018.

The stationary drainage pumps on Grand Isle are necessary for removing rain water or flood waters near homes and businesses behind the HPD or near the TSPL, but Rose feels uncertain about the pump stations' performance:

One of the main ditches or small canals that drains the water from the front to the back runs past our property, and every time there is an overflow, it is on our property. They have repaired the pumping stations, and it is supposed to be in a position where it maintains its integrity. I am hoping that is true.

Overall, respondents' comments regarding the structural measures implemented by the United States Army Corps of Engineers and the town of Grand Isle appear mixed. This may strongly be due to current geographical gaps. For example, the tidal surge protection levee only runs along the center of the island to reduce bayside flooding, while a section of the western Gulf side of the island is not protected by breakwater systems, causing the hurricane protection dune to erode more frequently. Nonetheless, it appears that all of these structural interventions aim to prevent flooding and mitigate other environmental hazards like abnormal tides, storm winds, and



shoreline erosion, whether or not they are successful in doing so. Moreover, findings reveal that in some cases, one structure depends on another, such as the combination of the levees and the drainage pumps, which appear to make a significant difference in flood impacts to different areas of Grand Isle.

### **Non-structural Measures**

In this section, I discuss the non-structural measures implemented on Grand Isle at the household, community, state, and federal level to help reduce flood loss and mitigate environmental risks. Non-structural measures involve state and federal programmatic measures which trickle down to community level interventions like flood insurance and homeowner's insurance, building codes, land use planning and environmental regulations, evacuation plans, and requirements to elevate homes. Individual or household non-structural measures include flood proofing.

#### *Flood Insurance*

Nearly every respondent mentioned flood insurance for mitigating losses and damage, but only some of them had flood insurance coverage at the time of the interview. Flood insurance is required for residents that do not own their home outright. For example, Mason, born and raised on the island, explained the risk of his home flooding even though it is elevated. He also mentioned the stagnation in home development on Grand Isle.

I have flood [insurance], yes. If the flood gets to sixteen feet, I'm just giving [the flood insurance company] my money, but you have to have flood [insurance]. As far as the rest of the insurance [goes], it's too much money. That's why people cannot build over here.

Mason's comment explains the risks with flooding, even with insurance coverage. Certainly, not having flood insurance coverage for homes or businesses is risky, but less than half of the

residents I spoke with insure the homes they own outright. When asked about having a flood insurance plan, William answered,

Nope. I used to have [flood insurance]. I paid everything off. I built a new house, and my flood insurance and all got too high, so I went ahead and pulled money out of my bank account and paid [the mortgage] off. Instead of [paying] my monthly flood insurance and all, [which was] higher than my house note for ten years, I went ahead and paid my house off. My house is fifteen feet above sea level. Why would I need flood insurance? Now, if I got a twenty-foot tidal wave, yeah, I will have flooding, but I do not believe that is going to happen.

Flooding depends on the home's height above sea level, whether or not it has living quarters below, and of course, the weather event. The decision to not carry flood insurance seems risky, even for an elevated home, but it has enabled some interview respondents to continue to afford to live on Grand Isle. It is important to mention that after residents elevate their home, flood insurance rates tend to decrease because flooding is less likely. The combination of economic and environmental vulnerability is clear here.

### *Homeowner's Insurance*

In addition to flood insurance, residents pay for homeowners' insurance to cover damage from windstorms, fire, lightning, and hail. All of the participants who elevated their homes to new standards were surprised by the significant increase in their homeowners' insurance rates following elevation. Almost all of them mentioned how expensive homeowners insurance is in general, while less than half noted having no homeowners insurance. Significant increases in homeowners' insurance rates have influenced some of the participants' decisions to pay off their home mortgage. From what I was told, the increase in rates result from being more exposed to coastal winds. Rose, a resident who raised two children on the island, explained insurance coverage from a socio-economic perspective:

People who can self-insure are buying [property], so you're getting a different class of ownership. Those relying on flood insurance or wind insurance are leaving. Not only that,

most of the jobs now are off the island. So, between not having work on the island and not being able to afford to live on the island, our young people are leaving. People who raised their homes about fourteen feet up, their flood insurance went down, but their wind insurance went up because they were more exposed to the wind than before.

By self-insuring, residents assume the risks themselves. For instance, Ben explained his home insurance coverage before and after Katrina:

Before Katrina, I was paying \$3,000 a year for insurance. I paid [off] my home but lost it for Katrina, [so I brought in another house] and the insurance agency went up to \$13,500 a year. I cancelled because I owned the [newer] home. I cannot afford the insurance, and I have two jobs. I have to take that chance. This is what I do, that \$3,000 I was paying every year, I am going to put it in special savings. If something happens, I will take that money out and rebuild my home. That is what I have been doing since [I cancelled coverage].

Because homeowner's insurance has become unaffordable for some residents, self-insurance becomes their next option. Noah, a local board member on Grand Isle, mentioned recent insurance decisions on the island as well:

If people don't have a mortgage, it's not worth paying insurance. It's a gamble because within three years, whatever you pay for insurance, you could have repaired any damage. You know what it costs to redo your walls, your downstairs...and you just sort of say, 'To hell with it. I'll just take the chance.' It's cheaper not to have the insurance and just do your own repairs. I wouldn't have insurance if I didn't have a mortgage on my house, no way. Not at \$8,000 a year.

Having home owners' insurance may cover some damage costs, but out of pocket expenses depend on the severity of damage as well as the level of coverage, if any. Homes built closer to sea level are also more vulnerable to flooding, while raised homes are more vulnerable to wind damage. Decisions not to elevate to new standards may emerge from the lack of affordability of homeowner's insurance coverage and may subsequently influence plans to stay on the island. Along with new elevation standards set by the Federal Emergency Management Agency and issued by Grand Isle's certified building officials, contemporary building codes have been adopted for homes that were rebuilt after Katrina and for any new developments occurring today.

### *Contemporary Building Codes*

Half of the respondents mentioned building codes as non-structural measures to reduce flood risks. When asked about community-based plans that help with flooding or flood preparation Justin, a resident whose adult children have moved away, stated:

Well, [if residents want to] have the [allowed] ten-by-ten shed built, it has to have break away walls. [The town building inspectors] do not want you to nail anything to the pilings.<sup>11</sup> Our town inspectors come in and tell people what they need before they start building, and then they will come back and inspect your home maybe a year later. Being honest with you, if another major storm comes in, the [building] regulations will get tougher.



Image 12: Elevated home with storage shed built behind the hurricane protection dune and several pilings supporting the foundation. Source: Miller, Lauren 2018.

---

<sup>11</sup> Pilings or posts are what several home foundations are elevated on in Grand Isle to withstand the impacts of hazards.

After losing her home and business to Hurricane Katrina in 2005, Kathy, a 50-year-old clerk, is in the planning process for building a new home on Grand Isle. When asked what she thought about the new building code process, she replied:

I have the house plans. I never started the permitting [process] yet, but your house plans have to [be] approve[d] and be according to code. [The new regulations] to build a house are more than double the cost. I cannot wait to build a home, but I am scared to build it. I tend to not want to build because I think that [some] year, it could be gone. I never thought that way before Katrina.

Since the mid-twentieth century, building codes adopted by the town of Grand Isle have changed several times, especially after major hurricanes like Betsy and Katrina. The new building code objectives attempt to mitigate flood losses and other environmental impacts to homes and businesses, but are expensive for returning residents to adopt. In addition, the codes may influence decisions for new development on the island, which influences Grand Isle's local economy, the natural environment, and the way flooding and drainage occurs. Since Hurricane Katrina, government officials have more strictly enforced land use and environmental regulations, and many residents brought up the sense of being judged for rebuilding here afterwards.

### *Contemporary Land Use Planning and Environmental Regulations*

Less than half of the interviewees mentioned land use permitting and regulations as a new non-structural strategy to reduce the impacts of flood risks and coastal hazards. Ava, a 62-year-old town official, explained her views on what it is like for residents to work with government agencies in charge of such regulations:

Ava: What makes it complicated with the agencies is [our need] to mitigate properties. Now, since the island is so popular, people are trying to buy the backwaters and the marshes, and it costs a good bit of money to mitigate or do anything with the property that you own. One of the problems with the agencies is that they look to see if there is a certain kind of grass or snail or whatever. [The agencies either] say, 'No, you can't do that or you're going to pay through the nose to do that.'

Interviewer: What kind of mitigations do people try to do?

Ava: On one particular lane, a man bought a marsh area, and he put some fill onto it to park an RV, put in a power pole, and a culvert. A couple of years later, the Corps came through, and he received \$47,000 dollars in fines, not counting the payment for the mitigation. Now, the town warns anybody who buys a piece of property and wants to build on it. They have to go through the Corps first who decides if the property is considered wetlands or not, then the process goes through agencies like the EPA, the Department of Natural Resources, all that stuff. *Then* the town can give the permits to do a mitigation if those agencies approve.

Ben, a local supervisor and owner of two businesses on Grand Isle, who has an elevated home on the bayside of the island, explained a new development permitted recently and how it has changed the chances that the downstairs area underneath his home will flood.

We had two developers that developed property, which is Queen Bess and Tropical Landing. Up until that [point in time], I was good; I was not flooding here. They got permits with the Corps, dug out, built big beautiful homes, and started selling property. By digging out all the marshland and building up their property by the levee system...this part of the levee [in front of my home] is the weak link now, and it is starting to sink. I flooded six times last year in my downstairs lounge.

Eager developers may be negatively impacting neighboring properties and their vulnerability to flooding. Both the USACE and the Environmental Protection Agency (EPA) issue building permits and enforce environmental regulations to deter harmful environment impacts. It seems that the problem is that the regulations and/or permitting system isn't working correctly, which is causing negative impacts for longer-term residents. In addition, residents who talked about non-structural programmatic changes appeared to be frustrated with obtaining permission to attempt to mitigate flooding on their property. As with the building codes, land use regulations have become stricter since Hurricane Katrina. It seems that at this point, both residents and town officials want to put in place flood mitigation projects without permitting review to feel more protected.

### *Rebuilding with or without Government Assistance*

The majority of respondents mentioned rebuilding their homes differently as a way to reduce flood risks. For example, Ethan, a 63-year-old resident whose home is now seventeen feet above sea level, explained how the town of Grand Isle has rebuilt even after the most devastating hurricanes, Betsy and Katrina.

It was 1965; I was eleven years old. I remember it like today. Betsy devastated the island. It tore the island apart. As soon as [the residents] came back after the weather passed, the residents [continued to] live off the land, and they all worked together and helped each other rebuild. They did not get any help from the government and FEMA and all that. Even today, like with Katrina, a lot of people came back to Grand Isle and put their things in order. FEMA did come. Some residents came back, and they worked hard, cleaned up, and fixed what they once had.

In the past, some people rebuilt without government help, especially if they did not have private insurance coverage. Rather than relying on government help, Rose instead relied on a religious organization to help her recover after Hurricane Katrina; she explained her experience with evacuating for Katrina and the stressful process of rebuilding afterwards:

A church group came down and helped me tear down the walls. You take [the recovery process] one day at a time. You do not look back, and you do not look forward because it is too overwhelming, and so you just do what you have to do that day. Because if you look at the whole thing, you just become immobilized and you know, being that it was on my shoulders, I could not afford that luxury. Our memories are all positive except for these kinds of issues with the weather and having to bounce back.

Veronica, an unmarried office clerk, described her life on the coast of Louisiana and how residents on the island maintain strength and resiliency during and after storms:

With some people, bad weather or storms make them panic, but when you go through so many things like that, it just becomes a way of life. I think a lot of people that live here on Grand Isle will tell you that. We rebuild [after storms]; whether the money comes from the government or not, we start rebuilding. If it comes, it comes. Grand Isle people are resilient, and they know how to survive. The rebuilding process starts right after a storm. The day people are able to come back, they start their clean-up process and whatever; they fix what they need to fix. If they get the money from their insurance or the government, great. If not, it needs to be fixed one way or the other.

After Hurricane Katrina, some islanders took new approaches to reduce flood loss by elevating their home or businesses, using stronger building materials, or saving money for repairs from flood damage and other environmental risks. For example, Justin, a local official, explained what he has done to protect his home from coastal hazards:

My dad and I, we built our own homes. We have one inch walls inside. We were raised here, you know? We went way above engineering. We went extra strong because it was our home; it's not a camp. We're vulnerable. We know when the weather's coming, and I never lost my roof. We have extra strong plywood, and we have extra walls.

Residents rebuild their homes on Grand Isle through grant processes, insurance plans, or with help from religious or national government organizations. But many also recover independently or with help from neighbors in the community after the storm.

#### *Community Evacuation Warnings*

Over half of the interview respondents mentioned community evacuation plans as a way to mitigate their exposure to flooding and other environmental risks. When talking about preparation for storms, Ben mentioned the community's routine for voluntary and mandatory evacuations:

If a storm is in the Gulf of Mexico, the mayor will call the volunteer evacuation. The town officials will go street to street to start telling everybody that it's a volunteer [evacuation], but now, it's done on Facebook too. Before mandatory evacuations, town officials get on conference calls with the federal government and other entities, towns and parishes, and states. Everyone is in on the conference call because if the hurricane comes into the Gulf, everybody is going to be affected by it one way or another. They talk about the storm and the predicaments like the tidal surges and [the amount] of rainfall.

Hank, a 67-year-old home maintenance employee, briefly mentioned community evacuation plans that prompt residents of Grand Isle to make decisions:

You get your ass out of here. [The town officials] just tell you that it is time to go. They will give you a notice, and they will help the old people, but other than that, you are on your own.



Another respondent, Ronald, a 70-year-old business owner, mentioned specific steps that that town takes for mandatory evacuations as well as childhood memories of not evacuating for Hurricane Audrey in 1957 and Hurricane Flossy in 1965.

When I was a kid, I remember we would walk from my house to the Coast Guard Station. Everybody would migrate there if they had low-lying homes because [the station] was a strong building. I remember walking knee deep [through the water] a couple times to the station. We knew a hurricane was coming. We would stay there for one or two nights, then we would go back home and start fixing things. Now, everybody has evacuations plans on Grand Isle. About a week before we know that the hurricane is going to impact [the island], the town [officials] asks people and tourists to come to Grand Isle to get their boats and house trailers.

When serious weather conditions are forecasted to affect Grand Isle, especially tropical storms and hurricanes, community officials issue evacuation notices. This is done door-to-door, via Facebook, and through local and national weather stations. Part-time residents are asked to dock their boats or move their house trailers off the island as well. Evacuation notices are a way for emergency officials to save lives. Whether voluntary or mandatory, notices influence or even confirm participants' decisions to complete efforts to pack, flood proof belongings, and leave the island. However, despite evacuation warnings, Grand Isle has one route for evacuation—LA 1. This is somewhat problematic since the coastal highway becomes congested once other residents from surrounding towns and cities begin evacuating as well.

#### *Individual or Household Evacuation Decisions*

Over half of the residents discussed individual or family evacuation plans during the interviews. Justin, a 62-year-old local official, mentioned the large distances residents travel for evacuation shelter:

We live by the waters, and we make a living by the waters, so we get the vehicles and trailer boats out. Residents stay with other families [living] farther away. The majority of people will rent a room fifty to one-hundred miles away. If it is very bad, they have to move further [north]. The problem is, we only have one road in and one road out.

But, some residents may not have the option or ability to leave the island for a major storm because of job responsibilities to mitigate flood damages from hurricanes on the island. For instance, Noah, a local member of the Grand Isle Port, mentioned staying more than once, before a hurricane hit the island:

[My job] entails me to hang in here until the very end or not leaving at all. I have only left for two storms, Hurricane Katrina and Hurricane Gustav. I cannot remember how many storms we have actually had. I think it has been like seven major storms that I have gone through [on the island] and quite a few smaller ones. A lot of them run together, and our last couple of big storms were one right after the other, like within ten days. We have had summers here where you might evacuate five or six times in the summertime.

During another interview, Rose, a 73-year-old curator, mentioned her strategy for evacuation preparation:

We watch the news and the federal weather center religiously. Sometimes we set an alarm to wake us up in the middle of the night to catch the latest tracking. You take your family photographs, documents, whatever clothes you think you're going to need for two weeks, anything that's of particular value, but that's all you take because there's just not enough room to take anything else. At the beginning of June, I pack my suitcase, and it stays packed during the entire hurricane season. One year, we evacuated four times that hurricane season and twice within a seven day period.

From what residents described, their evacuation responses depended on factors such as voluntary or mandatory orders from government officials and the availability of other family members to provide shelter in case of evacuation. While residents' decisions to evacuate Grand Isle before a major storm vary, overall, respondents depended on evacuation orders from town officials to confirm their decisions. As participants explained their decision-making processes, four sub-themes emerged throughout our discussions about individual or family decisions to evacuate: (1) residents who leave right away, (2) residents who leave after storm surveillance, (3) residents who leave last minute, (4) residents who stay for the weather event. Some folks proactively planned for evacuation orders by relying on their own judgment about the strength and possible course of the hurricane. Moreover, residents who lived on the island for many years had ideas of

what to expect and how to prepare based on personal experiences. Decisions to elevate homes are also based on personal experiences.

### *Home Elevation Post-Katrina*

The majority of the participants mentioned increasing the elevation of their home's foundation as a strategy to mitigate flooding, yet a little more than half of them elevated to meet the new elevation standards after Hurricane Katrina. Bernie, a recreation guide who lives at the center of Grand Isle's bayside, described what it was like to rebuild and lift her home after Hurricane Katrina:

Our house is over one hundred years old. After Katrina, when I saw my house, I just wanted to burn it and start anew. I never really witnessed that much mud, disgust, and displacement. We rebuilt from the same structure. Raising my house took thirty-three days because someone put our pilings in wrong. I was so used to being on the ground for thirty years. I remember it just looked ridiculous to see it that high!



Image 13: Elevated home built behind the hurricane protection dune and overlooking the Gulf of Mexico. Source: Miller, Lauren 2018.

Ronald, another resident living at the center of Grand Isle's bayside, referred to what he has done to protect himself, his home, and his two businesses from flooding:

I am lifting up my house now. The federal government came and helped a lot of people lift up their homes. So, right now, they are lifting my house up to the fifteen foot specifications that they came up with. As far as my businesses, I guess I really did not do that much to them. I lifted one business four feet off the ground. That helped a great deal. My businesses near the beach do not flood as much as we do in the back. My other business is a couple feet off the ground. Katrina [came from the Gulf] and brought about two feet or more floodwater in[to] each of my businesses.

Another resident William, who has lived on Grand Isle since he graduated high school almost forty years ago, disagreed with the town's elevation standards. During our conversation about rebuilding and home elevation, he mentioned:

The [changes] went from minimal to extreme. My property is on the high side. It's four feet above sea level, which is very good in Grand Isle. My house is now fifteen feet above sea level. The thing with the town's building department is that they think [the elevation height is] supposed to be eleven feet above ground. I disagree. It is supposed to be eleven feet above sea level. You are better off lower to the ground than up in the air. The higher up you go, the more wind you get.

When elevating their home, residents must meet certain standards with the base flood elevation (BFE) issued by FEMA, whose flood insurance maps designate the elevation standards for each property's flood hazard levels. In addition, residents on Grand Isle may choose to apply for a grant to elevate their home; the town then requires that residents elevate their house above BFE. Today, homes elevated to meet BFE standards range from eleven to seventeen feet above the ground. Other study participants' homes, elevated using older elevation standards, range from three to nine feet high. Since their homes' foundations survived Katrina and were built before newer BFE standards were issued, they are not required to elevate as high; this means that they are more vulnerable to floodwaters, but less vulnerable to wind.

### *Homes Not Elevated to Code after Katrina*

A smaller number of residents mentioned not elevating their homes after Hurricane Katrina. It is not clear if residents receive fines or punishments for not elevating their homes since none mentioned it; but I did not specifically ask them about it. Rose, who lived and worked on Grand Isle all of her life, explained:

My house is almost two hundred years old and cannot be elevated because it is not one complete foundation, so it would be a very difficult elevation, and the contractors did not want to contend with it. So, when I flood, you have to understand, I am only three feet off the ground.



Image 14: House (left) elevated up to code, next door to house elevated according to the older code (right). Both are behind the hurricane protection dune. Source: Miller, Lauren 2018.

When asked about whether she felt protected from the structural flood barriers on the bayside of the island near her home, Veronica responded:

My house is nine feet in the air and I have a little shed under my house. If my house would ever flood, [the bank] can have it. I do not have flood insurance because if my house floods, I am nine feet up. At least ten feet of water would have to come onto Grand Isle. Not that it is not possible! Plus, I am two or three feet above sea level.

Like Veronica, Oscar has also lived on Grand Isle for multiple decades. His home is located on the western end of the island, which has less protection from hurricanes and storm surge because there are no breakwaters nearby and the TSPL only runs at the center of the island.

Oscar: Fortunately, we are higher than most of the places that are on the bayside of LA 1. We still got water [from Hurricane Katrina].

Interviewer: Have you lifted your home since Katrina?

Oscar: No. It is at the same height. It was at eight feet when I bought it, and I never lifted it since. I could have gotten a grant to get it up to twelve feet, but if I would have done that, we were afraid we would lose the downstairs, and that is our activity room where everything goes on. Now, we cannot afford to carry flood insurance on it anymore. It is almost at \$9,000 for flood insurance [per year], and [the insurance] does not cover the downstairs [area]. Everybody on Grand Isle had so many claims [after Katrina], FEMA said we should not have a downstairs area and just live upstairs.

Home elevation standards have increased after major storms hit the island. Before Hurricane Betsy in 1965, insurance companies required homeowners to elevate at four feet. After Betsy, the elevation ordinance increased to eight feet. Then Hurricane Andrew hit the island in 1992, and another elevation ordinance required homeowners to raise their homes twelve feet above sea level. Today, the elevation standards range from eleven to seventeen feet, depending on the location of the home and the property's height above sea level.

### *Flood Proofing*

Finally, the majority of respondents discussed flood proofing as a way to mitigate potential storm damage. Decisions to begin this mitigation process correlate with evacuation behaviors, so timing and personal judgment about the storm that approaches play a large role in terms of the time residents give themselves to flood-proof their homes and/or businesses and pack belongings. For instance, Oscar mentioned the difficulties posed by limited time to protect his home and belongings from flood damage:

We made the downstairs waterproof to some extent, where water does not have as many damaging effects. If I get two or three feet of water in the downstairs area, the appliances

are gone, everything else is going to be fine. We have polyurethane on all of the furniture, and the only thing we have to do when we know a blow is coming...we just pick up all of the stuff and put it onto a twelve foot [long] table. We have containers that we use to load stuff up like the tools, and we put it in containers and pick it up, put it on top of things. We cannot haul everything upstairs. You do not have enough time. The whole thing is time. If there is a hurricane in the Gulf of Mexico or threatening the Gulf anywhere, we start hauling stuff upstairs.

Time is one of the most crucial resources that residents have during hurricane season. Kathy, a town clerk who owns two businesses, mentioned storing equipment off the island as a way to prevent flood loss from storms:

We keep our shrimping trolls and any extra equipment for my other business at some property north of here. It's a lot of work to lift all the shrimping equipment before a storm, so we kind of wait until the end to decide [to lift it], and sometimes my husband will stay to finish lifting, probably like two hours before the storm will be here. Also, shrimpers [on Grand Isle] have to get their boats out of the bay before the floodgates close so the boats will be in safe waters.

Noah, a 65-year-old resident, lives near the center of the island on the bayside. His home was built in the 1960s which is eight feet above sea level and includes a downstairs living area, which he wishes to keep as a workshop for his hobbies. When asked how he prepares for storms, he said:

My personal preparation is to move the major items that are the costliest to replace or those that I can carry upstairs without too much help. If it is a fast moving storm or quickly developing storm, you are frantically putting stuff together. Usually, you cannot get help because everybody is doing their own thing. Get it upstairs; get it off the island--that is the motto. The biggest problem for me is I have a lot of stuff. Quite often, [the hurricane] is not going to hit us or it is not going to be major flooding, so you kind of wait because it is too much work involved. I wait until the day before it hits, usually, before I start moving stuff.

Flood proofing appeared to be one of the most difficult damage prevention methods due to limited time, mental stress, and physical demands of moving so many things. For instance, residents with local fishing vessels use boat trailers to bring the boats into safe harbor about 30 miles from Grand Isle. Larger commercial fishing vessels as well as oil field vessels must be

boated north through waterways, which can take at least five hours, limiting time for moving other household or business items or helping others. However, half of the respondents were married, so they had another person in the household to help them with the flood proofing process. The other half of the respondents I spoke with said that they sometimes obtained help from people they knew, but that this did not always work out, especially if other people's time is restricted or if they did not live on or near Grand Isle.

All in all, Grand Isle's residents are resilient. They continue to rebuild and protect their homes and businesses on the island, but factors ranging from affordable housing to climate changes may begin to alter the resources necessary for living there.

### **Perceptions of Vulnerability**

This section analyzes the three main types of vulnerability the town of Grand Isle confronts: environmental vulnerability, rural vulnerability, and economic vulnerability. The inhabited barrier island is most environmentally vulnerable to hurricanes, tropical storms, and flooding related to climate change. Rural vulnerability relates to the island's rural and remote location that includes a lack of nearby resources to health care, a sense of being judged for staying, and affordability. Economically, Grand Isle is vulnerable to expensive insurance requirements due to escalating insurance claims after storm damage. Below, I analyze subthemes that relate to these three main vulnerabilities in further detail.

### **Environmental Vulnerability**

#### *Hurricanes and Tropical Storms*

All of the residents mentioned vulnerability to hurricanes or tropical storms, which affect the island either on the Gulf of Mexico side or the bayside. Residents made it clear that impacts



from storms and hurricanes vary by the direction of the storm. Ben, a father of eight, explained life on Grand Isle during hurricane season:

We go through hurricanes and floods year after year. You are on edge when storm season is there and you are going to get hit any day.

Veronica, a resident whose entire family lives on the island, described a season when the town received consecutive hurricanes, which caused her and her family to evacuate more than once:

I remember my mom and I came home after [Hurricane] Gustav, spent the night, and had to leave the next day for [Hurricane] Ike. If you don't leave before high tides start coming in [over the roadway], you're not going anywhere. We were packing up again, and I drove to the west end of the island to check the roadway near the bridge. The water was coming from the Gulf of Mexico and the bay, and it was meeting in the middle. We had to get out of there. You kind of panic when you see waves of water coming from the Gulf and then the tides coming in from the back. So, we finished loading up, and we took off again.



Image 15: Louisiana Highway 1 Bridge crossing Caminada bay at the western end of Grand Isle, Louisiana. Source: Miller, Lauren 2018.

People's feelings of vulnerability to hurricanes and tropical storms on Grand Isle are explicit, especially when they are describing active hurricane seasons which lasts from about June 1st to November 30th each year. The island is not impacted by major hurricanes every season, yet its environmental vulnerability to storms and flooding exists throughout the year. For instance, last winter, southern Louisiana experienced an arctic cold front. This extreme weather event affected Grand Isle and other communities in Louisiana with snowfall and icy bridges, making car travel very dangerous and impossible when the state Department of Transportation and Development (DOTD) closed roadways. Unusual events like this may increase over time, and residents will have to adopt additional behaviors to prepare, respond, and recover from the various impacts.

### *Flooding*

As with hurricanes and tropical storms, all of the respondents mentioned flooding on the island. Flood events are usually inseparable from hurricanes or tropical storms. Flooding may also occur during or after periods of heavy rainfall, and depends on the performance of stationary drainage pumps and the tidal surge protection levee. According to all of the residents I interviewed, flooding happened at the "back" or bayside of Grand Isle most often. Ava provided a personal experience with flooding at her home on the western bayside end of the island:

I cannot isolate a [flood] incident because we have had too many. I live on the western end of the island that is lower [in elevation], so I get water frequently. On [both] ends of the island, the water comes in, the water goes out. In the middle of the island, because the land is higher and because of the levees, when it rains enough, it holds the water [in] so we have to pump the water out. Flooding [also] depends on which side the storm goes [towards], and that influences how the water washes over you.

Residents like Ava who live on the western and eastern ends of the bayside of the island are more vulnerable to flooding from incoming tides or storm surge, especially since the tidal surge protection levee does not extend to protect properties on either ends. Similarly, Hank, a 67-year

old home maintenance worker who lives on the beach side of the island, talked about the normalcy of flooding on Grand Isle:

We've flooded a few times. [It] doesn't bother me. The water comes up, and it goes. With flooding, you just have to deal with it because you cannot really do anything. You just hope and pray that the water does not get as high [as your house above sea level].

Ethan provided a personal experience where his business was not effected by flooding because the property is located on a plot higher in sea level (than other parts of the island) and directly behind the hurricane protection dune:

My business did not get a drop of water in it during Hurricane Katrina. It's on the highest part of the island. Ten or fifteen feet of water came from the bayside, and when it got to my house, it was at eight feet of water, but as you came to the front of the island, water was lower and lower. Now, if Katrina had come from the Gulf side, it would have wiped my business out.

Flood vulnerability on Grand Isle appears to depend on geographic location and the height of the home or business foundation (above sea level). The island consists of various sea level elevations, so some areas are more vulnerable than others. Furthermore, the distance between homes or businesses and the ocean or bay, as well as the flood barriers' performance, affect flood vulnerability. For example, living on the back side of the tidal surge protection levee offers little protection from bay tides and storm surge, especially if homes or businesses are low-lying. Residents understand that flooding from hurricanes or smaller storms is also a given so, they must adapt to these weather events and find ways to be resilient after the loss of infrastructure and temporary displacement each time.

#### *Vulnerability to Loss of Infrastructure and Temporary Displacement*

In the event of flooding and storms, and the related damage to infrastructure and loss of electricity and water for days or weeks, residents may become temporarily displaced. Once basic utilities are up and running again, local officials allow residents to return so they may assess any

damages and begin plans to repair or replace what's been lost. Oscar, a resident who lives on Grand Isle with his wife, discussed place attachment and displacement after Hurricane Katrina destroyed the bridge:

It was about four or five days before [local officials] let us come back. We couldn't drive over the bridge [because Katrina destroyed it]. We had to walk or use a four-wheeler, but it was about a week and a half or maybe two weeks before we could come and work and clean up. My downstairs area had marsh grass and dead animals like snakes, opossums, and raccoons. We had quite a few snakes in that mess, most of them dead. It was a smelly subject, almost knee deep. We had to shovel it all out and almost start from scratch. No damage upstairs whatsoever. You have to love it here in order to live here. After Katrina, a lot of people moved away although they loved it here. They just could not handle the adversity.

Temporary displacement from their homes from damaging impacts to infrastructure is not new to residents on Grand Isle. Flooding and temporary displacement also make islanders vulnerable to looting. Rose put it this way:

When we came back from Katrina, the entire [beachside] levee was covered with picnic tables, refrigerators, ice chests... anything underneath the camps ended up [drifting] onto the levees. If you had something that belonged to you on that levee, I mean you could have had your name on it, the National Guard would not let you get it. They have zero tolerance for [looting]. One of the things the island faces after a hurricane is looting. People come in by boat at night and try to loot the homes that are still standing. They may launch at Lafitte and come in by boat. The Coast Guard and state troopers were out there to stop them because the island is very vulnerable after a storm. So we are vulnerable after the storms as much as we are during the storms.

As our climate continues to change, islanders may become increasingly displaced from their homes throughout the hurricane season, especially if the frequency and strength of hurricanes or storms increase.

One of the last questions I asked residents during the interview was if they thought they would ever leave Grand Isle. The folks I spoke with want to remain living on the island, even if they feel environmentally vulnerable. There is something about the island that outsiders or tourists do not get from visiting, a true love of living on the island.

### *Lack of Willingness to Leave the Island Permanently*

Half of the respondents mentioned never considering leaving Grand Isle permanently. As

Ben put it:

I am not leaving. As long as there is a grain of sand [here]...all of the above [keeps me here]...my friends, I love my job, [you can] fish anywhere you want, [get] fresh seafood daily; all of my family members are here. Living here is paradise. I could not live anywhere else. This is where my family belongs. We enjoy Grand Isle. There's no other place like it.

“All of the above” in Ben’s life seems to frame his determination to face the environmental vulnerabilities on Grand Isle. His sense of belonging is mutual to Oscar’s expressions of permanent settlement here:

Let me put it this way. My wife and I bought our third home here on Grand Isle. It’s a cemetery plot [laughs]. So, if I leave, that’s where they’re going to bury me. Right here. This is home for me, and it’s home for my wife. She’s the one that insisted that we get a tomb built, which we have.

Ronald, whose home was being elevated during the interview, discussed some of his reasons for continuing his full-time residency on Grand Isle.

I don’t think I’ll ever leave Grand Isle. I was born here, and it’s my home. I like not putting up with the hustle of red lights, [and] going to the store or the post office in a minute or two. The only thing you have to worry about is when hurricane season comes. I love Grand Isle. I don’t plan on leaving [laughs]. I know that I’m always going to come back, and I don’t have any plans on moving anywhere else.

Many Grand Islanders do not want to abandon their “home.” A lack of willingness to leave the island permanently is based on their sense of belonging to family and the rural community, despite the environmental vulnerability islanders face. The few respondents that were willing to move away related their willingness to move to the extreme weather events and the constant responsibility to rebuild or recover from hurricane or flood damages.

### *Willingness to Leave the Island Permanently*

Only a few participants felt certain about leaving the island. For instance, Rose explained that her daughters are pressuring her and her husband to migrate:

My husband and I are seriously thinking about leaving. We are being pressured by our two girls to leave. It makes more sense to us to eventually leave the island. It would be a real trauma for my husband to leave the island personally or permanently. My husband was the one that had really dug in and wouldn't even consider it. I realize that we're going to have to move, and I hate the idea of moving. . .

Rose mentioned considerations to migrate because of pressure from her daughters who live out-of-state who are not able to help out when she prepares to evacuate and recovers from hurricanes and flooding. Unlike Rose, who is still considering leaving the island, Veronica, the youngest interviewee at age 42, said that she would willingly leave.

Sometimes I call this my seven-mile long jail or prison [laughs]. I say I would leave it, and I probably would. I'm here because my family is here. I think once my parents are gone, I'll move. Things are so limited here. I don't see myself spending the rest of my life here. I guess I feel like there's just so much more the world has to offer [besides] this little seven-mile-long island. I would probably keep my house here to own my little piece of paradise, but to say that I would live here the rest of my life, I don't think I would.

Ava put an age limit to her continued residency on Grand Isle:

I don't want to be [very] old here. I'm old now, but I don't want to be old old, like when I need the doctor once a week and that kind of stuff. It's too far. The kids are always trying to get me to move. I love it [here]. The sand's in my toes. I figure I have another good twenty or twenty-five years [before I move].

These three respondents seemed sure of leaving the island sometime in the future, but their attachment to the island makes it painful to think about. Interestingly, this small group felt that they would eventually leave the island because of pressure from their adult children and aging in a rural placed with fewer amenities.

### *Mixed Views on Leaving the Island Permanently*

Less than half of the participants had mixed views about leaving the island permanently. After Hurricane Katrina, Kathy and her family lived temporarily with her sister in a town north of Grand Isle. She explained her decision to move back to the island:

As I walked down [my sister's] street, I thought, 'Do I really want to live in a Beaver Cleaver neighborhood like this?' And I came back to Grand Isle, and I had the water and such open space, so I decided not to leave. I don't think [I'll ever leave]. Family is what keeps me here. I do consider leaving, yes, but fifty percent of that is related to storms and flooding I guess. The other fifty percent is the remoteness of everything like Walmart, doctors, schools, everything like that.

Lastly, Mason, one of the oldest residents on Grand Isle who rode out Hurricane Betsy as a young adult stated,

I've been to thirty-six states and five countries. I wouldn't [ex]change any of that for Grand Isle. I've been here all my life. It's my home, and I love Grand Isle...the way of life, everything about this island. I would not [leave] unless I had to [because of storms and hurricanes]. I would not rebuild again. I'm too old for that. I would have to go live somewhere else.

When faced with further flooding and storms, respondents who voiced mixed thoughts regarding migration may eventually leave the island permanently due to a heightened sense of vulnerability. Like with Mason, he strongly prefers to stay unless the storms and hurricanes get to be too much, and he decides not to rebuild for the third time in his life. Islanders admitted their vulnerability to harsh weather, but they also made it clear that other communities in the United States are also vulnerable to weather events and disasters.

### *Accepting their Vulnerability to Storms, Hurricanes, and Flooding*

As full-time residents of Grand Isle, the majority of respondents indicated acceptance of flooding from storms or hurricanes as a way to manage their vulnerability. One widowed resident, Ava, mentioned what brought her to Grand Isle, her "paradise":

I moved here for a reason. I like it. My husband and I used to come here to fish all the time, and we decided that we wanted to stay. That was forty years ago. Having water all around you is the price you pay to live in paradise. You just learn to adapt and live with it.

Bernie's first thoughts of flooding returned to memories of life on the island during her childhood. During the 1960s, her parents helped manage apartment complexes for tourists.

My grandfather rented his rooms for \$12 a night [back then], and it was our way of life. All the years that I grew up [here], every summer, we would have bad rains that would flood our yard and some of the apartments. We were so used to flooding all the time that it was like a natural part of life. We became equipped because we knew we were going to flood at any given time. Really, I mean when I look back now, we would just pick our bedspreads up [during the night] in case it rained. It was a normal occurrence.

Accepting one's vulnerability to the natural environment may not create more insecurities since residents accept their situation and adapt to it as much as possible although, as the environment continues to change, so will residents' capacities to live and survive on Grand Isle.

#### *Climate Change Increases Vulnerability*

Half of the islanders mentioned observing environmental changes on Grand Isle, especially coastal erosion and loss of marshland in the area. Rose explained her environmental observations over the last five decades of living on the island:

The degree of flooding depends on what approach the hurricane takes to the island, and that's one of the [reasons why] marsh erosion is so important. When you came across the bridge, all of the water there was marsh[land] that impeded the approach of hurricanes [coming] from the bay. Also, our beach is washing away, so we're losing protection because it did form a barrier between us and the storm coming in. Our storms are getting much more severe than they used to be. It was really unusual for us to see a Category 3. Now, we're getting fours and we're getting close to fives. We're not getting hit by them, but we're faced with the possibility that we may, in fact, be part of their scenario.

Rose provided a great example of the increasing vulnerability to stronger hurricanes and increased flooding. Ronald, a 70-year-old resident, mentioned seeing surrounding islands eroding since duck hunting and fishing in the area since his twenties,



In the back of Grand Isle, we had some erosion problems, and when I was coming up, we had erosion more and more. I would go duck hunting or fishing, and all of the surrounding islands were kind of ate up, and now it's even worse. There was a lot of land back there, and as it ate up, the bays opened up more and more, so we got bigger and bigger waves that would pound on the island and that would erode these [surrounding] islands a little bit at a time. Also, our storm system looks like it's getting worse and worse...bigger and bigger storms.

Justin mentioned several environmental changes on the island. His comment is similar to the two respondents prior about the increasing intensity of storms, erosion, and flooding.

When I was younger, I learned that the island was eroding. We're [also] subsiding a little bit. So, the environment, the climate's changing, and storms are really getting stronger I find and in the winter too. The storms are more frequent even out of hurricane season. It's getting harder and harder [to adjust].

Interestingly, Justin was the only participant to mention the land subsidence issue, a natural phenomenon for barrier islands, which has a direct impact on flooding as well as the performance of the structural flood barriers. For half of the respondents, the most apparent environmental changes were coastal erosion and loss of marshlands in the area. Environmental impacts occur here, even though the community is isolated from the mainland.

### **Rurality and Isolation Contribute to Vulnerability**

The majority of folks discussed how the rurality of Grand Isle increased their vulnerability. Overall, the major services they felt distanced from were health services and grocery stores. Bernie, a 59-year-old native expressed worry about living far from health centers.

Sometimes I feel bad because we don't have hospitals and doctors [nearby]. As you get older, you have to start going to the doctor more and more, so that's a drawback of being on an island. You have so far to travel. If I'm having a heart attack, I'd still have to [drive] forty-six miles.

A forty-six-mile drive requires over an hour of time. When asked what he liked least about living on Grand Isle, Noah also mentioned an even longer drive to receive proper health services:

Probably the length of time to get to a major store. Sometimes it's a blessing, but sometimes it can be an inconvenience. Another part of the inconvenience is living so far

from health care. I go to Houma or New Orleans for anything so, almost two hours to do anything.

Being rurally vulnerable because of their isolation from health care services is a serious issue that islanders live with, especially in the case of emergencies. Veronica noted her views on the limited resources and high cost of living on Grand Isle:

Well, your resources are kind of limited. Some resources are a little harder to get your hands on. [The] cost of living is higher in a place like this because you're a little further away from civilization than most places.

As residents of Grand Isle age over time, access to health care resources likely will become more important. The folks I interviewed seemed to have accepted driving long distances from the island for forty years or more. Limited access to resources like supermarkets and shopping centers have not overruled the benefits of living in rural community, since half of the interviewees mentioned positive thoughts on not having any red lights, seeing people they recognized in their community, and being able to easily run errands, such as going to the post office or visiting family.

#### *Vulnerability to Disasters Exists Everywhere, Not Just on Grand Isle*

Almost half of the islanders commented on outsiders or the media questioning their decisions to live on the barrier island. Residents' comments came from their sense of being judged for staying, a phenomenon that researchers have found in many rural communities.

Talking about it seemed upset them so I decided not to probe any further after initial comments.

When asking if the floods and storms make her consider leaving Grand Isle, Veronica stated:

Yes, for that [reason], and on the other hand, I would say no because you have to deal with Mother Nature no matter where you go. Some places are just more extreme than others. If you go out west, you're going to deal with earthquakes and wildfires. If you go to the plains, you're going to deal with tornadoes and severe weather. If you go out east or north, you're going to deal with snow, blizzards, and ice. Down south, it's hurricanes and sometimes tornadoes [laughs]. So, you deal with the weather no matter where you go. Mother Nature's there. You cannot hide from Mother Nature.

Vulnerability to extreme weather events made Veronica somewhat more likely to consider leaving Grand Isle, although, she accepted that she will face “Mother Nature” no matter where lives. During our discussion about flooding on the island, Hank also felt the need to accept coastal dangers and risks:

You have to deal with it. That’s all. It’s just like California now, with the forest fires. People always ask why we live over here. I’d rather live here than in California because I know at least I have a chance here. If my place goes, we can put another one, but in California, they lose everything.

Interestingly, even though Frank admits to the risk of rebuilding after a major hurricane event, he felt less vulnerable than other folks in the country. Justin explained widespread vulnerability to natural disaster:

Being born and raised here, people always say, ‘Why do you live here?’ Well, I’ve been through so many hurricanes. In 1965, Betsy hit, wiped us out. I was a young boy. My daddy lost his restaurant and I asked him ‘Why are we living here?’ and he said, ‘It’s material things. I have my family, I’m thirty-seven years old, and we’re going to go back because we make a living in this area.’ There are disasters all over, but [it] looks like we’re always being picked on because we’re along the waters. Don’t listen to the media that’s questioning why we live here.

Again, participants made clear their vulnerability to coastal risks and hazards, but remarked on the vulnerability of other areas in the United States to defer criticism or doubt from outsiders.

*Perceptions that the Government Is More Concerned with Protecting New Orleans than Protecting Grand Isle*

A couple of residents mentioned Grand Isle’s importance as a barrier island for the region but felt that federal government ignored Grand Isle’s needs for the sake of urban areas like New Orleans. This is a common phenomenon in the literature on rural communities. For instance, Rose, a 73-year-old resident living on the bayside of the island, stated:

Quite honestly, Louisiana and the United States needs Grand Isle because if it were not for Grand Isle, there would not be a New Orleans. There is nothing between the metropolitan area and us. We act as a buffer for the metropolitan area, and somebody

needs to realize that soon. Without us, New Orleans would be in deep trouble more so than they are right now. My husband and I feel [like] we're going to lose [the island] one of these days and have resigned ourselves to that because we don't see anybody really concerning themselves in the long term.

Indeed, Grand Isle's geology serves to protect mainland, especially New Orleans, from hurricanes and storms. It is also the only barrier island in Louisiana that provides both wildlife habitats and settlements for people.

Justin, a lifelong Grand Isle resident, noted the importance of Grand Isle for protecting the New Orleans metropolitan area:

We are on the frontline. I can take you on a boat from here to New Orleans in thirty minutes, twelve minutes in a helicopter. It's like we're the forgotten soldiers on the front line.

The perceptions of feeling forgotten or less important than New Orleans relates to the following theme of residents' perceptions of being disregarded by the USACE. Although the barrier island helps buffer storm surges and other extreme weather impacts on New Orleans, residents felt less protected by the federal government than they imagine New Orleans to be.

### **Economic Vulnerability**

Like rural vulnerability, economic vulnerability depends on the natural resources and occupations available to residents in the area. Grand Isle's major economic industries are seafood, oil, gas, and tourism. Most people depend on these industries for their livelihood. To the extent that these industries are becoming more vulnerable to climate change, the economic vulnerability of Grand Isle residents will increase.

#### *Seafood and Oil and Gas Industries*

Ava explained raising children on the island with intention that they would have to move away and find work off island. As she put it,

I raised my kids to leave [Grand Isle]. Right now, with the [way] the oil field and the shrimping and fishing [is], it's not a good place for a young couple at the moment. You either work at school, the local grocery store or town hall. There are not many options because fishing is having such a hard time and the oil industry is bottoming out right now, so yeah, [young people] have to leave [to find jobs]. The prices of seafood are going up, the fishermen get paid little, the price of oil is high [raising costs to fishermen], and they have to really catch [enough seafood] to be able to [continue].



Image 16: Shrimp boats docked in the Caminada bay during sunset in Grand Isle, Louisiana. Source: Miller, Lauren 2018.

Mason explained how some people originally moved to the island to work with the oil and gas companies but later found themselves economically vulnerable as the industry declined over the past decades.

People moved down here [to] work for oil companies, but now the oil companies are gone! I think they're coming back. It looks like that new president...if they don't kill him or if they don't put him in the nuthouse, he's going to open all that out in the Gulf. He's already taken all of the regulations off, so now they can go out there like the old days [the fifties and sixties]. Build them rigs, pump that oil.

Interestingly, while expanding the oil and gas industries may improve the employment situation for some on Grand Isle, it may simultaneously increase Grand Isle's environmental vulnerability

as infrastructure for transporting oil and gas has negatively impacted the island's surrounding wetlands. Since prices for oil and gas fluctuate, oil field employment is inconsistent. Moreover, since the oil and gas industries cause pollution, they harm seafood and even tourism industries that many other residents depend on. One serious example is the British Petroleum Oil Spill in 2010.

### *BP Oil Spill*

When talking about the 2017 shrimping season, Ben mentioned the BP oil spill in tandem with negative shrimp and oyster harvests,

The beginning of May season is your top crop for brown shrimp. August is your white shrimp season. This year has not been good at all for either shrimp type. A lot of it is from the BP spill...the crabs, oysters, and shrimp [were affected]. My brother-in-law is a fourth-generation oyster fisherman. He hasn't fished for oysters in over three years. The oysters never grew back. It's never going to come back. My brother-in-law bought limestone, oyster shells, tried replanting, until one day, he was out using the oyster dredge because he wanted to replant and he picked up gunk and goo. It's still on the bottom. BP put a hurting on us.

When discussing the environmental and economic vulnerabilities Grand Isle has faced, Rose mentioned the 2010 BP oil spill as well:

I think our one-two punch was between Hurricane Katrina and the BP episode. I kind of think that the island has taken about as much as it can take. We've come back, but it's by the hardest. This business with BP...we've had a lot more sickness on the island than before and a lot of strange cancers and situations. You know, they settled with New Orleans and everybody up there, but Grand Isle kind of got shuffled to the side again.

The BP Oil Spill was an environmental disaster that Grand Isle and other coastal communities in the United States experienced directly. Its disastrous effects still impact Grand Isle's employment opportunities within the seafood and tourism industries and the health of town residents.

Grand Isle remains vulnerable to other human-made environmental disasters that may

impact its economy and its residents' livelihoods since the Gulf of Mexico has countless numbers of deep-water rigs and oil and gas pipelines traveling in all directions.

### *Tourism Industry*

As with the seafood industry, tourism is a seasonal industry which makes earning a living on rural Grand Isle more difficult. Veronica explained the island's three major industries this way:

The oil field was probably Grand Isle's number one industry here, and now it's tourists and seafood. We depend a lot on the tourists, and we depend a lot on the seafood industry, and I think if it wasn't for those two things, people wouldn't be able to live here. If you talk to any business person on Grand Isle, they will tell you, 'If you don't make it in the summertime, you just soon shut your doors and pack it in. You're not going to survive here in the winter time unless you have a steady job.' If you own a business here, it's seasonal.

Tourism also depends on the condition of Grand Isle's natural environment and, of course, the weather conditions. Ben expressed excitement when discussing the tourism season on the island:

The summer months are gorgeous, and it's really like a paradise. Really! That is why summer homes are here. People love Grand Isle. It is packed here in the summer months! In the winter months...over a thousand residents...summer months...it's four times the amount of residents, and during the Tarpon Rodeo...put another 8,000 people.

But, islanders are economically vulnerable during the peak of the summer tourism season because hurricane season begins in June. Rose provided a thoughtful prediction of the island's future with tourism:

I think we're going to end up much like Aspen and some of the other tourist centers where you don't have locals [that are] native to the area. They're [workers are] going to be living someplace else and coming in to work. We didn't have nearly as many camp owners as we have now. We call them 'camps;' they are [really] vacation homes.

The different types of vulnerabilities on Grand Isle—environmental, rural, and economic—impact islanders day after day, yet islanders continue to live here and survive the adversities. Environmental events like hurricanes and flooding may occur throughout the year, but residents learn to adopt practices to mitigate damages and accept the losses. Rural vulnerability to

isolation from health care services and feeling less protected by the government worries some folks. In terms of economic vulnerability, the area's natural resource industries interconnect and depend on one another, affecting rural livelihoods in complex ways. It is interesting to think about how the three types of vulnerability will continue to affect Grand Isle residents in the future and whether or not the island will reorient towards tourism and away from other industries.

## **Citizen and Government Conflicts Regarding Roles and Interests with Flood Risk**

### **Management Decisions**

During our interviews, residents revealed two themes and one related subtheme regarding responses or prevention efforts to flooding: (1) the difficulty in obtaining permits from several government agencies, (2) feeling that the Army Corps of Engineers did not hear their concerns, and (3) local recommendations for flood protection are not being included. Below I discuss the main conflicts that respondents mentioned regarding their severe weather responses and prevention efforts.

#### *Difficulty in Acquiring Permits from Relevant Government Agencies*

Several residents commented on the difficult permitting process which involve various government agency regulations. For instance Ben, a local official who works closely with permit applications, described what the process is like for street development on Grand Isle:

Our biggest fight is [with] the Corps of Engineers for permitting. The second biggest fight is with the environmentalists and the environmental impact [assessments]. If [the project] can impact an oyster, crab, [or] fish by raising a levee or putting rocks [out into open waters], it is a constant battle. The [agencies] would rather protect the [plants and animals] than protect human lives or our property. There are some streets that need to be developed right now...if it has black mangroves growing next to it, [the agencies] are going to come out and do an environmental study. It takes forever...it's just not right.



Justin, another town official, also mentioned having to acquire permits for flood mitigation on behalf of the town. He provided his experience with obtain permits to build drainage on the bayside of the island:

We have to fight the government, the state, and the eleven agencies that represent the whole environment. Look, I am for protecting the birds and the environment, but when it comes to flooding and protecting homes...I do not mean from major hurricanes, I know we are vulnerable to storms. Like to dig a ditch, you have to go through the Department of Natural Resources, the state, the environmentalists or the Corps to get permits. We are only here for a little while. We are tired of applying for permits and [getting denied].

Grand Isle is home to people as well as protected species that live in the nearby wetland habitats. Participants like Justin agree that these organisms need protection too, but development projects, drainage work, and flood protection are three of the town's main priorities. All of these respondents are reporting anthropocentric views (to protect human interests) rather than the broader biocentric views associated with environmental preservation. A few residents claimed that projects which the town levee board or public works office tries to obtain permits for are needed right away, but the application and review process can sometimes take a few years. Wetland habitats are sensitive to coastal erosion, salt-water intrusion, and mitigation projects, hence the environmental regulations set by federal and local agencies may conflict with the time pressure and anthropocentric interests expressed by many residents of Grand Isle.

#### *Perceptions of Not Being Heard by the Army Corps of Engineers*

Many residents mentioned feeling that their views and concerns were unheard or underheard by planners working for the Army Corps of Engineers. Hank, a retired resident, commented on the performance of the hurricane protection dune and the importance of resident input for the USACE:

The [HPD] is good, but [the Corps] cannot figure out [the design]. If [the Corps] doesn't come up with the idea, they are not doing it. They don't want input.

Another respondent, Bernie, who is married with two children now in college, explained a recent repair by the Corps of Engineers:

Before Tropical Storm Cindy hit, [the Corps of Engineers] had to hurry up, come down here, and add all those rocks around the clock near the bridge. They had to stop [the erosion] because [the waves] would have taken out Bridge Side Marina because [the waves eroded] the walkways, the piers going over [the levee], and the water was [as high as the dune]. Now, why did they bring in rocks when we're an emergency situation instead of putting rocks [in] all the while? I'm just an old Cajun woman, but I think a rock is stronger than a grain of sand. I'm not the Corps of Engineers, but they're not doing something right.

Bernie's last comment about being "an old Cajun woman" appears to represent the lack of communication and understanding with USACE plans to protect the island.

*Local recommendations for structural measures against coastal hazards need to be included*

The majority of respondents made suggestions to protect the island or mitigate environmental risks endangering human interests. The majority of participants also felt that their suggestions are ignored by the USACE or town planners. Kathy, a fifty-year-old employee in the town, had this idea to prevent Grand Isle's beach from shrinking:

At the west end of the island, [the USACE recently] had to add a rock levee. I think that's what they should do for the whole island, and I also think they should put another rock jetty out so many miles away so that it builds up the sand [deposits] so that we can still have a beach. We need the beach because Grand Isle is known for its beach.

Kathy's interests involve beach restoration for protection and ensuring the livelihood of islanders working with tourists. William, a resident whose family members have all left Grand Isle, shared his critique of the hurricane protection dune and tidal surge protection levee:

A levee system inland is a different thing than on this island. [If] you're on an island, the best way [to drain the floodwaters] is to let the water come in and let the water go out.

This is no longer the case on Grand Isle since both the beach and the bayside have a flood barrier. Ava, a 62-year-old resident, proposed this recommendation:

I know we need the levees. I would like to have more. If it was up to me and a lot of people here, we'd put a levee around the whole island about fifteen feet [high]...with the Corps of Engineers and the wetlands [near the bay], it really makes it tough [to do projects].

Overall, conflicts between citizens and government agencies regarding severe weather responses and prevention efforts on Grand Isle are different than most other places in Louisiana. The island's fragile geological features require acquiring permits from government agencies and expensive citations for mitigations that did not gain government approval ahead of time. Grand Isle residents also feel that their ideas about flood protection and mitigation are not really considered by the United States Army Corps of Engineers. Lastly, the respondents mentioned several recommendations regarding projects that would make them feel further protected. It is surprising that the Army Corps of Engineers does not listen to the locals that live on the island when they are the ones being affected by flooding, hurricanes, etc. Furthermore, government agencies have responsibilities to consider human interests and other living species in the natural environment. Locals' experiences must be valued and taken seriously. However, I do not necessarily believe that these conflicts are impeding overall severe storm mitigation efforts. I believe they reflect environmental regulations, the changing effects from climate change, and the residents' limited roles in mitigation decisions that make them feel more vulnerable.

## **CHAPTER 6: ANALYSIS**

This chapter interprets and analyzes my qualitative findings. The basis for this analysis stems from connections and deviations of my findings with the literature. Comparing and contrasting theories and bodies of research I describe in the literature to the results demonstrates the significance of my research questions and the relevance of my results. The six overall themes (below) provide a link for how my research expands on previous work as well as new/original findings. The six themes are (1) structural measures implemented on Grand Isle, (2) non-structural measures implemented on Grand Isle, (3) flood protection measures implemented at various levels, (4) levels of trust in such measures, (5) vulnerability to flooding, hurricanes, climate change, and the perceptions of vulnerability to such hazards, and (6) government and citizen conflicts regarding roles and interests with flood risk management decisions.

Interpretations and analyses of this study's qualitative results support the significance of the questions I initially asked. Additionally, connections to previous sources ultimately guide reflection and importance for research in the risk and vulnerability fields.

### **Structural Measures**

The interviewees mentioned similar structural measures to those listed in the literature. For instance, interviewees mention the hurricane protection dune (HPD) or embankment along the entire beach side (about 8 miles long), the tidal surge protection levee (TSPL) at the center of the bayside, and stationary drainage stations and systems that remove floodwaters after storms or hurricanes. The majority of respondents found that physical and environmental issues occur with the structural measures. Most issues occur with the HPD, which caused the most economic loss; this structural measure also suffered the most damage from wave impact throughout the year and required periodic maintenance to prevent erosion and failure (Sayers et al. 2013). Moreover, a

few residents mentioned how environmental impacts assessments must take place before any extensions to the TSPL or works to drainage systems took place. Although they did not completely support the bureaucracy of environmental protection because of their interests in reducing flood exposure locally, they understood that structural projects can be harmful to the surrounding ecosystems and also affect drainage. Also, respondents found that the structural measures are not able to currently maintain long-term flooding since the HPD required constant repairs, the TSPL required construction or additions, and the drainage stations were sensitive to power outages. Furthermore, several respondents found that the HPD and the TSPL added complexity to coastal flooding on Grand Isle because floodwaters became trapped within the two structures after hurricanes or storms passed; flooding persisted until the drainage stations pumped out waters through human-made canals and manual floodgates situated on the bayside. Overall, physical issues with structural design measures on Grand Isle limited flood protection along with heightened impacts of climate change such as increased flooding and sea level rise (Bradford et al. 2012; McNamee et al. 2014).

Interviewees also mentioned multiple segments of offshore breakwaters or rock jetties set along each side of the island (some missing due to funding) which helped impede coastal erosion and tidal flooding. Although some respondents found that the placements of the breakwaters were inaccurate; they also found that physical issues occurred least with these structural measures. Further research is needed in coastal communities to try to understand better why breakwaters deviated from the literature, but it may be due to their fundamental objective of deterring coastal erosion.

Interviewees wanted to make clear that the direction of the storm or hurricane has a significant role in the degree of flooding on the island. When hurricanes or storms traveled west

of Louisiana, the wind and storm surge moved south from the Gulf of Mexico and impacted the beachside HPD and breakwaters. On the other hand, if the hurricane traveled east of the state, the wind and storm surge moved north and affected the bayside of the island, the TSPL, and the breakwaters. In the case of Hurricane Katrina, which made landfall on the eastern side of the state, residents who lived on the bayside were more impacted by flooding. At the same time, the HPD retained floodwaters that moved towards the Gulf of Mexico plus, drainage pumps were destroyed so it took several weeks to replace the pumps and drain the stagnated floodwaters.

Overall, interviewees disclosed that all of the structural interventions on Grand Isle were necessary to protect the community from flood impacts, but additions and improvements to each measure, especially with the HPD, were essential for residents to feel less exposed to flooding in their community. Comments for structural improvements discussed necessary extensions to the TSPL along the eastern and western bayside to protect residences from high tides, the need for additional breakwater systems on each side of the island to impede tidal waves and slow erosion, especially on the western end of the beach near the HPD, and the need for larger pump stations to remove floodwaters faster and reduce flooding to some extent.

### **Non-structural Measures**

Interviewees mentioned several non-structural measures similar to ones found in the literature including homeowners', wind, hail, and flood insurance, flood-proofing homes and businesses, evacuation plans, building alterations or codes, land-use planning policies for development, weather forecasts or flood and storm warnings, hazard mitigation grants i.e. for home elevation, laws for zoning and building permits, and knowledge sharing (Bradford et al. 2012; Fox-Rogers et al. 2016; Manning-Broome et al. 2015; Sayers et al. 2013). Over half of the participants responses revealed that flood insurance was the least important non-structural

measure since the majority of their homes were above base flood elevation. On the other hand, interviewees found flood proofing and evacuations plans to be the most important non-structural measures to reduce risks; these two measures go hand-in-hand.

Ultimately, adopting certain non-structural measures to increase safety and mitigate flood damage and other environmental risks related to climate change depended on the household's financial status. Residents with enough economic resources (income, retirement, savings, etc.) adapted significantly better to flooding and other coastal risks with non-structural measures such as homeowners' or flood insurance. Having insurance is crucial for minimizing loss from coastal risks and disasters, but not every household in my study could afford coverage. Those who could not self-insure, paid off their home mortgage, and recovered losses on their own. The majority of interviewees mentioned homeowners' insurance as the most expensive non-structural measure, and some felt uncertain about making payments in the future.

Residents also mitigated damage to their homes by flood proofing. If time allowed, residents lifted or brought belongings upstairs, transported vehicles or boats off of the island, and brought in outside equipment to minimize damage to other homes during the weather event. In regards evacuation plans, residents who left found shelter away from the island for several days or weeks, purchased fuel and food, prepared travel supplies, and collected important papers. Some residents stayed with friends or family members who live further north, while others purchased lodging in hotels. Single individuals were more vulnerable to flooding during the evacuation process, especially if it was fast-moving storm, because they had to flood proof and evacuate by themselves.

Interviewees also mentioned non-structural building codes and land-use planning policies for development to reduce flood exposure. First, for new construction, half of the residents

applied for building permits with multiple government agencies (USACE, EPA, DNR, etc.). Second, once federal agencies approved the application, house plans had to be approved by local building officials who worked for the town. Third, about a year after residents built the home, local building officials inspected the house to make sure it was up to code. Last, land-use policies also required that residents acquired permits for mitigation or projects on the property, such as digging a culvert or pouring a concrete slab for parking. If locals did projects without approval from federal to local government agencies, the property owner received expensive fines.

Hazard mitigation grants for home elevation were very popular on Grand Isle. Residents found this non-structural measure very helpful to reduce flood exposure, even those who have not adopted the measure. Home elevation decreased flood risk, but certain heights above sea level left the home more vulnerable to intense winds from storms and hurricanes; this is one reason why the price of such insurance increased.

### **Levels at which Structural and Non-Structural Measures Were Implemented**

Interviewees mentioned several structural measures implemented at various levels laid out in the literature. They mentioned federal and community levels of implementation most frequently. In regards to measures implemented at the federal level, interviewees suggested federal management of structures (e.g., HPD and breakwater systems) by the USACE (Laska et al. 2005) does not entirely flood proof the community successfully. In addition, participants mentioned national agencies like FEMA, which issued insurance policies and federal grant programs for home elevation (Burby 2006; Manning-Broome et al. 2015). Applicants applied for grants to elevate their home with local building officials. Lastly, interviewees highlighted federal assistance with homes that were rebuilt, drainage systems that were repaired, and mandatory evacuation plans.



Interviewees also mentioned non-structural measures mostly at the community level, which involved evacuation warnings, town ordinances, management of the tidal surge protection levee (TSPL) by the local levee district, and friends who helped each other to rebuild after major hurricanes or clean after flood events. As suggested by the literature, many interviewees sought information on potential natural hazards from multiple sources (television, radio, internet, and family or friends), moved furniture upstairs, evacuated, and communicated about flood risk (Dziakle et al. 2013; Kellens et al. 2013; Sayers et al. 2013). Participants also mentioned land-use planning, zoning and building permits, and building alterations/codes put into effect by federal agencies, managed at the community level, and adopted at the household level. In addition, interviewees noted that voluntary and mandatory evacuation notices are first broadcasted through state and federal media, implemented at the community level, and finally adopted at the household level.

In some cases, all of the residents discussed flood proofing and evacuation measures at the community level before they were adopted at the household level. For example, post-hurricane, residents and local officials discussed who needed help with flood proofing or evacuation measures and shared with neighbors and family members what measures they planned as well as their expectations before the storm or flood. Moreover, folks informed each other as to where they would be staying once they evacuated the island. Finally, interviewees mentioned flood proofing and evacuation measures implemented at the household level and that some residents had time to help others who needed assistance.

One finding that deviated from the literature involved federal grant programs for home elevation issued to the state; instead of local contractors, in the case of Grand Isle, state government officials hired federal contractors to elevate residents' homes. The government

probably hired outside contractors and not local ones because they originally funded the elevation program. Interviewees also revealed something unexpected regarding home elevation. Many said that their newly elevated homes, reaching heights between 11 and 17 feet above sea level, sometimes led them to decide to ride out the storm or flood instead of evacuating. I think this is potentially dangerous for residents; this needs further investigation.

Interviewees in my study did not mention local communities adopting non-structural measures from recovery funds managed by the state. Neither did they suggest that state departments were initiating programs to promote homeowner adaptations and preparedness information. Nonetheless, participants did mention state involvement during emergencies regarding conference calls with local and federal officials before evacuation orders were made, as well as state laws and policies for development of streets or homes and mitigation projects. Also, they noted that Jefferson Parish (county) has assisted residents who cannot drive in evacuations, held public hearings on flood protection, provided drainage pumps for the town during emergencies, and supported financial and political repairs to the HPD and TSPL.

### **Level of Trust in Structural and Non-structural Measures and Influences of Trust in Such Measures**

In this study, I also examined trust regarding interviewees' evaluations of how well structural measures provided flood protection on Grand Isle. Overall, interviewees did not completely trust the structural measures because of previous structural failures during or after weather events. For example, in 2017, storm waves from Tropical Storm Cindy eroded the hurricane protection dune on the western end of the island. If the town had taken no action, the western end of the dune would have breached, and nearby homes and businesses would have flooded by the storm's surge. Also, interviewees who felt that the structural measures worked

well felt protected and thus adopted fewer non-structural measures than residents who mentioned several drawbacks with structural measures, who subsequently adopted more non-structural measures. Still, not all of the interviewees had the capacity to adopt some of the non-structural measures. For example, some residents reported not elevating their homes up to code because of significant increases in homeowner insurance rates after elevation because of increased wind exposure. Plus, more than half of the participants got rid of flood insurance after elevating their homes since they reported feeling less exposed to floodwaters. Like in the literature, I found that trust in structural measures caused some residents to avoid implementing non-structural measures, but so were factors like expensive insurance, the age of the home, and interests in keeping downstairs living quarters. Trust in structural measures may decrease as residents continue to observe failures as flooding increases. If this decrease in trust in structural measures does not push residents to further adopt more non-structural measures, the damaging impacts of the next major hurricane may.

The literature also suggested that levels of trust in flood structures influenced citizens' perceptions of future flooding (Terpstra 2011). Interviewees in my study appeared not to completely trust that the HPD, TSPL, drainage systems, and breakwaters would deter flooding because of past observations of structural failure and acceptance of the island's increased vulnerability to flooding, which influenced their views on potential flood impacts in the future. Trust or confidence in the current structural systems in place may increase if additions and improvements to these structures are completed at the federal and community levels.

The literature also found that expectations from neighbors or local leaders motivated residents to adopt non-structural measures, which I found in my study when participants mentioned their responsibilities to watch weather forecasts, evacuate, and flood proof, but not so

much with adopting flood or homeowner's insurance. In addition, the literature suggested that trust in non-structural measures may be altered over time since their effectiveness is difficult to observe until flooding occurs (Shah et al. 2018). The interviewees in this study illustrated this regarding home elevation. Some respondents mentioned that home elevation would be helpful, but many others worried about a large enough storm surge washing over the island that would flood their home, even if the home met the most recent flood standards of between 11 and 17 feet.

Overall, participants had some trust in structural and non-structural measures for flood protection. Experiences with flood exposure and observing the measures in place affect levels of trust also influenced how households chose to mitigate flood loss. Trust in structural and non-structural measures will also change as the severity of flooding and storms increase from climate change. Thus, the majority of participants felt that the integrity of structural measures and the more affordable insurance are important ways to decrease their flood exposure.

### **Vulnerability to Climate Change-related Flooding and Other Environmental Risks**

As discussed above, people in Grand Isle have attempted to mitigate vulnerability to flooding and storms from climate change by taking a variety of structural and non-structural measures which somewhat reduce the susceptibility to damages (Sayers et al. 2013). Even with current structural measures in place, interviewees in this study suggested that the community remains vulnerable to flooding and environmental threats like coastal erosion and intense hurricanes. In addition, non-structural measures remain sensitive to climate change (Smith et al. 2001). For instance, newly elevated homes may be affected by rare storm surges or high winds, which lead to damaging debris hitting residents' homes, even those elevated up to seventeen feet above sea level.

Another area of vulnerability to climate change found in the literature and in my interviews is the loss of marshland. Originally, the issues of significant wetland loss in Louisiana resulted from the historical dredging of wetlands for the development of numerous oil and gas pipelines as well as flood management barriers affecting silt deposits upriver along the Mississippi and away from the traditional delta deposit areas in the Gulf coast. However, degradation of Grand Isle's surrounding wetlands is now worsening from the effects of stronger hurricanes, especially in the back bay area. Both human-made and natural wetland loss causes residences and business to be more vulnerable to the combination of high tides, storm surge, and hurricane damage.

As noted in the background section, Louisiana's vulnerability to flooding originally prompted early colonial settlers to mitigate flood impacts by building levees; it was not until the late 1800s that federal authorities took over the responsibilities of levee building and maintenance for the purposes of water navigation and flood protection (Colten 2017). Human policies and physical control of the lower Mississippi by the United States Army Corps of Engineers and local levee districts still thrive in the culture of flood protection in Louisiana, but in the past several decades, human control over water has prompted coastal restoration efforts that aim to decrease the loss of wetlands along the Louisiana's coast. Wetlands or marshlands are important for reducing flooding and hurricane impacts, but "since 1932, Louisiana has lost approximately 2,000 square miles of land, nearly the size of Delaware" (Roberts 2017).

Dominating nature to control flooding is one of core principles of the USACE; this group is also heavily involved in the restoration projects happening in coastal Louisiana. Grand Isle is a place where we also see the core principle of dominating nature for human interests, but as my interviewees suggest, people on Grand Isle have accepted that their community will never be

completely flood or hurricane proof. Also, since government entities (e.g. FEMA, USACE, the Town of Grand Isle) have strengthened building and environmental regulations, non-structural measures have significantly increased here, demonstrating new behaviors also work with the natural environment instead of exclusively attempting to control the environment.

Temporary displacement from hurricanes will also occur more often as climate change increases the intensity of these weather events. Residents mentioned being temporarily displaced for several days or weeks after a hurricane, so it is crucial for them to have temporary places to live, food and water supplies, savings, and generators for their return home. Beginning to recover or rebuild significantly depends on when the residents can return home, the severity of the weather event, the ability of the local government to recover basic utilities like electricity and running water, and whether the household decides to migrate.

As the literature suggests, people's perceptions of vulnerability depend on their past experiences with flooding and other environmental risks like hurricanes (Collenteur 2015). All of my interviewees mentioned having several experiences with flooding and hurricanes during their time on Grand Isle. Because of this, interviewees seemed to worry less about future floods and storms and feel better prepared to deal with them. Floods and storms have become a "way of life" for islanders, mainly because such events typically happen every year. Ultimately, each interviewee's various experiences with managing the effects of hazards affect their perceptions of vulnerability, especially if they cannot afford coping mechanisms such as insurance or home elevation. For instance, interviewees with flood or homeowners insurance (or both) and elevated homes were less likely to feel threatened by flooding than those who lacked these measures, although my findings deviate from the literature when interviewees mentioned feeling more threatened, but less able to prepare for a major hurricane. For example, all of the interviewees

discussed how Hurricane Katrina in 2005 made them feel more vulnerable to major hurricanes, but only four of them have since protected their homes via standard home elevation and full insurance coverage; the others have dropped flood insurance coverage entirely and/or remained in homes that were elevated to lower, outdated standards. Residents with newly elevated homes mentioned feeling less susceptible to flooding but recognized that storm surges from major hurricanes may still affect them. Since they perceived that their newly elevated homes were still not entirely flood-proof, they continued to pack up their important belongings and evacuate to protect themselves.

The literature also suggests that perceptions of vulnerability depend on people's subjective assessments of "shelter, distance from the projected point of impact, and the structural integrity of safety mechanisms" (Patterson et al. 2010:128). When assessing shelter, interviewees mentioned their home's height above sea level which lowered their chances of flooding but increased the chances of wind damage. Interviewees also assessed their vulnerability to flooding by recognizing their home's distance from the bay or the beach, the distance from the HPD or TSPL, and how well the structural measures such as the TSPL, HPD, and drainage systems work.

In addition to the literature on vulnerability, perceptions depend on how the household or individual assesses hazards and their ability to take preventative, non-structural measures that will reduce their exposure (Fox-Rogers et al. 2016). For example, in my study, some people seemed to accept the risk of flooding, but also felt the need to take individual actions that might mitigate their flood exposure, such as flood proofing, buying insurance, removing downstairs living rooms, and evacuating.

Aspects of vulnerability found in this study but not in the literature include interviewees justifying their continued residency on the island and embracing their environment by accepting that they are vulnerable to climate change-related hurricanes, tropical storms, and flooding. The majority of my interviewees mentioned being questioned or feeling judged for their choice to live in a rural area that is economically and environmentally vulnerable. According to my study, residents often justified their decisions to live on Grand Isle by comparing Grand Island to other disaster-ridden regions of the United States such as California being impacted by wildfires and Oklahoma being vulnerable to tornadoes. Although Grand Isle residents appeared to have a deep understanding of their vulnerability and knew how to deal with the climate-related risks they confront based on their past experiences, they continued to report feeling judged negatively for their choice to live on the remote island. Some interviewees noted criticisms from the members of the mass media, while others mentioned being judged by nonresidents and visitors. Despite recognizing the vulnerable living conditions on the island, ten of my interviewees said they were unwilling to change the course of their life by migrating somewhere else. The four who reported considering migration appeared to factor in the physical changes to their environment increasing over time, such as erosion and the increasing intensity of weather events around them.

Although Grand Islanders face multiple risks from their living environment and climate change, according to my findings, their love for the island is why they stay. All of the interviewees mentioned feeling vulnerable to climate related-flooding and other environmental risks. As their natural environment continues to change, so will residents' preparation for storms. Their skills and knowledge about storms and flooding will have to continuously be adapted to the changing risks and impacts of climate change; ultimately, their coping abilities may become exhausted.



Furthermore, the threshold of tolerance involving environmental vulnerabilities and response or recovery on Grand Isle needs to be considered as the community faces the impacts of climate change. In light of climate change, there is real potential that residents on Grand Isle will become involved in resettlement plans like residents of Isle de Jean Charles in southeastern Louisiana. In 2016, the Department of Housing and Urban Development publicized a federal government grant and resettlement plan for a majority Native American tribe of Biloxi-Chitimacha-Choctaw (Davenport and Robertson 2016). Like the Isle de Jean Charles, Grand Isle' may soon encounter a threshold for climate change-related vulnerability which will mean resettlement for all residents.

### **Conflicts between the Government and Citizens Regarding Roles and Interests with Flood Risk Management Decisions**

As found in the literature and in this study, flood risk management incorporates both engineered and community aspects to reduce an area's flood exposure. However, the roles, interests, views, and decisions regarding flood risks and land use differ between government entities and citizens. For example, in my study interviewees mentioned "fighting" several government agencies to obtain permits for development or flood mitigation. Since the government and its experts seek to analyze flood risks scientifically (Baan and Klijn 2004), they must evaluate the impacts of proposed flood- and storm-mitigation projects beforehand to ensure that they will conserve the environment and avoid worsening flood impacts from development. Meanwhile, citizens reported feeling frustrated with waiting for approval that may sometimes take several years; they prefer rapid action to reduce flooding and other storm impacts and to recover from storms. Local people's interests in community flood protection conflicted to some extent with the interests of national and state government to conserve and restore the

environment in the region; this caused residents to feel more vulnerable to flood risks since the community cannot complete mitigations as soon as possible due to the need for broader environmental review.

A few interviewees in my study reported feeling that the federal government is more concerned with protecting New Orleans than Grand Isle. The disastrous impacts of Hurricane Katrina in the whole region changed interactions between Grand Isle residents and the federal government. Since that storm, the government has implemented stricter land use regulations and new building codes and has begun stricter enforcement of insurance requirements. Even though Grand Isle helps to buffer New Orleans and the state from hurricanes and storm surge, several interviewees mentioned feeling like Grand Isle was a forgotten rural community.

Another finding that the literature mentions is that residents sometimes reported feeling that their opinions regarding flood risks management projects went unheard or under-heard by the government experts, such as officials of the USACE. Interviewees commented that USACE officials failed to listen to their assessments of the hurricane protection dune's performance or design, even though they had witnessed the structure's performance firsthand. My findings suggest a lack of communication between the general public and USACE officials as well as a lack of public understanding regarding the USACE's plans to reduce flooding on Grand Isle. In addition, the majority of interviewees mentioned suggestions on ways to improve existing structural measures put in place by the USACE.

This study's findings reveal a layer of vulnerability for interviewees that stems from federal oversight of the area's environment. Flood risk management decisions are no longer in the direct hands of the local community because federal regulations and environmental protection of the island were strengthened after Hurricane Katrina. For instance, to make

drainage improvements, the Town of Grand Isle must apply for a permit through the United States Army Corps of Engineers. Drainage improvements involve using equipment to "sweep out" a drainage canal after a storm, hurricane, or levee breach leaves behind sediment or debris which obstructs the flow of water to the pumps. According to one public works employee from Grand Isle, approval for drainage permits may take up to three years. Environmental regulations and project assessments are critical for sustaining plant and wildlife habitats that attract migratory birds and other living organisms, but the expanded bureaucratic process this has entailed has caused several residents to feel more vulnerable to flooding and less prepared for future floods. Also, because the federal agencies issue citations and fines those who put in place flood mitigation projects without receiving permits, frustration of locals with the federal agencies is increasing. Lastly, interviewees from Grand Isle wanted to be the priority to the government, which conflicts to some extent with the responsibility of federal and state agencies to protect two completely different type of habitats, human and natural.

All in all, the basis for this analysis stems from connections within the literature as well as deviations with my findings. Comparing my findings with the theories and bodies of research I described in the literature review above reveals the significance of my research questions and necessary steps to understand the findings that deviate. Six overall patterns (below) provide a link for how my research expands on previous work as well as new/original findings. The six overall themes include (1) structural measures implemented on Grand Isle, (2) non-structural measures implemented on Grand Isle, (3) flood protection measures implemented at various levels, (4) levels of trust in such measures, (5) vulnerability to flooding and climate change-related risks and the perceptions of vulnerability to such risks, and (6) government and citizen conflicts regarding roles and interests with flood risk management decisions.

## **CHAPTER 7: CONCLUSION**

This qualitative study of Grand Isle, Louisiana reveals residents' reactions to climate change-related storms and flooding on a barrier island. This qualitative study used fourteen in-depth interviews on residents' perceptions of vulnerability to flooding, hurricanes, and climate change. The findings from this study may be relevant to people and communities, particularly rural ones, in other parts of the United States and the world facing climate change-related storms and flooding.

As discussed earlier, the people or town of Grand Isle mentioned several flood and hurricane interventions to try to mitigate their harmful impacts. The structural measures they implemented include the hurricane protection dune, tidal surge protection levee, breakwaters or rock jetties, and drainage pump stations. The various non-structural measures taken include flood insurance and homeowner's insurance, building codes, land use planning and environmental regulations, evacuation plans, home elevation, and flood proofing. However, the structural and non-structural measures have physical, environmental, economic, and long-term drawbacks which influence residents' level of trust in the efficacy of those measures.

Moreover, their past experiences with flooding and hurricanes influenced interviewees' perceptions of their vulnerability to the increased natural hazards associated with global warming. Most of my interviewees clearly remembered specific belongings they had lost, the types of vehicles that had flooded, as well as their emotions as they returned to the community and rebuilt their homes and/or businesses after earlier storms and floods. The various structural and non-structural measures taken on Grand Isle may not withstand future impacts of global climate change. The stability of these measures may dwindle as extreme weather events continue and stakeholders become unable to maintain these measures physically and financially in the

future. Half of the interviewees anticipate losing their homes or belongings to floods and hurricanes in the future. They also expect structural and non-structural measures to fail given the increased severity of storms and flooding, sea level rise, and shoreline erosion associated with ongoing climate change.

As discussed above, protecting their homes and community remains a priority, despite the increase of government involvement with flood management and regulation of the environment. State and federal government agencies have implemented various regulations and projects to try restore the coast and protect Louisiana from rapid wetland loss to lessen the impacts of future flooding and hurricanes. Government and citizen disagreements on flood risk management in Grand Isle are caused by lack of communication, different views of risk, and different interests in land uses. Disagreements may also occur with restoration projects if a gap in communication and understanding persists. Other coastal areas or barrier islands can look to Louisiana for coastal protection and restoration efforts as a guide for facing the effects of climate change. In addition, decision makers in other coastal or island communities in the United States may want to look at my study for suggestions for possible structural or non-structural measures to take, residents' perceptions of vulnerability to flooding, hurricanes, climate change, and government and citizen disagreements on flood risk management which may prove useful to their own communities.

This thesis has several theoretical points. As the impacts of climate change continue to negatively affect the Town of Grand Isle, government and community support attempting to alleviate environmental vulnerability here likely will diminish. Insurance coverage may become unavailable as residents of Grand Isle continue to file claims after flooding, hurricanes, etc. The impacts from climate change may influence migration patterns for residents, especially those who are aging. These factors will increase out-migration, especially if the elderly residents'

homes are destroyed, and community support or social networks will not survive as residents are forced to migrate. Moreover, residents involved with shrimping and tourism activities may continue to live here if the industries can recover quickly from the impacts of climate change, but potential developments in the petroleum industry, and the associated pollution and environmental destruction, may negatively impact the fishing and tourism industries. As the town's population decreases, so will government concerns for community flood protection strategies. Because various structural and non-structural measures provided by the government and community offer limited protection from the potential effects of climate change related weather events, Grand Isle may eventually become an area used solely for recreation, and year-round residence may come to an end.

Methodologically, my insider/outsider research status contributes significantly to how interviewees were collected. I was able to occupy an insider status during data collection because of my background as a Louisianan. At the same time, I was able to apply an outsider status which allowed residents to thoroughly describe their experiences and perceptions with flooding, hurricane, and climate change to someone who was not a part of their community. This overall status allowed residents to feel comfortable during interviews and allowed some to recommend me to those who would be interested in talking about life on the island.

My study of residents on a barrier island who are on the brink of leaving the island captures an interesting empirical moment. It is unclear that people will be able to remain permanently on Grand Isle considering the uncertainty of the continuation of federal policies and funding that assist with rebuilding, affordable insurance plans, coastal erosion combined with sea level rise and the loss of wetlands, access to natural resource occupations, and overall government support with structural and non-structural projects.

## **Limitations of this Study and Recommendations for Future Researchers**

This thesis is limited in several ways. The main limitation was the small sample size. Having a larger sample size may have enabled me to attain saturation, which would improve the quality of my findings. Moreover, it would have enabled me to explore a broader range of experiences with coastal flooding and environmental risks as well as people's different levels of trust in the structural and non-structural measures. Collecting interviews with government agency workers also would have been helpful for understanding their interpretations of flood risk while also shedding light on their efforts to conserve and restore the environment. In addition, this would have provided a fuller picture of the potential conflicts between officials and residents. Another limitation of my thesis is that I did not include interviews with part-time or seasonal residents, who may have had different perceptions or taken different measures than full-time residents.

In the future, in addition to employing a larger sample size and collecting interviews with government officials and part-time residents, future researchers should ask whether or not interviewees have prepared hurricane survival kits, whether they have family disaster plans, and what their plans are for any pets they must shelter during times of emergency. Each of these non-structural measures requires additional resources before an extreme weather event. It might also be useful for future researchers to include members of younger age groups in the sample. It would be fascinating to know if younger people had the same perspectives on flooding and environmental risks from climate change as their older counterparts.

Future research might also focus more on the nature of the conflict between Grand Isle citizens and government officials. Jefferson Parish (county) has held public hearings for the general public, but participants did not really mention these hearings during interviews. Future

researchers may want to investigate these hearings and focus on government and community leadership, public participation and involvement, and the emergence and possible resolution of political conflict.



## Appendices

### **APPENDIX A: Script for Introducing Study and Explaining Informed Consent**

#### Opening and Informed Consent

The purpose my study is to understand how people of Grand Isle, Louisiana view levees as flood protection measures and what other flood protection and mitigation actions you have taken.

You will be asked to participate in an in-depth interview that will require answering questions related to your familiarity with levees (or other projects) that have been built in Grand Isle, Louisiana. There are minimal risks to you, however answering questions may cause you to think about feelings that may upset you. Your decision to take part in this research study is entirely voluntary, and you may refuse to answer any questions or withdraw from the study at any time without penalty or loss of benefits to which you are normally entitled. Furthermore, you may leave the study for any reason.

Your identity and records will be kept confidential and will not be released without your consent except as required by law. If the results of this study are written in a scientific journal or presented at a scientific meeting, your name will not be used. Your signed consent form will be stored in a cabinet separate from the data. If you have any questions about the research now or during the study, please contact myself at 337-315-1728 or by email at [lauren1.miller@umontana.edu](mailto:lauren1.miller@umontana.edu). If you have questions regarding your rights as a research subject, you may contact the University of Montana Institutional Review Board at 406-243-6672.

May I audio-tape the interview? If necessary, I may jot down detailed notes during our interview instead. Data from this study will be used for an academic research thesis.

## **APPENDIX B: Interview Guide Part A**

1. What has your life on Grand Isle been like for you?
2. What do you like most about living here? Least?
3. How long have you lived here? If moved as an adult, what brought you to Grand Isle?
4. What are your personal experiences with flooding and extreme weather events on Grand Isle?
5. What have you done to protect yourself and your home and business (if any) from flooding, etc.?
6. What has been done in your community to reduce the harms of flooding and other extreme weather events?
7. Tell me about the levee here on Grand Isle.
  - How well do the levees work?
  - Can you give me examples of when it worked well?
  - How well did the levee work during the last big storm/hurricane? Explain.
  - I am here to learn more about the role of the levees in this community. If you were going to explain this to someone who were not familiar with levees, what would you want them to know
  - Has the levee ever not worked very well? Explain.
8. What do you think the benefits of levees are?
  - Why is that?
  - Can you give me an example of that?
  - Any other benefits?
9. What do you think the drawbacks of the levees are?
  - Why is that?
  - Can you give me an example of that?
  - Any other drawbacks?
10. What regulations did you go through to build or rebuild your home?
  - Have any regulations change since you first moved here?
  - Have any of your family or friends moved away because they had trouble with flooding?
11. Besides the levees, are there any other community or government plans that you rely on?
  - What types of government or community plans do you use? Any others?
  - Which plan has been most helpful? How so?
  - Which plan has been least helpful? How so?
  - What insurance plan do you rely on?

- 12.** Besides the levees and the things you mentioned in response to #5, have you and your family done anything else to protect your home and belongings against flood damage (e.g. boat, RV)?
- What all have you done? (generate list and have explain each)
  - Did you take any other measures?
  - Which measure has been most helpful? Discuss why.
  - Which measure has been least helpful? Discuss why.
  - Which was most expensive? Discuss why.
  - Which was least expensive? Discuss why.
- 13.** Now let's talk about your employment. Do you own your own business? If not, skip to #14. If so, have you done anything to protect it or insure it against flood damage?
- What all have you done?
  - Did you take any other measures? (e.g. sand bags, stilts, storm windows, insurance, etc.)
  - Which measure has been most helpful? Discuss why,
  - Which has been least helpful? Discuss why,
  - Which was most expensive? Discuss why,
  - Which was least expensive? Discuss why,
- 14.** Tell me about Tropical Storm Cindy and how you got through that storm.
- What storm protections worked?
  - How about the levee/rock jetties – how did they do?
  - Did that storm make you change your mind about the levee or want higher stilts for house, more flood insurance, etc.? Explain.
- 15.** Do you think you'll ever leave Grand Isle?
- If not, what keeps you here?
  - If so, what makes you consider leaving?
  - Any relation to floods/storms?
  - Any relation to distrust in levee or levee failure?

## **APPENDIX B: Interview Guide Part B**

Thank you for all of your comments. Now I'd like you to answer a few more socioeconomic and demographic questions.

1. What is your date of birth?
2. Where were you born?
3. What is your current marital status?
4. Who do you currently share a household with? (Number, relation to interview subject)
5. Are you employed? If so, what do you currently do for a living?
6. What is your current annual income?
7. Educational attainment?
8. What roles do you have in the Grand Isle community?
9. What types of insurance are you covered by, if any?
10. Do you own a business? If so, list name and field and duration of ownership.
11. Does your business have flood insurance? Amount?

<b>Current Annual Income</b>
<b>Please select one of the following ranges.</b>
\$0 - 4,999
\$5,000 - 9,999
\$10,000 - 14,999
\$15,000 - 24,999
\$25,000 - 34,999
\$35,000 - 49,999
\$50,000 - 74,999
\$75,000 - 99,999
\$100,000 - 149,999
\$150,000 - 199,999
\$200,000 and over

### **Closing**

1. Thank you for your time today. Your participation in this study has been very valuable with explaining...
2. Is there anything else you think it is important for me to know?
3. If you were conducting this interview, what questions would you have asked that I did not?
4. Do you have any questions have for me?

## References

- Abel, Nick, Russell Gorddard, Ben Harman, Anne Leitch, Jennifer Langridge, Anthony Ryan and Sonja Heyenga. 2011. "Sea Level Rise, Coastal Development and Planned Retreat: Analytical Framework, Governance Principles and an Australian Case Study." *Environmental Science and Policy* 14(3):279-288.
- Alexander-Bloch, Benjamin. 2013. "The Louisiana Seafood Industry's History, from Start in 1700s to Present, Discussed." *New Orleans Business News*. Retrieved July 27, 2018 ([https://www.nola.com/business/index.ssf/2013/02/the\\_louisiana\\_seafood\\_industry.html](https://www.nola.com/business/index.ssf/2013/02/the_louisiana_seafood_industry.html)).
- Allen, James. 1997. "Salt Tolerance of Southern Bald Cypress." *U.S. Geological Survey*. Retrieved June 18, 2018 ([https://www.nwrc.usgs.gov/factshts/fs92\\_97.pdf](https://www.nwrc.usgs.gov/factshts/fs92_97.pdf)).
- Amadeo, Kimberly. 2018. "BP Spent \$56.4 Billion on Spill So Far." *The Balance*. Retrieved June 29, 2018 (<https://www.thebalance.com/bp-gulf-oil-spill-facts-economic-impact-3306212>).
- American Community Survey (ACS). 2013-2017. "Total Housing Units." Grand Isle, Louisiana. Retrieved June 10, 2018 ([https://factfinder.census.gov/faces/nav/jsf/pages/community\\_facts.xhtml?src=bkmk](https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk)).
- Baan, Paul J. A., and Frans Klijn. 2004. "Flood Risk Perception and Implications for Flood Risk Management in the Netherlands." *International Journal of River Basin Management* 2(2):113-122.
- Berg, Bruce L. 2007. *Qualitative Research Methods for the Social Sciences*. Boston: Pearson/Allyn & Bacon.
- Berg, Robbie. 2018. *Tropical Cyclone Report Tropical Storm Cindy, 2018*. National Hurricane Center. Retrieved June 26, 2018 ([https://www.nhc.noaa.gov/data/tcr/AL032017\\_Cindy.pdf](https://www.nhc.noaa.gov/data/tcr/AL032017_Cindy.pdf)).
- Berg, Robbie. 2013. *Tropical Cyclone Report Hurricane Isaac, 2012*. Retrieved June 27, 2018 ([https://www.nhc.noaa.gov/data/tcr/AL092012\\_Isaac.pdf](https://www.nhc.noaa.gov/data/tcr/AL092012_Isaac.pdf)).
- Bethel, Matthew B., Lynn F. Brien, Michelle M. Esposito, Corey T. Miller, Honora S. Buras, Shirley B. Laska, Rosina Philippe, Kristina J. Peterson and Carol P. Richards. 2014. "Sci-TEK: A GIS-Based Multidisciplinary Method for Incorporating Traditional Ecological Knowledge into Louisiana's Coastal Restoration Decision-Making Processes." *Journal of Coastal Research* 30(5):1081-1099.
- Beven, John and Robbie Berg. 2018. *Tropical Cyclone Report Hurricane Nate, 2017*. National Hurricane Center. Retrieved June 27, 2018 ([https://www.nhc.noaa.gov/data/tcr/AL162017\\_Nate.pdf](https://www.nhc.noaa.gov/data/tcr/AL162017_Nate.pdf)).

- Beyer, Jonny, Hilde C. Trannum, Torgeir Bakke, Peter V. Hodson and Tracy K. Collier. 2016. "Environmental Effects of the Deepwater Horizon Oil Spill: A Review." *Marine Pollution Bulletin* 110(1):28-51.
- Blake, Eric and David Zelinsky. 2018. *Tropical Cyclone Report Hurricane Harvey, 2018*. National Hurricane Center. Retrieved June 27, 2018 ([https://www.nhc.noaa.gov/data/tcr/AL092017\\_Harvey.pdf](https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf)).
- Bradford, R. A., J. J. O'Sullivan, Van der Craats, I. M., J. Krywkow, P. Rotko, J. Aaltonen, M. Bonaiuto, S. D. Dominicis, K. Waylen and K. Schelfaut. 2012. "Risk Perception—issues for Flood Management in Europe." *Natural Hazards and Earth System Sciences* 12(7):2299-2309.
- Burby, RJ. 2006. "Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing about Wise Governmental Decisions for Hazardous Areas." *Annals of the American Academy of Political and Social Science* 604:171-191.
- Burley, David, Pam Jenkins, Shirley Laska and Traber Davis. 2007. "Place Attachment and Environmental Change in Coastal Louisiana." *Organization & Environment* 20(3):347-366.
- Collenteur, R., H. Moel, B. Jongman and G. Di Baldassarre. 2015. "The Failed-Levee Effect: Do Societies Learn from Flood Disasters?" *Natural Hazards* 76(1):373-388.
- Colten, Craig E. 2010. *Perilous Place, Powerful Storms: Hurricane Protection in Coastal Louisiana*. Jackson:University Press of Mississippi.
- Colten, Craig E. 2017. "Environmental Management in Coastal Louisiana: A Historical Review." *Journal of Coastal Research* 33(3):699-711.
- Colten, Craig E., Jessica R. Simms, Audrey A. Grismore and Scott A. Hemmerling. 2018. "Social Justice and Mobility in Coastal Louisiana, USA." *Regional Environmental Change* 18(2):371-383.
- Davenport, Coral, and Campbell Robertson. 2016. Resettling the First American 'Climate Refugees'. *The New York Times*. Retrieved December 18, 2018 (<https://www.nytimes.com/2016/05/03/us/resettling-the-first-american-climate-refugees.html>).
- Dawson, Alma, and Kathleen de la Peña McCook. 2006. "Rebuilding Community in Louisiana after the Hurricanes of 2005." *Reference & User Services Quarterly* 45(4):292-296 (<http://www.jstor.org.weblib.lib.umd.edu:8080/stable/20864558>).
- Dierauer, J., Nicholas Pinter, and Johnathan Remo. 2012. "Evaluation of levee setbacks for flood-loss reduction, Middle Mississippi River, USA." *Journal of Hydrology* 450-451 (no issue no.): 1-8.

- Działek, Jarosław, Wojciech Biernacki and Anita Bokwa. 2013. "Challenges to Social Capacity Building in Flood-Affected Areas of Southern Poland." *Natural Hazards and Earth System Sciences* 13(10):2555-2566.
- Federal Emergency Management Agency. 2012. "Best Practices: Promoting Successful Mitigation in Louisiana Post Hurricane Katrina." Retrieved July 1, 2017 ([https://www.fema.gov/media-library-data/20130726-1859-25045-4595/best\\_practice\\_compilation.pdf](https://www.fema.gov/media-library-data/20130726-1859-25045-4595/best_practice_compilation.pdf)).
- Fulkerson, Gregory M., and Alexander R. Thomas. 2013. "Urbanization, Urbanormativity, and Place-Structuration." *Studies in Urbanormativity: Rural Community in Urban Society*:5-30.
- Fox-Rogers, Linda, Catherine Devitt, Eoin O'Neill, Finbarr Brereton and J. P. Clinch. 2016. "Is There Really Nothing You Can Do? Pathways to Enhanced Flood-Risk Preparedness." *Journal of Hydrology* 543(B):330-343. Retrieved February 15, 2018 (<http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=120142548&site=ehost-live>).
- Grand Isle Hurricane Protection*. New Orleans District. 2009. Retrieved July 10, 2018 (<http://www.mvn.usace.army.mil/About/Projects/Grand-Isle/>).
- Hilhorst, Thea. 2004. *Mapping Vulnerability: Disasters, Development, and People*. New York: Earthscan.
- Homeowners Assistance Program*. 2012. Retrieved July 10, 2018 (<https://www.road2la.org/HAP/default.aspx>).
- Hung, Hung-Chih. 2009. "The Attitude Towards Flood Insurance Purchase when Respondents' Preferences are Uncertain: A Fuzzy Approach." *Journal of Risk Research* 12(2):239-258. doi: 10.1080/13669870802497702.
- Hunt, Constance. 1999. "A Twenty-First Century Approach to Managing Floods." *Environments* 27(1):97. Retrieved October 4, 2018 (<https://search.proquest.com/openview/75540929235f88cb0a5a46f1a31d2439/1?pq-origsite=gscholar&cbl=43427>).
- Hurricane Handbook: How to Be Prepared During Hurricane Season*. 2018. Lafayette:Lafayette Utilities System.
- Investments in Residential Construction*. 2018. Retrieved June 6, 2018 (<http://www.rebuild.la.gov/Residential.aspx>).
- Jones, A. L., and Michael R. Phillips. 2010. *Disappearing Destinations: Climate Change and Future Challenges for Coastal Tourism*. Chippenham: CAB International.

- Kellens, Wim, Teun Terpstra and Philippe De Maeyer. 2013. "Perception and Communication of Flood Risks: A Systematic Review of Empirical Research." *Risk Analysis*. doi: 10.1111/j.1539-6924.2012.01844.x.
- Knabb, Richard, Daniel Brown, and Jamie Rhome. 2005. *Tropical Cyclone Report Hurricane Katrina, 2005*. National Hurricane Center. Retrieved June 28, 2018. ([https://www.nhc.noaa.gov/data/tcr/AL122005\\_Katrina.pdf](https://www.nhc.noaa.gov/data/tcr/AL122005_Katrina.pdf)). Updated on September 14, 2011.
- Knabb, Richard, Daniel Brown, and Jamie Rhome. 2006. *Tropical Cyclone Report Hurricane Rita, 2006*. National Hurricane Center. Retrieved June 28, 2018 ([https://www.nhc.noaa.gov/data/tcr/AL182005\\_Rita.pdf](https://www.nhc.noaa.gov/data/tcr/AL182005_Rita.pdf)). Updated on September 11, 2014.
- Kundzewicz, Zbigniew W. 2002. "Non-Structural Flood Protection and Sustainability." *Water International* 27(1):3-13. doi: 10.1080/02508060208686972.
- Laska, Shirley, George Wooddell, Ronald Hagelman, Robert Gramling and Monica T. Farris. 2005. "At Risk: The Human, Community and Infrastructure Resources of Coastal Louisiana." *Journal of Coastal Research* 1(44):90-111.
- Leslie, Paul. 1979. Review of *Grand Isle on the Gulf: An Early History* by Evans, Sally K., Frederick Stielow, and Betsy Swanson. *Journal of the Louisiana Historical Association* 21(3):322-323.
- Louisiana Department of Natural Resources (LDNR). 2007. "Grand Isle Barrier Shoreline Stabilization Study: Preliminary Engineering Report Part 1: Basis of Engineering." Retrieved March 12, 2018 ([ftp://ftp.coastal.la.gov/Large%20Data%20Requests/SBEACH/CPRA%20design%20reports\\_up%20thru%202013\\_Aug/125\\_Grand%20Isle\\_CHE\\_SWAN.pdf](ftp://ftp.coastal.la.gov/Large%20Data%20Requests/SBEACH/CPRA%20design%20reports_up%20thru%202013_Aug/125_Grand%20Isle_CHE_SWAN.pdf))
- Love, N. 2008. "Louisiana Road Home Program: Federal Aid for State Disaster Housing Assistance Programs. Government and Finance Division." Retrieved June 8, 2018 (<https://www-heinonline-org.weblib.lib.umt.edu:2443/HOL/Page?collection=congreg&handle=hein.crs/crsagmk0001&id=1>).
- Manning-Broome, C., Jeannette Dubinin and Pamela Jenkins. 2015. "View from the Coast: Local Perspectives and Policy Recommendations on Flood-Risk Reduction in South Louisiana." *Policy Report*. Baton Rouge: Center for Planning Excellence.
- McNamee, Kerry, Evan Wisheropp, Christopher Weinstein, Andrew Nugent and Laurie Richmond. 2014. "Scenario Planning for Building Coastal Resilience in the Face of Sea Level Rise: The Case of Jacobs Avenue, Eureka, CA." *Humboldt Journal of Social Relations* 36(1):145-173.



- Meyer-Arendt, K. 2011. "Grand Isle, Louisiana: A Historic US Gulf Coast Resort Adapts to Hurricanes, Subsidence and Sea Level Rise." Pp. 203-217 in *Disappearing Destinations: Climate Change and Future Challenges for Coastal Tourism*, edited by Jones, A. L., and Michael R. Phillips. Chippenham: CAB International.
- Meyer-Arendt, Klaus J. 1985. "The Grand Isle, Louisiana Resort Cycle." *Annals of Tourism Research* 12(3):449-465. doi:10.1016/0160-7383(85)90009-X.
- National Research Council. 2012. *Dam and Levee Safety and Community Resilience: A Vision for Future Practice*. Washington, DC: The National Academies Press. doi.org/10.17226/13393.
- National Research Council (US) Water Science and Technology Board, issuing body, and National Research Council (US) Ocean Studies Board, issuing body. 2014. "Reducing Coastal Risk on the East and Gulf Coasts." Washington, D.C.: National Academies Press.
- Padgett, Jamie, Reginald DesRoches, Bryant Nielson, Mark Yashinsky, Oh-Sung Kwon, Nick Burdette and Ed Tavera. 2008. "Bridge Damage and Repair Costs from Hurricane Katrina." *Journal of Bridge Engineering* 13(1):6-14.
- Pallardy, Richard. 2018. "Deepwater Horizon Oil Spill of 2010." *Environmental Disaster, Gulf of Mexico*. Retrieved June 27, 2018 (<https://www.britannica.com/event/Deepwater-Horizon-oil-spill-of-2010>).
- Patterson, Olivia, Frederick Weil and Kavita Patel. 2010. "The Role of Community in Disaster Response: Conceptual Models." *Population Research and Policy Review* 29(2):127-141.
- Patton, Michael Q. 1999. Enhancing the Quality and Credibility of Qualitative Analysis. *Health Services Research* 34(5):1189. Retrieved March 11, 2017 (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1089059/>).
- Roberts, Faimon. 2017. "Is Louisiana Land Loss Slowing Yes, but..." *The Advocate*. Retrieved December 17, 2018 ([https://www.theadvocate.com/baton\\_rouge/news/environment/article\\_28af97a2-673e-11e7-b64d-cf8ec8ce5b83.html](https://www.theadvocate.com/baton_rouge/news/environment/article_28af97a2-673e-11e7-b64d-cf8ec8ce5b83.html)).
- Sayers, Paul, Li Yuanyuan, Gerald Galloway, Edmund Penning-Rowsell, Shen Fuxin, Wen Kang, Chen Yiwei and Tom Le Quesne. 2013. *Flood Risk Management: A Strategic Approach*. Retrieved September 28, 2018 (<https://think-asia.org/handle/11540/81>).
- Schott, Timothy, Chris Landsea, Hafele, Gene Halfele, Lorens, Jeffrey Lorens, Arthur Taylor, Harvey Thurm, and Walt Zaleski. 2012. "The Saffir-Simpson hurricane wind scale." *NOAA/National Weather Service*. Retrieved July 5, 2018 (<https://www.nhc.noaa.gov/pdf/sshws.pdf>).

- Scolobig, Anna, B. Marchi and M. Borga. 2012. "The Missing Link between Flood Risk Awareness and Preparedness: Findings from co Studies in an Alpine Region." *Natural Hazards* 63(2):499-520. doi: 10.1007/s11069-012-0161-1.
- Shah, M.A.R., A. Rahman and S.H. Chowdhury. 2018. "Challenges for Achieving Sustainable Flood Risk Management." *Journal of Flood Risk Management* 11:S358. doi: 10.1111/jfr3.12211.
- Simmons, Robert C., Scott Chase, Matt Brincka and Darcy McNamara. 2016. "Shore Stewards Guide for Shoreline Living." Retrieved June 10, 2018 (<https://research.wsulibs.wsu.edu/xmlui/handle/2376/6449>).
- Simpson Strong House Tips. 2017. "What are hurricane straps used for?" Retrieved August 10, 2018 (<https://www.youtube.com/watch?v=kuZ6haiqhNU>).
- Smith, Joel B., Hans-Joachim Schellnhuber, M.M.Q. Mirza, Samuel Fankhauser, Rik Leemans, Lin Erda, Laban Ogallo, B. Pittock, Richard Richels and Cynthia Rosenzweig. 2001. "Vulnerability to Climate Change and Reasons for Concern: A Synthesis." Retrieved October 6, 2018 (<http://gyohe.faculty.wesleyan.edu/files/2018/05/53.pdf>).
- Smith, Valene L. 1998. "War and Tourism: An American Ethnography." *Annals of Tourism Research* 25(1):202-227. Retrieved August 1, 2017 (doi.org/10.1016/S0160-7383(97)00086-8).
- So, You Live Behind a Levee! What You Should Know to Protect Your Home and Loved Ones from Flooding.* 2010. Retrieved June 1, 2017 ([https://www.lrh.usace.army.mil/Portals/38/docs/civil works/So You Live Behind a Levee.pdf](https://www.lrh.usace.army.mil/Portals/38/docs/civil%20works/So%20You%20Live%20Behind%20a%20Levee.pdf)).
- Stielow, Frederick. 1982. "Grand Isle, Louisiana, and the New Leisure, 1866-1893." *Louisiana History: The Journal of the Louisiana Historical Association* 23(3):239-257. Retrieved June 11, 2018 (<https://www.jstor.org/stable/4232187>).
- Terpstra, Teun. 2011. "Emotions, Trust, and Perceived Risk: Affective and Cognitive Routes to Flood Preparedness Behavior." *Risk Analysis* 31(10):1658-1675. Retrieved February 22, 2018 (doi: 10.1111/j.1539-6924.2011.01616.x.)
- Terpstra, Teun, Michael K. Lindell and Jan M. Gutteling. 2009. "Does Communicating Flood Risk Affect Flood Risk Perceptions? Results of a Quasi-Experimental Study." *Risk Analysis* 29(8):1141-1155. Retrieved August 22, 2018 (doi: 10.1111/j.1539-6924.2009.01252.x.)
- The Nature Conservancy. 2018. "Places We Protect: Grand Isle, Louisiana." Retrieved October 23, 2018 (<https://www.nature.org/en-us/get-involved/how-to-help/places-we-protect/grand-isle/>).

- Theriot, Jason P. 2014. *American Energy, Imperiled Coast: Oil and Gas Development in Louisiana's Wetlands*. LSU Press. Retrieved July 15, 2018 (<https://books.google.com/books?hl=en&lr=&id=N5DpAgAAQBAJ&oi=fnd&pg=PP1&dq=American+Energy,+Imperiled+Coast&ots=3v--sb1h49&sig=O1b-qAOMQGMuJeNuxV6naI5cebc#v=onepage&q=American%20Energy%2C%20Imperiled%20Coast&f=false>).
- “Welcome to Grand Isle!” 2018. Town of Grand Isle. Retrieved January 19, 2016 (<https://www.townofgrandisle.com/>).
- United Nations. 2017. *The Ocean Conference Fact Sheet*. New York. Retrieved October 29, 2018 (<https://www.un.org/sustainabledevelopment/wp-content/uploads/2017/05/Ocean-fact-sheet-package.pdf>).
- U.S. Army Corps of Engineers. 2018. *Projects on Grand Isle*. Retrieved on May 22, 2017 (<http://www.mvn.usace.army.mil/About/Projects/Grand-Isle/>).
- U.S. Census Bureau, 1950. *Census of Population and Housing, Profile of General Demographic Characteristics*. Washington DC: U.S. Census Bureau, Department of Commerce.
- U.S. Census Bureau, 1960. *Census of Population and Housing, Profile of General Demographic Characteristics*. Washington DC: U.S. Census Bureau, Department of Commerce.
- U.S. Census Bureau, 2017. *Population Division. Annual Estimates of the Resident Population*. Washington DC: U.S. Census Bureau, Department of Commerce.
- U.S. Congress. Senate. *The National Flood Insurance Act of 1968, as amended and The Flood Disaster Protection Act of 1973, as amended, 42 U.S.C. 4001 et seq. Office of the General Council Report and Federal Emergency Management Agency*. Retrieved July 15, 2018 ([https://www.fema.gov/media-library-data/20130726-1752-25045-9854/frm\\_acts.pdf](https://www.fema.gov/media-library-data/20130726-1752-25045-9854/frm_acts.pdf)).
- Vojinovic, Zoran, and Jingmin Huang. 2015. “Flood Risk: The Holistic Perspective. London: London: IWA Publishing. Retrieved on October 27, 2018. (<https://www.iwapublishing.com/books/9781780405322/flood-risk-holistic-perspective>).
- Wall, Bennett, John Rodrigue, Light Townsend Cummins, Judith Kelleher Schafer, Edward Haas, and Michael Kurtz. 2013. *Native Peoples and European Contact*. Pp. 7-100 in Louisiana: A History. Wiley. Retrieved on May 17, 2018 (<https://www.wiley.com/en-us/Louisiana%3A+A+History%2C+6th+Edition-p-9781118619292>).

Wallace, Ruth A., and Alison Wolf. 2005. *Contemporary Sociological Theory: Expanding the Classical Tradition*. Upper Saddle River, N.J.: Prentice Hall Retrieved on April 1, 2018 (<http://www.loc.gov/catdir/toc/ecip0421/2004018208.html>).