Extreme Weather and Society

Shirley Laska *Editor*

Louisiana's Response to Extreme Weather

A Coastal State's Adaptation Challenges and Successes

Springer Open

Extreme Weather and Society

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Foreword

Projections of future extreme weather; environmental history; social diversity, inequality, and vulnerability; environmental justice; impacts of historic disasters; actual and potential impacts of policies designed to mitigate disaster losses and adapt to changing coastal conditions; distinctive local and regional cultural traditions; cultures and livelihoods at risk; and recommendations for future risk reduction and adaptation policies and actions—all these topics and more are addressed in this comprehensive volume, which promises to be an indispensable resource for all those seeking to respond to hazard-related environmental stressors, both in Louisiana and beyond.

These pages contain both broad and in-depth analyses of the "wicked problem" posed by hazards and climate change. As several authors note, in contrast with problems that have specific solutions, even difficult ones, wicked problems are highly complex and novel, difficult to define and frame, and subject to multiple and often divergent interpretations of the nature of the problem and how to address it. When policies and programs are created to deal with wicked problems, those solutions often lead to more problems. Adding to this challenge, climate change has been labeled a "super-wicked problem" (Levin et al. 2012) for four reasons. First, there is pressure to act; time is running out to address the problem. Second, those who are trying to reduce the risks posed by climate change, from individuals to corporations to nation-states, are also contributing to it. This means that adequate responses to climate change will require radical, fundamental changes in behavior and social organization. Third, climate change poses a major global collective action challenge, but there is no overarching authority that can compel or manage action. Fourth, both current and proposed solutions focus on near-term timeframes, but addressing the problem requires long-term thinking and strategies that must be sustained over time—which is almost unthinkable under contemporary governance regimes and in light of conflicts over the significance (and even existence) of the problem. The authors in this volume rightly characterize climate change adaptation as a multigenerational challenge, but policies can shift whenever political power changes hand.

The chapters in this volume explore various facets of this super-wicked problem. Among the things we learn in these pages is that the entire state of Louisiana is at risk from land loss, sea level rise, and intensified storms and flooding. Trying to address those vulnerabilities through federal post-disaster mitigation funding, one disaster at a time, or on a project-by-project basis, is not an effective approach, but current policies, such as FEMA's emphasis on post-disaster mitigation projects (as opposed to pre-disaster ones), shape state and community mitigation options. As the discussions here argue, in the current policy environment, the emphasis should be on forward-facing, system-focused post-disaster strategies that are based on the best available science, but that are also just and sensitive to the needs, values, and preferences of the members of affected communities—what the editor refers to as *exceptional recovery for essential resilience.* At the same time, steps must be taken to move toward policies that call for large-scale programs that are not tied to specific events.

Attempts to address the conundrums of climate change and associated extremes are fraught with difficulty. With respect to coastal land loss, an environmental risk that Louisiana faces more than any other state in the nation, the book documents how the concept of restoration may be embraced in the abstract, but on-the-ground projects to address land loss are often contested. Ambitious restoration projects like the state's Coastal Master Plan represent a major step forward, but they overemphasize technocratic and engineering-based approaches while downplaying the importance of local preferences, and they can be out of step with efforts aimed at strengthening community resilience. Programs that are broad in geographic scope are appropriate for the scale of the problem of land loss, but local voices, particularly those of marginalized groups, may be muted by such efforts. Similarly, managed retreat from rapidly disappearing coastal areas makes complete sense conceptually, but the chapter authors show how complex this process is in practice. For example, what constitutes a fair and just relocation process for tribal peoples with a prior history of forced relocation? How can the distinctive cultures of coastal natural resource communities be maintained when environmental refugees are required to abandon the places where those cultures flourished? What happens to place-based livelihood strategies and family traditions when communities are uprooted? Relocation *from* endangered coastal regions means relocation *to* somewhere else—typically somewhere else in Louisiana. However, what if those new locations are lacking in adequate services, personnel, and administrative capacity and are economically depressed—as many rural communities in Louisiana are—and what if the residents of receiving communities are less than welcoming? What if those receiving communities are also vulnerable to disasters like the so-called unexpected flooding of 2016?

This volume addresses in rich detail the aftermath and recovery following Hurricane Katrina. The importance of a political economy analysis of hazards and disasters is a thread that runs through these discussions. Katrina's devastation was caused in no small measure by the activities of the oil and gas industry and the interest that promoted projects such as the Mississippi River-Gulf Outlet (MR-GO). Occurring in a historical context of spatial racism, that devastation disproportion-

ately fell upon the poor, racialized, and minoritized residents of New Orleans. We learn in these chapters how those residents were further marginalized during the recovery process. Deprived of public housing, ignored in many recovery plans, priced out of a rising rental market in part because of the scarcity of living-wage jobs, and unable to cope with the loss of kin and friendship networks and neighborhood solidary, many never returned. And we learn how, guided by neoliberal logics of recovery such as land speculation, privatization, and the reduction of public services, the "new" New Orleans is becoming whiter, less affordable, and more gentrified, but spatially remains strongly racialized. These and other research findings provide a strong critique of putatively color-blind policies that are blind to their effects on people of color.

Discussions in this volume also show how, in the context of major disasters and accelerating land loss, Louisiana has become a laboratory for new efforts to alleviate those problems, such as the LA SAFE (Louisiana's Strategic Adaptations for Future Environments) program and the Gentilly Resilience District in New Orleans. Both were funded primarily through the National Disaster Resilience Competition, a collaboration of the Department of Housing and Urban Development and the Rockefeller Foundation. In these chapters, questions arise regarding whether such projects, developed with limited funding on a one-time basis, are replicable and scalable. The broader feasibility and efficacy of these and other experiments can only be assessed over time.

As some chapter authors note, issues of federalism inevitably arise in any discussion of hazards and disasters. The contradictions of federalism are yet another example of the wickedness of the problems discussed here. Within the US federal system, decisions in areas that are important for hazard mitigation, such as land use, are largely outside the purview of federal and state jurisdictions. Federal government requirements like the Disaster Mitigation Act of 2000 cannot ensure that the mitigation plans that are required by the law are adequate—or that they are implemented. Federal post-disaster assistance programs require financial participation on the part of states and local jurisdictions, with the latter showing considerable variation in their ability to meet matching requirements. Because specialized skills are needed to even apply for some federal forms of assistance, that assistance favors well-resourced, high-capacity large cities, as opposed to smaller communities and rural areas.

At several points in the book, the authors argue for the importance of state action in disaster risk reduction and climate change adaptation. The importance of states is inarguable, particularly in the current policy environment, in which federal leadership has rolled back measures such as the flood risk management standard and federal climate change action planning and has withdrawn from the Paris Climate Agreement. States are considered closer to local communities than a distant federal bureaucracy and more sensitive to the distinctive concerns of different populations and interest groups within their jurisdiction. At the same time, in a neoliberal political economy, many states lack the capacity to ensure the provision of even basic services, much less those associated with hazard mitigation and climate change adaptation. Some states are not politically inclined to develop such capacity.

Moreover, as the Louisiana case illustrates only too well, state governments are susceptible to capture by powerful economic interests, to the detriment of many of their residents. The same is the case for local communities, whose decisions, absent significant organized opposition, tend to conform to growth machine imperatives.

Researchers have a tendency to identify problems and leave their solutions to others. This is not the approach taken by the authors in this volume. Virtually, every chapter proposes strategies for ameliorating problems like those associated with population relocation and including marginalized groups in adaptation decision-making and ends with policy recommendations. Quite frequently, the recommendations focus on the importance of framing and tackling problems holistically, blending a knowledge of the technical and scientific aspects of particular challenges with an understanding of their human dimensions. Louisiana itself is a testament to the inadequacy of technological fixes, from levees that provided a false sense of protection and then failed repeatedly to projects like MR-GO which caused erosion and contributed to Katrina's storm surge.

At many points throughout this volume, the authors refer to Louisiana as a canary in the coal mine, a harbinger of things to come, and a microcosm in which to analyze national and global disaster and climate change challenges. As these authors show, although undeniably unique in so many respects, Louisiana illustrates starkly the kinds of issues with which many other communities, states, and nations are currently grappling and will continue to be forced to contend with as climate change progresses and intense hydrometeorological events occur with greater frequency. Both the issues and dilemmas identified and the recommended actions proposed here are relevant for communities across the nation and around the world.

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Reference

Levin, K., Cashore, B., Bernstein, S., & Auld, G. (2012). Overcoming the trajectory of super-wicked problems: Constraining our future selves to ameliorate global climate change. *Policy Sciences*, *45*(2), 123–152.

Preface

When a particular location is selected to be the topic of an edited volume, the editor has to select contributors who have experience with that location and have done research there on the topic of the book within the discipline(s) sought for it. Simple? Well, no. One has to *interactively* identify appropriate subtopics—in this case for human/social response to extreme weather risk and adaptation to it—with what scientists of that discipline *have* studied within the locale, i.e., Louisiana. However, the assignment from the "Extreme Weather and Society" series editors Bill Sprigg, an atmospheric scientist, and Sheila Steinberg, an environmental/social scientist, added to the requirements: to include multiple disciplines, not just my discipline of sociology, because they believe in and are approaching the series to enhance "an emerging *trans-disciplinary* field of study of extreme weather."

They expected contributors from multiple disciplines to be included in one of their series volumes and that those selected should offer a logical weave of findings and policy/practice implications for extreme weather/climate change adaptation. Given my career of transdisciplinary research collaboration as well as numerous assignments to multidisciplinary advisory boards within Louisiana and in other states and serving on the National Academy of Sciences multidisciplinary teams for environmental/societal risk topics, I was already a "practitioner" of the approach and thus enthusiastically sprung to the challenge.

This book honors the series editors' goals with 10 disciplines represented in the 22 contributors, including 1 by a biophysical scientist and 4 chapters having multiple authors from more than one discipline.[1] I believe that the disciplines of the contributors selected are all very relevant to the serious societal need to swiftly and appropriately address the adaptation to extreme weather including climate change.

In order to ensure that such a transdisciplinary edited volume would be approachable to more than specialists of an individual chapter's author(s)' discipline, 5 of the 11 chapter manuscripts were reviewed by relevant expert reviewers from different disciplines than their authors, 4 chapters had coauthors from different disciplines,

[1] Anthropology, architecture, geography, history, marine science, planning, public administration, sociology, urban studies and GIS.

and the other 2 were reviewed by the book's editor who does not have their specialty but is a specialist of the their topics. The reviewers were selected based on the interaction between the editor and first author of each chapter with those reviewers selected having very solid credentials. All of the authors were very positive about having their manuscripts be subjected for review because they were committed to the series editors' goal of transdisciplinary access and utility. Each contributor responded fully to suggestions made by the reviewers.

A State Case: Louisiana Social Science Resources for Climate Change Adaptation

No different from any other resource, how a state fares in providing human resources able to address extreme weather and climate change will contribute to its success doing so. To reinforce this point, I call your attention to the recently created Social Science Extreme Events Research (SSEER) *interactive map*, funded by the National Science Foundation and created by the Natural Hazards Center at the University of Colorado. Into the software is inputted the existence of social scientists engaged in extreme events research, their credentials, and *where they are located*. This GIS product recognizes the importance of the location of social scientists to achieve "communicating ongoing project or research outcomes to affected communities and decision-makers."[2] While just launched, it will be interesting to follow how many Louisiana social scientists register. A recent report on this question did not show Louisiana as having a robust number of such researchers. The comments of a presenter at a recent meeting on the Sacramento Delta who had done a literature search on social science research on deltas reported very limited findings: "Only research on New Orleans and the Mardi Gras culture."[3]

To pursue this part of the Louisiana case, social science resources, the chapter authors were examined. Approximately half of the 21 authors of the chapters have been trained at Louisiana universities and half outside of the state. Fourteen hold academic or nonprofit organization positions within the state, and seven are in academic institutions outside of the state. The latter are affiliated with universities along the Gulf Coast and in the South, Northeast and California.

Three of these scientists outside of the state have left positions within Louisiana to go to these institutions in other states. A possible explanation is that scientists experienced with climate change research are in demand by other areas struggling with similar challenges and thus have out-of-state opportunities. This appears to be the case with the small group examined. Future science human resource research will be important to reveal how scientists respond in their personal careers to

[2] EAGER: Interdisciplinary and Social Science Extreme Events Research, Natural Hazards Center, University of Colorado. https://hazards.colorado.edu/news/research-projects/eager-interdisciplinary-and-social-science-extreme-events-research. Accessed January 27, 2019.

[3] Personal communication, January 30, 2019.

extreme weather challenges and whether these challenges harm or enhance a state-level "pool" of extreme weather scientists focused upon a particular state's adaptation challenges.

What is believed by this editor is that extreme weather adaptation should include consideration by universities within a state and by state management boards of higher education of whether the state is committed to creating and nurturing adequate numbers of scientists specializing in these topics within the state's universities. A recent effort introduced by the Louisiana State University Sea Grant Program reflects well on Louisiana in this matter to overcome the shortfall noted above because it is focused on enhancing state specialists among the young faculty. The program is called *La D-I-A*:

> (It) supports scholars interested in applying their work to real world problems and sharing these discoveries with diverse audiences. By encouraging multidisciplinary research efforts and strong links with coastal communities, the Louisiana Discovery-Integration-Application Program (La D-I-A) connects science, communication and coastal residents. In essence, the program provides a two-way conduit between university research results and community needs.[4]

This is a very encouraging development in Louisiana's need for very extensive research on extreme weather and climate change and adaptation to it and the ability of scientists to collaborate with the state's communities supporting them to adapt better to extreme weather and climate change.

It is with gratitude that I thank the chapter contributors for working with me on their chapters and their refinements. The book would also not have been possible without the assistance of two key individuals—both recent graduates of Louisiana universities—who prepared the chapters for submission (Olivia Porter, MURP, JD) and who created detailed maps or refined the many figures necessary to enhance such topics (Julie Torres, MS ES). I am honored to have had such a team.

More authors than would be expected had to complete their chapters while moving to new positions or being occupied by family responsibilities such as the arrival of three babies and one grandbaby. They have asked me to dedicate our book to these very young twenty-first-century recipients of the adaptation successes that their parents, grandparent, and other authors of this book are contributing in support of their futures.

To Willa, Elias, James, and Pia.

New Orleans, LA, USA Shirley Laska

[4] https://www.laseagrant.org/outreach/ladia/

Contents

Chapter 1
Introduction to the Book: "Ahead of the Curve"

Shirley Laska

1.1 Louisiana: A *Whole State* with Extreme Weather Challenges

The coastal areas of Louisiana have been subject to extreme weather ever since the Mississippi River began to create the Delta land 7000+ years ago (Roberts 1997). The extreme weather first impacted the indigenous population that has lived here for millennia and, over the last 300+ years, multi-ethnic immigrants, refugees and enslaved peoples who settled among them (Owens 2015). While inland floods have occurred intermittently over the decades, the two very extreme rain events in the spring and summer of 2016 began to change the framing of the state's extreme weather experiences: No longer was Louisiana two "states" – the coast subject to extreme weather effects . . . and a safer inland. The image of the state in the eyes of government entities, of inland riverine residents, was changing, and likely observers from outside of the state were also seeing the state differently: It is now a state subject to extreme weather *throughout* – urban, rural, coastal, and inland watersheds. And that extreme weather is exacerbated by climate change. Weather specialists declared that in Louisiana, both Hurricane Isaac in 2012 and the summer 2016 inland storms were enhanced by it – stalling the storms' advance and thus generating their extreme precipitation effects (Wiel et al. 2017; Peterson et al. 2016; Kossin 2018).

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When these inland floods occurred, it became evident to this book's editor – a researcher and adaptation[1] practitioner studying Louisiana flood risk for about 35 years and having begun research on an inland flood of 1983 – that sadly, the whole state had now moved into an extreme weather state category. I believe this change warrants study of Louisiana *as a unit*: examining and understanding better the level of experience and response embodied within the geographic/political entity of an American state and its government bureaucracies, its communities and citizens. It is hoped that this research will benefit both Louisiana and – as an exemplar – other states, whose extreme weather risk is increasing like Louisiana's has done or is likely to increase in the near future as the new US Global Change Research Committee Report (Jay et al. 2018) portends.

The timeliness of a *statewide* "extreme weather" book became quickly obvious when state and local officials initiated after the 2016 floods adaptation programs additional to those focused only on the coast. As the book took form, some eight state extreme weather adaptation programs and one city program began to take shape. Also, adaptation as reflected in the new programs was no longer siloed in one or another relevant state agency. The watershed program was created and implemented by five state agencies, and the coastal restoration's community/parish capacity and capability study approached the project so that the findings could be shared with the watershed program and possibly expanded statewide (see Sect. 1.3.1). The evolving programs demonstrated an appreciation of the interconnectivity organizationally and experientially of the challenges for the whole state. The "connection" had been made between coastal adaptation and inland adaptation to begin to grow *statewide* adaptation as the goal.

This chapter has the following aims:

1.2 Introduce the key Louisiana extreme weather and climate-change induced conditions that prompted the preparation of this book as well as demonstrate *adaptation* and *adaptation risk* to Louisiana's most current extreme weather and disastrous flood levels of the Mississippi River, which are likely climate change-enhanced threat.

1.3 Summarize the recent adaptation programs that have been created within the state. Then argue that an effective way in which climate-induced extreme weather adaptation can occur in the earlier stages of this climate adaptation phenomenon is through existing federal disaster recovery programs – as the new Louisiana programs are currently being funded. How to achieve climate adaptation through this means is diagrammed, and the details are presented. The process of *exceptional recovery* from disasters if successful results in *essential resiliency* – resiliency embracing "just," comprehensive qualities – and "grows" climate change adaptation.

[1] Climate change *adaptation* is adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change (Burton et al. 2001). Climate change *mitigation* refers to actions that reduce the human contribution to the planetary greenhouse effect (National Climate Assessment 2014).

1.4 "Place" the book's chapters about Louisiana as expanding the exceptional recovery/essential resilience model; about one-half of the chapters directly address one of the two very related concepts. In addition, four chapters describe/expand the topic of Louisiana's new adaptation programs and are identified in Table 1.1. Finally, the chapters which analyze challenges of *traditional disaster recovery* will be identified because these challenges will only be exacerbated by climate-induced extreme weather events and thus must be appreciated and their solutions addressed. It is critical not to split the challenges and solutions to traditional disaster recovery from those that are emerging from climate-induced extreme weather events.

1.5 End the chapter with a challenge to the readers: Will the recommendations offered by the chapter authors for extreme weather adaptation be more successfully accomplished and achieve their goals if the states/communities – *subnational* units of government – are the true managers of the adaptation process instead of the federal government which is emphasized at present? While the consideration of community adaptation has been embraced in the twenty-first century (Burton et al. 2001; NASEM 2018; Rockefeller n.d.), it is argued that the technical aspects and especially the financial aspects of turning from federal management/control to state and local units have not been adequately considered. Therefore, I propose that shifting to subnational levels is not adequately informed if these real issues are not considered and addressed. This section will offer considerations –both pro and con– for this change to subnational adaptation emphasis and encourage robust research to achieve the critical "essential" adaptation success needed.

1.2 The Louisiana Case: Extreme Weather and Climate Change Experiences

The state of Louisiana's twenty-first-century flood inundation is represented by nine individual extreme storm maps that were combined to create the composite map (Fig. 1.1). In addition to the 9 storms represented in the composite map, another 14 storms occurred that caused additional flooding, mostly within the same areas as the 9 storms represented (see Appendix 1 for the full list). No such map as the composite in Fig. 1.1 was available for use in this book; it had to be constructed. Not to have state-level composite maps that are kept up to date and readily available for researchers, practitioners, and government officials, especially for states subject to so much extreme weather flooding, is a significant gap of needed information for addressing extreme weather events and adaptation to them. (See Appendix 1 for expanded description of the types of data used for the included maps, the methods of map creation, and the recommendations for enhancing map resources.)

The majority of Louisiana floods can be traced to 54 tropical weather events, the third largest number that impacted a US state within the last 166 years. Texas (64) and Florida (117) are the only two states with more (National Hurricane Center

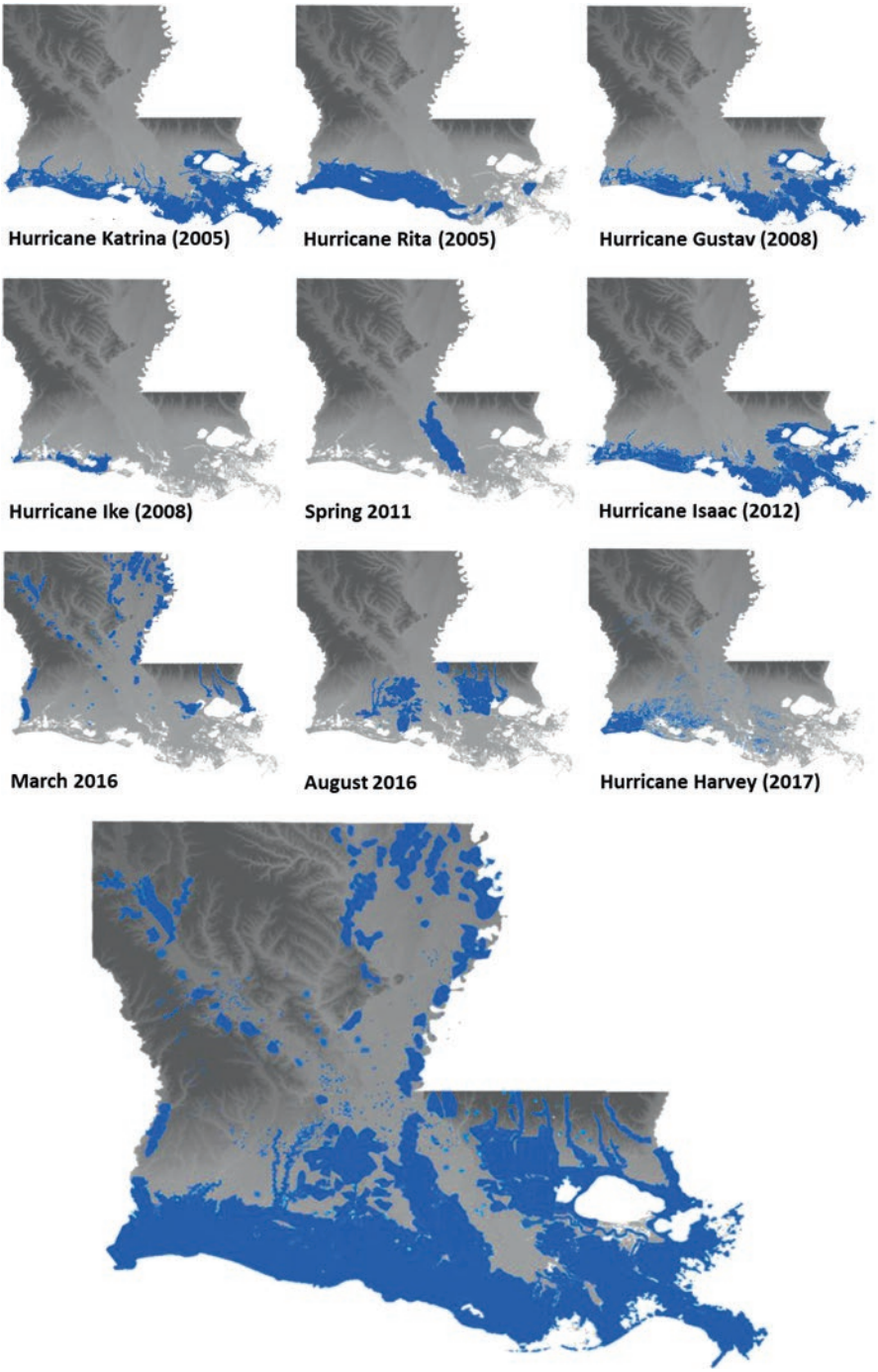

Fig. 1.1 Flood inundation coverage maps for selected hurricanes and intense rainfall events in Louisiana during the twenty-first century (top) and composite flood map (bottom)

2018). The inland flooding that prompted the creation of this volume (spring and summer 2016 and December 2018) set river records for flood levels that ranged from 15% to 30% higher than previous records that were set as far back as up to 66 years ago (Schleifstein 2019).

The most serious hurricane experience for Louisiana was Hurricane Katrina in 2005, the deadliest and costliest of mainland US storms ever (NHC 2018). Climate change-related qualities of very warm Gulf of Mexico waters and increasing sea level rise (Union of Concerned Scientists 2017a) exacerbated the storm's impacts, especially the significant storm surge that the public was not warned of adequately because it was not included in the Saffir-Simpson scale.[2] Unfortunately Katrina became a "perfect storm" due to these storm and atmospheric qualities combined with weak storm protection (Day et al. 2007), and an ill-conceived ship navigation channel cut through the marsh directly targeted to New Orleans (Freudenburg et al. 2009).

Louisiana is also ranked number one in two other extreme conditions – coastal land loss and sea level rise. Coastal Louisiana was built from sediment suspended in Mississippi River waters flowing down the continent that was deposited in fanlike patterns as the river swished back and forth on the Louisiana coastline that began at the border with the Pleistocene uplands (see Fig. 2.2 in Boesch). However, levees built by early settlers and strengthened after the massive 1927 flood restricted the continued capacity of these depositions to replenish the marshland created by the earlier flows (Couvillion et al. 2011). Resulting marsh subsidence and erosion are exacerbated by saltwater intrusion into the marshes via the thousands of canals created over more than a century of oil and gas exploration (Turner and McClenachan 2018; DeLaune and Pezeshki 1994). Saltwater intrusion via these canals kills the grasses and other plants that hold the marsh soil, resulting in more soil eroding into the water and being washed out into the Gulf, thus causing land loss. Since 1932, approximately 2000 square miles of coastal Louisiana have been lost (Couvillion et al. 2011).

Relative sea level rise is predicted to be higher in the coastal Mississippi Delta than anywhere in the world by the end of this century (Parris et al. 2012). This is the result of the subsidence just discussed combined with *eustatic* (global) sea level rise (Rovere et al. 2016) caused by increasing freshwater input and temperature-induced thermal expansion of the world's oceans (Pahl 2016). New measurement techniques identify even more sea level rise on the Louisiana coast than earlier described (Keogh and Tornqvist 2019). The ramifications of such an increase in elevation of the Gulf of Mexico waters along coastal Louisiana are demonstrated by the dramatic number of Louisiana communities expected to be chronically inundated by 2035 in the intermediate sea level rise scenario: some 59 Louisiana communities, including New Orleans, comprise two-thirds of the 91 US communities coast-wide predicted to be so harmfully affected (Union of Concerned Scientists 2017b) if the state's

[2] The Saffir-Simpson scale failed to adequately consider the powerful storm surge caused by Katrina. Seven years later surge measurement was added to National Weather Service forecasting tools (National Weather Service 2012).

coastal restoration efforts are not adequately funded (Davis and Boyer 2016), implemented, and effective.

Finally, as this manuscript is being submitted to Springer in early summer, 2019, the Mississippi River is in the midst of the longest period of high-flood stage in the history of its flood measurement and has surpassed the duration of the 1927 flood (from midwinter expected through midsummer). This event has been caused by extreme storm patterns in the upper Midwest resulting in record-breaking flood elevations all throughout midcontinent rivers that feed the Mississippi. The extremeness of the patterns is suspected to be caused by climate change (Stott 2016). Discussing this particular example of Louisiana extreme weather risk provides the bridge between the just-described presentation of Louisiana's frequent and severe storms via the twenty-first-century storms and *adaptation*, including *adaptation risk*, the two concepts that are the focus of this book.

There are three foci of the protection, i.e., adaptation, which the Corps of Engineers provides to Baton Rouge and New Orleans beginning upriver: the Old River Control Structure(s), the Morganza Spillway, and the Bonnet Carre Spillway. The first maintains the percentage flow between the Atchafalaya Basin and the current Mississippi River channel of 30/70%. Without it, the percentages would reverse, and the two Mississippi River cities would no longer be able to support ocean-going ships and river commerce as it is known today. Due to the extreme importance of this structure remaining intact and providing that service, improvements were made to it in 1973. The Morganza Spillway reduces flood levels for Baton Rouge and relieves flood level pressures on the Old Structure. Finally, the Bonnet Carre permits the Corps to maintain the river below flood stage at New Orleans. Thus, these adaptations serve the goals for which they were designed.

However, the diversions pose *adaptation risks* to the floodways through which the diverted water flows; and it appears very clearly that with frequent and extreme weather events, the risks which these adaptions pose to other communities and livelihoods become disasters in their own right. The harmful impact of the two diversions is on (1) the Atchafalaya Basin (the Morganza Spillway) and (2) Lake Pontchartrain and the Mississippi Sound (the Bonnet Carre) as released water from the latter passes through the lake to the Gulf of Mexico.

Both spillway paths have been "threatened" by this year's high water. While the Corps of Engineers announced a date for the Morganza Spillway opening, it postponed it three times and then postponed it "indefinitely" when this manuscript was going to the publisher; but it is known how the opening would have impacted the spillway from the opening in 2011, only the second in the spillway's history. What is at risk if the Morganza is opened are parts of western Terrebonne Parish, parts of Morgan City, and the Atchafalaya crawfish harvest, rice, sugarcane, cattle farming, and wildlife. Similarly, the Bonnet Carre silted and freshened (added freshwater to brackish) Lake Pontchartrain and, especially harmful, freshened the Mississippi Sound where the freshwater infusion has put at extreme risk the oyster harvest, dolphin and sea turtle populations, and tourism through these wildlife mortalities. Public meetings of community leaders and commercial fishing organizations seeking redress of this harm occurred in late May when the impacts

became clearly evident. Newspaper headlines tell the story: "Waveland (MS) 'first in line' for damage from opening of the Bonnet Carre," and "Fisherman outraged by freshwater impact on the Mississippi Sound."

At a public meeting, May 29, 2019, near Biloxi, MS, the attendees wanted first to describe the *layering* (Laska et al. 2015*)* of earlier event impacts that they had experienced – beginning with the BP oil spill and the opening of the Bonnet Carre the earlier time this year (and the third in 4 years) upon which they declared that the current adaptation measures to protect Louisiana river cities posed additional (adaptation) risks to them. They clearly perceived the adaptation event as being so harmful because it came on top of the other events in addition to being a serious event itself, i.e., compounding harm. Although adaptation has been represented as a positive, constructive concept when used in the conversation of climate change, equally important is the need to understand better that adaptation is not a concept free from doing harm and that harm likely increases with the magnitude of climate change. Considering adaptation risk is undertaken in several of this book's chapters: especially Chaps. 3, 5, 6, 7, 8, and 9.

Louisiana's extreme weather history and its predicted future of extraordinary risks – this book does not even include heat waves and droughts that appear also to be in the future of Louisiana – place the state "ahead of the curve" in experiences and thus make it a "poster child" for understanding climate change impacts and for learning about and improving adaptive responses. Extreme weather affects 4.5 million Louisiana residents – rural as well as urban (25/75% population distribution) and coastal as well as inland areas (60/40% population distribution). It impacts a wide variety of communities, cultural groups, and economic activities, both local and national, including farming, ports, fisheries, and tourism, which employ the state's residents. Additional impacts are found in oil and gas extraction/petrochemical production whose normal operations present the state with environmental risks – making their threat even more serious when impacted by extreme weather.

1.3 Framing Climate Change-Induced Extreme Weather Adaptation

It would be better to consider and to implement adaptation to climate change-induced extreme weather in a methodical fashion, separate from immediate disaster recovery and separate from uncertainties and fluctuations in funding, with the proposed critical changes from previous extreme weather response clearly identified and included in the societal adjustments to extreme weather. It would be ideal to refine systematically the adaptive responses applying the results of careful climate change social, physical, and atmospheric scientific research and engineering/design and include more than one method in the same effort after considering the compounded benefits (Bailey et al. 2017). What is different with climate change dynamics taking all major vulnerability dimensions into consideration? How is it different? What has caused the differences? What differences will bring the most

harm to the social structure, to the social processes, and to the residents as well as the land and ecosystem? How rapidly will these changes occur? What are the differences: magnitude, frequency, and changes from past extreme weather events such as slow-moving storms when they had moved more rapidly in the past? Who is at risk, more than before the extreme weather-induced changes occurred? How can the identified useful adjustments be made economically, with deliberate speed, to protect the largest number of communities and widest array of residents, especially those most vulnerable, and to protect them for the longest time into the future? How can adaptive capacity (Gitz and Meybeck 2012) be enhanced with the new responses? And, of course, how can the adaptation occur while not harming others and other ecosystems?

I believe that those considering what climate change will bring – be they citizens or specialists – are naively assuming that such an adaptive response will likely happen. If a challenge is seen, it is in understanding the likely changes and synching our response successfully with them and in motivating the society to take the necessary adaptive steps. Our society does not raise concerns that the response will not occur as we do about the *mitigation* of CO_2 gases, the other response believed to be absolutely necessary in addressing climate change. With the new weather changes, it is believed that new adaptive responses will be determined and implemented. "No problem" as the younger generation likes to say. On the contrary, the chapter content in this book and the new adaptation programs which Louisiana has introduced within the past few years assert that *both* climate adaptation and mitigation pose huge challenges to achieve success.

1.3.1 Louisiana Adaptation Innovations and Proposed Early Climate Change Response[3]

Eight climate change-related adaptation programs came into existence and evolved during the conceiving and preparation of this book (Table 1.1 and Appendix for agency descriptions of each). This was an increase of eight from only two evident programs of significant size before that time and the beginning small steps of the nonstructural aspects of the Coastal Master Plan, which is a substantial amount of growth. Previous programs included the environmental and physical structural efforts undertaken by the Louisiana Coastal Protection and Restoration Authority (LA-CPRA) entitled the *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (Coastal Master Plan) and, one combination of structural and human dimensions, the Community Rating System (CRS) of the National Flood Insurance

[3] Andrea Galinski, Assistant Scholar, Dept. of Landscape Architecture, College of Design, Construction and Planning, University of Florida, had intended to contribute a chapter to this volume on the topic of new adaptation programs but was unable to do so due to a career change from LA-CPRA to Florida. However, she enthusiastically volunteered to offer her assistance with this section. I am appreciative of that willingness.

Table 1.1 Large, new (since 2016) LA state and local adaptation programs being implemented currently

Locale emphasis	Description (URL citation)	Govt. unit/program/funding
Coastal	1. Coast-wide wetlands and barrier islands restoration efforts with *addition of* **Flood Risk and Resilience Program** (CPRA 2017) *(Hemmerling* et al.*, in this book) (Birch and Carney, in this book)*	LA Coastal Protection and Restoration Authorization (LA-CPRA)/2nd 5-year Master Plan/ multiple federal and state sources
	2. Awarded Purpose (since modified): **Resettlement** of Isle de Jean Tribe of Biloxi-Chitimacha-Choctaw (La. Div. Admin. 2015; 2019, April 23) *(Jessee, in this book)*	LA Office of Community Development (OCD)/Natl. Disaster Resilience Competition (NDRC)/ HUD-CDBG-DR
	3. Gentilly Resilience **District Storm Water Management** Project funded for major project implementation of the Greater New Orleans Urban Water Plan developed during the decade (New Orleans 2019) *(Birch and Carney, in this book)*	City of New Orleans, Office of Resilience and Sustainability (ORS)/ Natl. Disaster Resilience Competition (NDRC)/HUD CDBG-DR
Inland	4. **Resettlement** of Pecan Acres subdivision, New Roads, near False River and Silverleaf, City of Gonzales (La. Div. of Admin. 2019, March) *(Peterson, in this book)*	LA Office of Community Dev. (OCD)/Buyout and Resilient Housing Incentive. CDBG-DR from 2016 flood/2017 and Natural Resources Conservation Service, USDA
Both	5. LA SAFE. **Determination of 3-tiered coastal areas risk– remove structures, elevate, settle, and parish engagement model projects to respond** (La. Div. of Admin. 2019, April) *(Birch and Carney, in this book)*	LA Office of Community Development (OCD)/Natl. Disaster Resilience Competition (NDRC)/ HUD-CDBG-DR.
	6. **Adaptive capacity for resilience of coupled coastal-inland system** (LSU-CSS 2017) *(Birch and Carney, in this book)*	LSU-Coastal Sustainability Studio/ NAS Gulf Research Program and Robert Wood Johnson
	7**. Framing riverine flood management using watersheds** (Office of the Governor 2018) *(Birch and Carney, in this book)*	Office of the Governor/Watershed Initiative /CDBG-DR from 2016 flood
	8. **Parish flood risk and resilience capability and capacity assessment** (CPRA 2018)	LA CPRA/Flood Risk and Resilience Program evolved to support CPRA nonstructural and the watershed Initiative/multiple federal and state sources

Program (NFIP), a voluntary program for recognizing and encouraging community floodplain management activities that exceed the NFIP's minimum standards. While, as the title denotes, the Coastal Master Plan focused on the coastal storm and sea level rise, the participating Louisiana CRS communities, some 43 in number, are scattered throughout the state but still mostly in the coastal areas (FEMA 2018b).

There is likely limited data from other states with which to compare the large number of new programs created so close together by Louisiana state agencies and one community. The emergence of such a number within a 4-year time span suggests with little doubt that the different state government agencies, and the largest city, New Orleans,[4] have been recently rapidly growing in their appreciation of the need for extreme weather adaptation. The recent 2016 floods, which damaged 146,000 homes and amounted to approximately $10 billion in economic damage, have likely contributed to reframing adaptation efforts away from a coastal focus alone to a statewide need and effort. The following are (1) a summary of these programs, (2) the description of one for which there is no analysis in chapters contained within this book, and (3) the challenges of such a "surge" of efforts occurring approximately at one time. These topics, it is hoped, will contribute to understanding what we can expect in other areas as they experience more climate change-related impacts or how we can contrast what Louisiana is doing with what other states, communities, and regions of the country are currently undertaking to grow in adaptation knowledge and best practices.

The Louisiana programs are distributed among coastal, inland, and a combined emphasis (Table 1.1). Three of the programs are as would be expected coastal programs, one is specifically inland, and four are both coastal and inland or "coupled" coastal-inland systems. It may be hypothesized that the coupled are likely to be the most fruitful – as is considered in Birch and Carney, Chap. 12, and Peterson, Chap. 7, in this book. However, more research needs to be done on this concept before more knowledgeable assessments of coupling can be described and even better refinements made.

The organizations which created the new adaptation programs range from the state's coastal agency – La Coastal Protection and Restoration Authority (which includes several programs and initiatives – Coastal Master Plan, Flood Risk and Resilience Program, and the Parish Flood Risk and Resilience Capability and Capacity Assessment) – to the agency which manages disaster response, the Office of Community Development (OCD) (three programs – Community Resettlement from the National Disaster Resilience Competition, the LA SAFE program similarly funded to engage and encourage communities and parishes experiencing different gradations of risk from the coast inland to adapt appropriately, and the the inland resettlement of two neighborhoods) to the Governor's Office (Watershed Initiative) and to Louisiana State University's Coastal Sustainability Studio's adaptive capacity for resilience of coupled coastal-inland systems.

This volume was not intended as an analysis of only new adaptation programs (as the programs did not exist/or exist in their current complexity when the book was conceived), but rather it has evolved to describing them and then benefitting from various chapter authors analyzing critical issues of the programs that impact adaptive behavior (see Table 1.1 for the specific chapters that address the various

[4] The work on effective water management began after Hurricane Katrina. The program mentioned herein is an area-wide implementation of the ideas developed since that catastrophic event, especially after 2010.

programs). Further research it is hoped will also be taken up by others, including further research by the contributing authors of this book's chapters. These programs are, in effect, Louisiana's "testing ground" for its climate-induced extreme weather response.

Only the newest program, and one thus not described by the authors of the chapters, will be described as an example of where the state's adaptation efforts stand at publication of this volume after which there will be a beginning analysis of what happens when eight adaptation programs are "gestated" at about the same time. Obviously, the opportunity to follow these programs, to consider if and how they are blending, complementing one another, and defining different areas of need and of professional specialty, is a font of opportunity for those interested in climate change adaptation research.

A number of Louisiana's new programs for responding to climate change-enhanced extreme weather have evolved out of the state's 2017 Coastal Master Plan, which includes recommendations for restoration projects, structural projects (like levees and floodgates), and nonstructural flood mitigation projects (such as home elevations or voluntary acquisitions) across the Louisiana coast. The 2017 Master Plan provides a comprehensive assessment of how coastal storm surge-based flood risk may change over the next 50 years, as well as offers recommendations on where and to what extent nonstructural efforts would most benefit the resiliency of coastal Louisiana. (The plan recommends approximately $6.2 billion in nonstructural mitigation measures in multiple communities over the next 50 years.)

Importantly, the Coastal Master Plan shifts the state's focus from post-disaster storm recovery to planning for proactive flood risk reduction actions. In addition to these mitigation project recommendations, the 2017 plan also lays the groundwork for a state-led program that can better align federal, state, and local funding to advance the implementation of such projects. The aim of CPRA's Flood Risk and Resilience Program is to prioritize areas for nonstructural mitigation and to develop a state-led grant program that supports the implementation of such projects by parishes. The program encourages resiliency actions across a range of state, parish, municipal, and academic/NGO actors through a suite of resiliency policy recommendations. Building more resiliently is also encouraged through funding incentives for increased flood risk standards with up to 100% of a nonstructural mitigation project potentially funded by the state. The program also more broadly aims to advance awareness of current and future flood risk, promote greater inter-agency coordination, and provide resources to build local capacity.

One recent initiative developed under the Flood Risk and Resilience Program (Table 1.1, #8 program) includes the development of a capacity assessment for coastal and near-coastal parishes to better determine their ability to implement nonstructural projects as well as related plans and policies. Andrea Galinski, a former CPRA long-term staff member, explained:

> We wanted to better understand what the current ability is to implement nonstructural projects (and broader resilience/flood risk reduction plans and policies). A capacity assessment was also going to be part of a broader Watershed Initiative across the state, and so this assessment was slightly modified and became framed as a "pilot" that could be used for that effort. (Personal written communication, May 10, 2019)

Galinski also notes that this capacity assessment has helped CPRA to better understand the existing gaps and local needs and has also been informative to other state agencies involved in watershed assessment including the Louisiana Department of Transportation and Development (DOTD), OCD, Governor's Office of Homeland Security and Emergency Preparedness (GOSHSEP), and the Department of Natural Resources (DNR). One important lesson that emerged from the assessment included parishes' concerns with state coordination and actions, which has led to a significant consideration of how state agencies can better coordinate both horizontally (across state agencies) and vertically (between federal and local levels) to reduce flood risk.

What should be the initiation and implementation of a state-level movement toward addressing a "new" problem – in this case extreme weather risk likely associated to climate change and now being experienced by residents throughout the state? Is a flurry of programs the usual way change happens? And then they begin refining their missions, synching their goals, some achieving institutionalization while others fall to the wayside. There is a lack of clarity about if/how these eight human dimension programs will synch. It is not known that they will. Will some be redundant but still stay in existence? Will they expend resources while not achieving the needed integrated framing and implementation of the best adaptive efforts? That the answers to these questions are not known is likely very "normal" for such moments of crisis and a beginning of a broader society push to address serious risk.

However, these and similar questions are being asked about the evolution of this now "macro" adaptation response. Local WWNO public radio reporter Travis Lutz (2019, May 26) queried the director of the La. Office of Community Development with such a question about yet another program, the LA SAFE Program (#5 program in Table 1.1). The director of the Office of Community Development replied: "It is about a new way of thinking about investments we make every day. . ." There is no doubt with all of the energy, new bureaucratic structure, program content, and efforts to identify a path forward that Louisiana is in the midst of a "sea change" in adaptation. Only time and committed research will tell those interested if and how the state succeeded and what can be learned by other states from Louisiana's responses, successes, and failures.

1.3.2 Today's Reality of Climate Change Adaptation

To reiterate, all eight Louisiana significant innovative adaptation projects were, or will be, funded as a result of a specific declared disaster: seven extreme weather and the eighth the Deepwater Horizon oil spill. Given that "tie" to a specific disaster, there is no reason to believe at this time that adaptation innovations will occur regularly, in large numbers and at great investment expense separate from a disaster's recovery funding, its damage legacies. Much effort and resources will have to be invested over a long period of time, and social change occur in major ways so that continual successful adaptation takes place. The reason for such a strong negative assessment by this author to the likelihood of stand-alone adaptation is due to the

current resistance to implementing "normal" (not climate change induced) extreme weather resilience efforts. Louisiana is a case in point but unfortunately not one out of the ordinary for US states. It is "nestled" within the norm: there has been very little appetite in Louisiana and in other states for stand-alone extreme weather resilience efforts, traditionally called "pre-disaster mitigation" by FEMA (The Pew Charitable Trust 2018a, b).

Extreme weather adaptation typically occurs during the recovery period *after* major disasters strike (The Pew Charitable Trust 2018b) as in the seven Louisiana examples offered in this chapter. While "pre-disaster flood mitigation" is a term embedded in the vocabulary of the Federal Emergency Management Administration (FEMA), commitment to adapting to an extreme weather threat *before* another weather event occurs in a particular location is currently qualified as "aspirational," as indicated by the modest number of successful awards in FEMA competitions for states, the small amount spent by state governments, their lack of interest in collecting data that would measure such pre-disaster mitigation effects (The Pew Charitable Trust 2018a, b), and the modest interest in the FEMA Pre-disaster Mitigation Program. Louisiana is no exception. For fiscal 2017, the latest year data are available, Louisiana did not receive any funds from FEMA for pre-disaster mitigation (FEMA 2018c).[5]

While there are some new pre-disaster funding opportunities within the new Disaster Recovery Act of 2018,[6] state and local governments are currently challenged to compete successfully and then to implement such systematic adaptation now (The Pew Charitable Trust 2018a). Therefore, if pre-disaster mitigation has not happened much to date with extreme weather disasters, how rapidly and successfully will these funding enhancements lead to significant increases in pre-disaster adaptation in the future? While some of the qualities of the new climate change extreme weather might prompt more pre-disaster adaptation – such as increased magnitude, frequency, clearly observable difference from earlier extreme weather – that link has yet to be studied and, if found to be the case, may not occur repeatedly for quite some time. As the data in the beginning section of this chapter demonstrated, Louisiana has been subject to extreme weather events on the average of more than one a year since the beginning of the twenty-first century. This rate of impact has not motivated the state to successfully compete for pre-disaster mitigation funds as mentioned above (FEMA 2018c). Now there appears to be changes in that response, but the efforts are still being funded by resources tied directly. Research needs to be conducted specifically on this question: Does a significant number of disasters, or continual events, or extreme ones not experienced before or for a lengthy time motivate states to seek pre-disaster mitigation (adaptation) funds more frequently and to successfully qualify for them? If the results of such research lead to the

[5] The disposition of those submitted fell into categories: identified for further review, did not meet hazard mitigation assistance requirements, and not selected.

[6] Improvements in support of pre-disaster implementation for resilience include a reliable stream of 6 percent set aside for public infrastructure pre-disaster hazard mitigation (Section 1234) (FEMA 2018c).

answer "No," then even more concern must be expressed about our culture's assumption that climate change adaptation will be significantly forthcoming. Right now, we should assume that the challenge to adapt prior to disasters will be equivalent to the challenge to mitigate CO^2 emissions.

It may be that the effort needed to recover from *particular disasters* or *catastrophes* such as Katrina consumes the citizens' efforts and emotional energy such that interest in continual adaptation is just too much. Or the motivation to adapt is strong while recovery is going on but it fades afterward. Meyer and Kunreuther's recent work (2017) tries to explain these barriers suggesting social psychological causes, i.e., emotions, which discourage commitment to adaptation: myopia, amnesia, optimism, inertia, and simplification of threats and thus responses. The science to explain resistance to constant attention to addressing risk needs considerable additional refinement. And the addition of the qualities of climate change extreme weather – new magnitude, sudden, more frequent, unusual qualities,[7] having both temperature extremes in same event and more media coverage – will also add new dimensions to the needed research. It may be that these qualities will somewhat overcome the impediments to adapt described by Meyer and Kunreuther (2017). They are dramatic, "never have happened before," and extremely damaging, and those qualities beg for attention to a response.

However, given this lack of commitment *now* to continual extreme weather adaptation absent a significant disaster event to draw attention to the topic, I argue that a resiliency framing that focuses on what adaptation is possible in the recovery from a *particular disaster* is the more appropriate focus for this early climate change extreme weather adaptation period, to make these recovery funds as productive as possible in achieving adaptive recovery, rather than merely addressing recovery as putting it back the way it was.

Two new emphases of the Disaster Recovery Reform Act of 2018 (FEMA 2018b) commit to enhancing resilience during the disaster recovery: Section 1235a ensures the Hazard Mitigation grants must "increase resilience to future damage, hardship, loss or suffering" (Section 1235a) and that damaged public facilities be repaired to the latest codes and standards to strive for resilience (Section 1235b). In the spirit of these new federal "commitments," I will now describe a revision of a recovery framing that was first offered in an earlier publication (Laska 2012) to reflect the argument that disaster recovery must be the locus *currently* of much climate change adaptation.

[7] A Louisiana example reinforces the qualities of unusualness of weather events that bring residents' attention to climate change: On December 29, 2018, as this chapter was being prepared, inland flooding occurred in some of the same area flooded by the 2016 spring and summer floods. Television news reporting quoted a victim: "We didn't have any time to prepare for the flooding because what happened in 24 hours in the spring of 2016 happened within a few hours this time."

1.3.3 Exceptional Recovery for Essential Resilience

The extreme weather adaptation frame offered here combines two concepts – *exceptional recovery* and *essential resilience* (Laska 2012).

The *exceptional recovery process* has qualities that have been identified and developed by the authors of this book's chapters. The recovery process must:

- Be based on a robust commitment to citizen participation
- Honor community self-determination of recovery processes and outcomes
- Have a deep commitment to social justice in the recovery processes at all levels of government response
- Expect a sophisticated recognition by government officials of historical experiences that have led to socially constructed vulnerabilities "causing" the current disaster impacts (Tierney 2014; Wisner et al. 2004)
- Appreciate the economics of the recovery process itself that do not support the enablement and adaptation of the entire community to future extreme weather but rather the interest of the corporations that are used to address the damage and of the "growth machine" (Molotch 1976) putting developer interest ahead of community residents
- Have a deep understanding of the institutionally induced harm that manifests itself in the current government-managed recovery including the technocratic framing of disaster funding as dependent upon benefit/cost and to develop recovery processes that are free of such harm

Without such a robust understanding, the recovery process will contribute to reproducing the vulnerabilities that caused the extreme weather event to generate harm in the first place through a disaster or even a catastrophe from which the community or region is now recovering.

Adding the adjective *essential* to the sought-for resilience gives consideration to the qualities of resiliency that must be part of the outcome of the exceptional recovery. The prolific array of publications that have appeared in the last couple of decades speak to the enhancing of the qualities of the society that permit it to "bounce back" or change so that the form the community/region takes after a disaster enables life to go on effectively, e.g., "resiliently." As has been repeatedly affirmed, such resiliency extends way beyond preventing the physical event or modulating generally what the extreme weather event can do to a community physically. The use of essential resiliency in this discussion of climate change adaptation is to encourage the consideration of what qualities of a society, of a community, are *essential* to the robust improvement of the community to withstand future climate change-induced extreme weather impacts. To reiterate, it is the robust, carefully considered *essential* improvements that redound to the benefit of all social classes, races, ethnic groups, and the social organization that supports the full community's ability to function satisfactorily that are the requirements of successful adaptation.

By using such a reasoning, sometimes the improvements that are of focus in disaster recovery can appear to have little to do directly with recovery. However, the work of the chapter authors within this volume and their like-minded researchers reminds us that resilient communities are socially and economically healthy communities with continual efforts to prevent social class, race, and ethnic disparities and discrimination. If, for example, as Andreanecia Morris and Lucas Diaz describe in Chap. 9, lower-income families in a highly hazard risk community like New Orleans are able to improve their income and/or reduce the percentage of their income spent on housing located near good employment, their resilience "when the next storm hits" rises. And if the housing they rent has the ability to be physically resistant to storm winds and water, and to be repaired after the earlier storm, their chances of returning to the community, to their social network, to their employment, and to the contribution which they made before the event are greater, and therefore the entire community is more resilient following the recovery and into the next disaster if one happens. Thus, essential resilience, the outcome of the exceptional recovery process, should be *additive with deliberation and inclusivity*. It should also recognize at its core that much disaster vulnerability is social and economic, not physical (Wisner et al. 2004).

The diagram created for the original concept in 2012 (Laska 2012) has been refined for this book (see Fig. 1.2). It visualizes the difference between the recovery from a disaster undertaken in more traditional ways – support victims in recovery, return their damaged houses to what they were before the event with minimal changes except for elevation for those damaged over 50%, and assist in the repair of the infrastructure of the community back to what it was before the storm other than

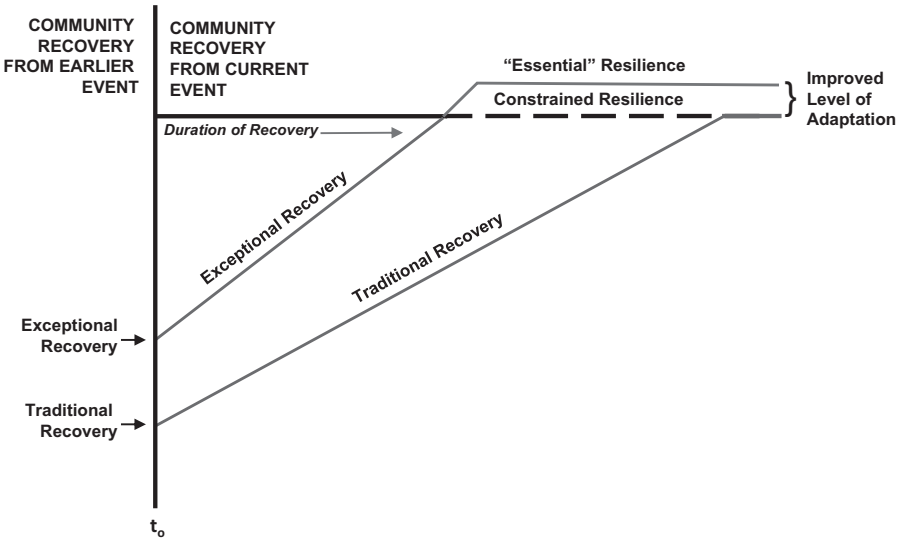

Fig. 1.2 Resilience deltas when community function is/is not enhanced by pre-event vulnerability reduction measures, i.e., adaptation. (Figure adapted from Laska (2012))

some required improvements due to code improvements. The traditional response is compared to a more adaptive, resilient approach – committing to understand both the physical and especially the social vulnerabilities and undertaking recovery approaches which adhere to the state-of-the-art regulations, community plans, land-use planning, and other resilient qualities including the best scientific knowledge of the anticipated climate change-induced extreme weather effects. Such a process is inclusive of citizens in the learning and decision-making processes.

With the *traditional recovery* being built from the last disaster recovery, the resilience that existed before a disaster will take longer to get back to, and no significant improvement will occur. With *exceptional recovery*, the recovery from each extreme weather disaster event will be more rapid, and the level of resiliency will rise to a better level because the goal will be *essential resilience* (to prepare for the possible next event). Kuhlicke and Steinführer (2010) state that the impact of these adaptations to the phase just before the next disaster, the *new anticipation phase*, would differ from the one described above, in a way that reflects learning and social change, or, to put it differently, a new hazard cycle begins which is not a repetition of the one previously experienced. It will be more resilient. And the community officials and the citizens will be developing a capacity to function adaptively in this more effective way.[8] Diagrams such as the one contained herein help communities, states, and federal government officials and staffs to visualize the simple outline of the process and the outcome. What each level of government might contribute through the exceptional recovery process to the essential resilience goal will be considered in the last section of this chapter.

The irregularities of extreme weather events place the destruction and thus the recovery efforts in different time frames, sometimes the same and sometimes different specific locations and at different levels of disaster – the vagaries of tornado outbreaks in the upper South and Midwest being an example. These uncertain conditions require that the capacity and focused attention of the exceptional recovery be coordinated and documented by state-level or regional agencies within the state rather than only by local communities. One wants the lessons available to all communities and counties subject to a variety of extreme weather disaster events, not just the ones who have experienced a disaster in the past.

Louisiana has the Office of Community Development (LAOCD) which functions primarily as the agency administering the federal disaster response funds. It also sees itself as the state agency responsible for resiliency enhancement:

> OCD-DRU manages the most extensive rebuilding effort in American history and works closely with local, state and federal partners to ensure that Louisiana recovers *safer, stronger and smarter* than before (Louisiana Division of Administration, Office of Community Development n.d.).

[8] Note: Recommending this model of a resilience process is not done ignorant of the fact that disaster occurrence is highly uncertain. Tying adaptation to disaster events may not be the best way to achieve resilience. Just to reiterate, it might produce more resilience at this time than efforts independent of extreme weather events.

Additionally, Louisiana has eight regional planning districts and an umbrella association, Louisiana Association of Planning and Development Districts (LAPDD), which declares interest in recovery and resilience (LAPDD 2018). These organizations can enhance the state's efforts to share the exceptional recovery successes.

1.4 "Placing" the Chapters into Exceptional Recovery/ Essential Resilience Framework

Can what is learned from research about Louisiana's experience make a contribution to better adaptation by those states growing in extreme weather experiences? This book represents what the American Academy of Arts and Sciences (AAAS) calls "science during crisis" (2019). All of the chapter authors and I hope that this effort adds *long-term adaptation* to the AAAS's goal for scientists and practitioners to "improve crisis response and recovery." The crisis is climate change-enhanced extreme weather impacts.

Part I of the book includes only one chapter that very successfully blends bio/physical/atmospheric analysis with the human/social dimensions of extreme weather response, what is called the "coupled natural-human coastal system" (NASEM 2018). It is written fully in the spirit of the goal that the book honor transdisciplinary research and analysis. Donald Boesch, a native Louisianan with a national reputation for bioecological oceanographic research, academic environmental science management, and environmental policy focused on climate change adaptation, has honored the transdisciplinary goal with a fully integrated discussion of Louisiana's growing extreme weather challenges and their effects on and response by communities and residents of the state.

The chapters in Part II consider methods (exceptional recovery) of achieving successful essential resilience and what challenges are/have been encountered with the efforts undertaken. Chapter 3 by Zachary Lamb is about the force of in the process of recovery planning, specifically the role of representing seriously flooded neighborhoods as green dots on widely publicized maps that indicate which neighborhoods were proposed "for sacrifice" to recovery redevelopment by turning them into green spaces for holding floodwater. The maps reinforced a politically insensitive representation of class and race privilege in the Katrina recovery planning process contributed to by out-of-town planning consultants and city development leaders. This public memory from Katrina recovery planning taints implementation of the current New Orleans Rockefeller-HUD $141 million resiliency grant for climate change, almost 15 years after Katrina. It demonstrates that exclusion of citizen participation in recovery planning is a mistake and calls into question government legitimacy in response to one disaster and reduces the likelihood of *exceptional recovery* occurring before the next.

Chapter 4 by Kevin Gotham and Megan Faust considers the benefits and drawbacks of national versus state/local responses to extreme weather in a comparison of New Orleans after Hurricane Katrina and New York City after Hurricane Sandy.

Encompassing cases merge the combination of state/local and national efforts/policy and consider the benefits and drawbacks of each configuration. Given the expected challenges with relying on federal solutions and aid for extreme weather adaptation, especially for events impacted by climate change, such a comparative consideration and refinement of the *subnational* level are critical for future successes.

Chapter 5 by Scott Hemmerling, Monica Barra, and Rebecca H. Bond offers a very comprehensive description of the evolution of Louisiana's coastal restoration efforts. This chapter offers a picture of one, if not *the* largest, *state*-managed environmental restoration program in the country and its evolution from a project-to-project process to an ecosystem modeling approach. If and how the citizen participation process has improved to support the large, ecosystem-impacting projects is framed in social justice terms. Similar to the green dot example, the risk to rural residents of the project's fisheries impact results in the authors arguing for the importance of creating a planning process that offers an important role to citizen participation and that trusts its importance and contribution to the success of proposed policies and restoration projects.

Part III includes two very different chapters about the issues involved in moving coastal residents inland. Chapter 6 by Nathan Jessee recounts the resettlement process to date of an indigenous tribe that partnered with the state of Louisiana to seek funding for such after two earlier efforts at resettlement failed. The process and challenges to a successful resettlement are presented, and the parallels to earlier treatment of indigenous Americans are described. Resettlement has been romanticized in American culture, while implementation contains parallel structural violence consistent with past experiences of indigenous peoples.

Chapter 7 by Kristina Peterson examines a topic to date rarely found in the social science literature: The dynamics of the relations of climate displaced populations with the receiving communities and their existing challenges. Differences in cultural backgrounds, race and social class are considered as challenges to overcome but may also be seen as opportunities with a firm commitment to make them be so. Peterson proposes approaches that could address these differences and ways migration could be framed to achieve a positive acceptance by the receiving communities including the focus of culture, food, and religion as unifying elements of the "blending" cultures rather than barriers. She also examines issues of identifying environmentally healthy high ground to avoid the repeat victimization that occurred to Katrina migrants during the 2016 floods that hit central Louisiana and flooded them again in their new locales and encouraging receiving community residents and the in-migrants to work together for an improved inland community.

Part IV is organized to include research on adaptation challenges that confront communities of varying sizes, types, and geographic framings, including work on urban, suburban, rural, and watershed communities.

Chapter 8 by Anna Livia Brand and Vern Baxter and Chap. 9 by Andreanecia Morris and Lucas Diaz consider the extreme challenges of achieving *urban* exceptional recovery in the context of economies that understate risks to lower income residents. They examine the way the government and the economy frame recovery

in a neoliberal political economy paradigm. The authors demonstrate how social and environmental injustice were manifest in a racialized recovery of New Orleans that stands as an extension of pre-Katrina forces and decisions. They recommend ways to return to citizen participation and expanded citizen influence in the recovery process as ways to deracialize it. Chapter 9 provides a case study of the efforts of a housing coalition to modify the "regime" of decision-making and implementation of adequate affordable housing after Katrina by negotiating a compromise of vested interests. Affordable housing, in crisis mode 14 years after Hurricane Katrina, is seen as a key element to a more resilient and disaster-adaptive populous.

Chapter 10 by Michelle Meyer, Brant Mitchell, Shannon Van Zandt, and Stuart Nolan considers how a climate change-affected extreme weather event presents different requirements for an adaptive recovery. First, the speed of the disaster – multiple inches of rainfall in a short period of time – requires the development of different response assistance as pre-event evacuation is not possible because there is no known severe event predicted early enough to initiate evacuation. This new need is described. Second, the impact is discussed of how a storm with such a deluge of flooded areas outside of the floodplain contributes even more to housing shortages post-event for renters who compete with flood victims in search of rentals, if only as a temporary habitation during rebuilding.

While the population in Louisiana is predominantly urban, coastal rural areas have been subject to frequent destructive storms, while significant inland areas joined this challenge after the 2016 floods. Research on Katrina was severely criticized for its focus on New Orleans to the detriment of learning more about the *exceptional recovery* challenges rural areas experienced. Chapter 11 by Alessandra Jerolleman focuses on the theories of rural extreme weather risk and response with the spring 2016 flood as the case analyzed. Limited resources, distance from the state's power brokers, and possibly being asked to serve as receiver communities while under rural stresses are clearly evident in rural extreme weather challenges.

Design and planning principles explored through a resilience thinking lens can inform a science-based but socially grounded program to increase adaptive capacity, but they are not without their challenges. Chapter 12 by Traci Birch and Jeff Carney offers a review and synthesis of adopted community planning principles and processes that suggest disparate planning frameworks, and agencies are addressing physical and social environmental needs, but a more holistic approach to adaptation is needed.

1.5 Subnational Adaptation Management: What Each Level of Government Might Best Contribute to the Exceptional Recovery Process and Essential Resilience Outcome?

The theme of this book – a state's experiences and responses to extreme weather including that which is climate change-induced – will likely be a theme studied over and over again as more states move into the trajectory of such challenges. California

is certainly a state that has a near-term robust history of extreme weather/climate experiences and their responses to them like Louisiana, a recent comparison made by Hayden and Cochran (2019). Others could also be mentioned – Texas, Florida, North Carolina, Virginia, New Jersey, and New York.

Undertaking a book about a state also gives me the opportunity to explore if/how more emphasis on state and local adaptation response/control rather than federal would be more effective. I asked specialists their opinion about the question. One replied: "The role of states in hazard mitigation planning was a hot topic up until about a decade ago, but there has been a real drop off."[9] Yet while the interest in the state role has waned, Berke's research itself showed that "federal policies do not make a difference in local land use actions, but state policy exerts a strong influence" (Berke et al. 2014). The increases in climate-induced extreme weather suggest that new research on the combinations and leadership emphases of the government levels are highly warranted. Reinforcing the critical nature of adaptation efforts, former Regional Administrator for the US Department of Housing and Urban Development (HUD) in New York and New Jersey during the region's recovery from Sandy, Irene, and Lee, Holly Leicht, stated: ". . . it is a huge financial and administrative challenge for cities and states to prepare for the ever-widening range of threats the future may hold" (Leicht 2017, p. 2). Note the emphasis on subnational despite her holding a federal agency administrative position.

While the chapter authors were not asked to consider specifically whether/if subnational adaptation would be more successful, they were asked to consider social justice issues about their topics. I ask the reader to consider whether what you learn from the chapter authors may contribute to your assessment of the role of subnational adaptation, including the benefits or not for social justice in extreme weather response. For example, Scott Hemmerling and his co-authors consider the social justice challenges of the state-level coastal restoration plan. That it is at the state level does not seem to have helped the program commit and implement social justice processes and outcomes systematically from the beginning as they have committed say for diversion sediment physical engineering modeling. One might have assumed because the state coastal restoration efforts are closer to the residents and to the communities, that might have been the case. Continuing the thinking, would a federally run coastal restoration program have done any better? Do we as a society know how to fully engage citizens and communities in the critical decision-making process related to climate change extreme weather response that honors residents and communities fully? It is an imperative that we learn how to do so: "Just recovery requires the full harnessing of communities' transformative and adaptive capacity, honoring their definitions of resilience, in order to reduce risks for the future" (Jerolleman 2019, p. 99).

[9] Personal communication with Philip Berke, Director, Institute for Sustainable Communities, Texas A & M University, March 11, 2019

1.5.1 Qualities of the Government Levels That Challenge/ Benefit Adaptation

How can the interaction of these three concepts – essential resilience, exceptional recovery, and level of government – be framed for future research on the topic? What has to be considered for each level and the interaction among them to be considered to answer this question? This section will reinforce the need to consider the qualities and challenges of each level of government when deciding whether the federal or the subnational level is best to lead the adaptation. Examples of pros and cons of emphasizing the various levels of government for successful climate change adaptation are offered in Table 1.2. It is not the goal of this introductory chapter to immerse the reader in the details of each of these positive or negative qualities. Rather it is the intent to demonstrate the complexity of the answer to the question: Which level? And, to add to that complexity, the question of which levels serves the most adaptations or the most important adaptations? Or the recovery trajectory, the exceptional recovery, or the utilization of the achieved essential resilience? *MUCH* more research is absolutely necessary.

1.5.2 Avoiding Harm While Improving Federal/State/Local Adaptation Configurations

With this deeper exploration of improving extreme weather adaption by reconfiguring the role of the levels of government comes a serious conundrum, and it is flagged by the recommendation I am making to continue to link adaptation with recovery – a *federally* overseen and funded effort – while I am asking you to think about how emphasizing state and local actions might generate more productive climate adaptation than federal. Adaptation innovations must be conceived and implementations attempted and evaluated at different levels of government *while* the current government level in charge of recovery and mitigation is utilized to respond to current disasters and develop improved adaptations. And, there is no time to delay working on both adaptations – within the current federal system *and* adaptations managed by the lower levels of government.

An example of the challenge framed in this conundrum can be seen in the extreme difficulties which the community and the state of Louisiana are having in trying to achieve just resettlement of the Isle de Jean Charles Biloxi-Chitimacha-Choctaw Tribe (Jessee, Chap. 6, this book). The funding came from the innovative Rockefeller/ HUD CDBG-DR NDRC discussed in several chapters of this book. Thus, the funds are *federal funds governed by CDBG requirements*. While the plan that was awarded the $48 million proposes that the Tribe (local) be in charge of the implementation and follow the designs the Tribe created with design/experienced construction implementers, some indigenous, chosen by them, the state has modified that plan to conform to the CDBG implementation process. The Tribe is not in charge; the

Table 1.2 Pros and cons of different levels of government taking dominant role in climate change adaptation

	Pros	Cons
Federal	Knows what practices work for mitigation/adaptation and can give guidance (Leicht 2017) Can hone adaptation standards with nationwide data input and then enforcement Currently where most of the taxes are collected for the country and thus the funding is located (Bullock 2016) Encourages adaptation actions when there is insufficient local support for some such as required elevation for residential structures	Some states/communities may feel that federal requirements are meddling in local and state efforts (Leicht 2017). Freeboard elevation requirements are an example One size fits all – but does it? Mitigation (adaptation) outcomes less flexible and thus may be less useful for specific locales Beginning to be overwhelmed by disaster events and costs and thus threatening to limit recovery funds (FEMA 2018a; Becker 2019) Extremely slow pace of providing recovery response and showing no sign of improving the pace turn locals against federal role in exceptional recovery (Laska et al. 2018) Inadequacy of the federal disaster response staff (GAO 2018; Montjoy et al. 2010). No expectation that federal adaptation management by them would be better Heavy imbalance between recovery efforts for homeowners versus renters/landlords (Hersher and Benincasa 2019). Why expect otherwise for adaptation? Extreme social justice challenges Funding only the most secure protection measures that are appropriate for all flood hazards has been at the expense of explaining and encouraging "less perfect," but much less expensive, efforts that can be effective for shallow, slow moving flood and drainage problems (Wetmore 2019)
State	Can easily seek best practices from peers (states) with similar risks (Leicht 2017) Place-based realities and appropriate approaches more evident (Leicht 2017) Sharing adaptation ideas among its constituent communities more proximate, within some similar conditions, more personal sharing experience (State of Louisiana 2018) State is responsible for land-use regulations which will be even more important with adaptation	Possible infrequency of events occurring reduces capacity to use the opportunities for adaptation due to loss of methods in bureaucratic memory loss. Unfortunately, with the prediction of increased climate change disasters expected, this concern may wain Resistance to adaptation due to perceived additional costs of building construction by developers such as resistance by the Louisiana Codes Council to require extra elevation when building residential structures (Smith and Booher 2017) Limited state planning regulations nationwide to address hazard mitigation that would be supportive of climate change adaptation (American Planning Association 2018)

(continued)

Table 1.2 (continued)

	Pros	Cons
Local	Public/private partnerships may be more doable at local level (Leicht 2017) Better place-based approaches are achievable (Leicht 2017). In the context of "agency," residents can feel and further develop the connection between their knowledge, engagement, and resilience adaptation outcomes to their community's risks (Laska 1986, 1990) Experiencing the climate change-induced extreme weather event with all of its specific extreme and unusual qualities provides a direct link between experience and impetus to adaptive action, overcoming psychological resistance (Meyer and Kunreuther 2017) Achieving adaptation successes or even failures that induce adaptation revisions builds resident capacity and feelings of agency (Laska 1986, 1990)	Neoliberal capitalism encourages benefitting the redevelopment class not necessarily to the benefit of the community, especially poor and racial, ethnic, and Native American minorities (Brand and Baxter, Jessee, both this book) Before citizen capacity to participate is grown, the citizens may not be enable to have full participation in the decision-making, and thus they can be harmed (Lamb, this book) Disparate financial resources among communities may put some at extreme risk even though residents invest in considering adaptation, rural communities, for example (Jerolleman, this book)
Across levels		Multiple administrative layers – at all the different levels of government – hamper efficient, effective, and timely use of disaster recovery funds (Sloan and Fowler 2015). They may hinder climate change adaptation even more due to noninstitutionalized nature of new activities At both federal and state levels, better resourced states and communities and more politically powerful ones – usually co-occurring – likely will achieve most adaptation opportunities

Note: Appreciation to Alessandra Jerolleman for contributing to refining this list. (Personal communication, May 9, 2019)

implementation process and outcomes are not what the tribe intended (Jessee, again, Chap. 6, this book). Brunner and Nordgren (2016) suggest that past adaptation successes succeeded in making incremental adaptation progress when and where they could adapt their resources to the *circumstances in a community.*

Has this been done adequately with the Tribe? Despite the federal regulations, could it have been done better, like Brunner and Nordgren (2016) propose? Adapt the adaptation resources to the *circumstances in a community* as much as is currently legally possible; and challenge the federal government to adjust their rules and regulations as climate adaptation opportunities emerge in configurations different from the actions current federal programs and rules prescribe. Could climate change innovation have been successfully implemented within the bureaucratic constraints?

Merely coining it a *resilience innovation* was totally inadequate to facilitate an innovation. This example stands as a clear example of the challenges that the country, the states, and the communities are/will have transferring from the earlier recovery model to an adaptation one that is community- and state-based.

The Tribe's cultural and interpersonal existence is being put at extreme risk because the innovation they proposed to reduce their physical and cultural risks from extreme weather, and for which the $48 million was awarded, does not fit the current federal rules and procedures and goals of the state – that being a generic model for resettlement or any CDBG program's implementation. The Tribal members and leadership are caught "dangling" between what they proposed to do – resettle from the physical coastal risk in a manner that would encourage tribal and lifeway survival – *and* what the federal and state governments are prepared to do, which are actually currently being carried out.

Extremely important, this conundrum was not recognized by the Tribe before the competition was implemented by a foundation and a federal agency; to this author's knowledge, it was not even considered adequately and without public communication of the challenge by those who put the competition together and implemented it. Innovation can seriously harm when it is not thoroughly thought through as much as possible *before* the innovation is attempted to be implemented. Careful study of climate adaptation innovation while it is being developed and during its initial/early implementation is an absolute requirement for just, equitable implementation of it. This holds for whichever level of government is the lead as well as the partners at the other levels. The Tribe's innovative plan which got the proposal selected, the $48 million awarded, was caught in a government system that could not handle the innovation.

The tension between innovation and government rules and regulations threatens the most vulnerable more because it is they who need the adaptation the most and the earliest. It is very, very likely that the Tribe will decline in maintaining its cultural practices and tribal interpersonal dynamics that they had before participating in the stressful Rockefeller/NDRC innovation application and ensuing project that has not addressed the vision and the goals the Tribe articulated in their application. We cannot accept this risk to them as the price *they* pay for the society not approaching the Tribe's climate change adaptation very, very carefully. Perhaps the likelihood of increased risk and harm to the most vulnerable should have excluded them from even seeking their resettlement through the competition? No more powerful a conundrum than that.

1.5.3 Speed of Recognizing Importance of Subnational Climate Change Response

When the project of creating this case study book first began, the editor believed that the subnational response to extreme weather was not being adequately considered for climate change-induced extreme weather response rather than just for "normal"

disaster recovery. I asked myself: Was there developing a statewide response? Were those responding seeing the differences between previous extreme weather events and what is occurring in the present? What challenges to adaptation were being experienced in specific Louisiana regions and community types of the state? What climate change adaptation efforts were being "birthed"? And their success? It was believed that from such a realistic case combining pre-climate change response with climate change response, recommendations would emerge for the utility or not of subnational adaptation to climate change as it becomes a more powerful driver of extreme weather. The chapter authors contributed their research on specific topics related to this: human-natural system interface, resident engagement requirements, and social justice considerations for those most vulnerable, moving of residents out of coastal risk, and resilience considerations with new climate change risk.

What was not anticipated was how rapidly the recognition of the role of the subnational response was being recognized within Louisiana and also being recognized around the nation. As discussed in Sect. 1.3.1 of this chapter, eight Louisiana adaptation programs were "birthed" during the preparation of this book. And, very clearly from media reports during the same period, subnational leaders – mayors and governors – are stepping forward to assume leadership of climate change adaptation and mitigation without being required to do so (Hersher 2018; Hirji 2019). Media reports of two such responses that were reported during late 2018 confirm this rapidly growing interest in subnational response.

The first example is the response to the release of the *Fourth National Climate Assessment*, Vol. II in late November 2018. Created by government agencies and citizens, it portended a future fraught with *rapidly increasing* climate/weather risks. The next day a media story reported that newly minted US governors recognized that the response to such a threat must include state-level action. The Associated Press headline read: *Natural Disasters Will Be a Priority for Incoming Governors* (Mulvihill 2018).

Similarly, US mayors and governors challenged President Trump's administration in their rejecting climate change by not sending an American representative to the UN Framework Convention on Climate Change (UNFCC) in the fall of 2018. Pittsburgh Mayor Bill Peduto commented:

> There are more than federal governments at stake now, and the sub-national level is really where it's going to get implemented anyway. . . It's really nice when nations sign documents, but what it really comes down to is *what we do in our own neighborhoods and what we do in our own cities*. (NPR 2018)

It is a critical time to consider how to accomplish the most successful essential adaptation. To that goal it is hoped that this volume about Louisiana and its response to extreme weather at the state and local levels engage other states and their government officials, residents, applied resilience research university and nonprofit researchers and practitioners and college students considering their futures to develop successful, just, equitable adaptations to climate-induced extreme weather, to achieve essential resilience. And the chapter authors and I have the same hope for more successful adaptation to essential resilience for Louisiana, for most of us are natives or "adopted natives" of the state. Finally, in emphasizing the state and local levels of response, we hope to have contributed to the very necessary body of

research about which level of government is poised to best lead these adaptation initiatives most successfully. There is no time to spare in appreciating the answer(s) to this question.

Appendix: Sources of Descriptions of New State and City Adaptation Programs (Numbers Coincide with Numbers on Table 1.1 on Page 9)

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Part I
Louisiana's Risks Anticipating the Future Challenges to Other U.S. Coastal Communities

Chapter 2
Managing Risks in Louisiana's Rapidly Changing Coastal Zone

Donald F. Boesch

2.1 Introduction

While both strategically important to the nation and bountiful in so many ways, Louisiana's coastal zone has always been difficult to access and risky to live in. Much of its landscape consists of wetlands: bottomland forests, swamps, marshes, and mangroves that are continuously, seasonally, tidally, or meteorologically inundated. Most of what passes for dry land is just a few feet above sea level and subject to episodic flooding from the mighty rivers – the Mississippi and the Atchafalaya – that flow through it, locally intense rainfall, and ocean storm surges. Powerful tropical storm winds and associated tornadoes pose additional weather threats to human communities and the built environment.

The complex and dynamic water world that is coastal Louisiana constrains where people live and how they move across the landscape. Early European settlers were confronted by devastating river floods almost immediately after their arrival, and, despite the flood protection systems and elevated infrastructure that were developed over the next 300 years, the threats of rising waters and damaging winds have remained a fact of life for south Louisiana communities and enterprises. Both have moved and adapted in response to extreme weather events in ways that have decreased, but sometimes increased, their vulnerability.

While extreme weather events challenge social resilience, i.e., the ability of communities to cope with and adapt to stresses and disruptions, these transient phenomena are experienced against a background of powerful secular (in the sense of long duration) trends that further test this resilience. Particularly since the mid-twentieth century, the coastal landscapes have been rapidly deteriorating as a net result of geological subsidence, human interference with the processes that build and sustain

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the coastal landscape, and substantial modification of its hydrology. Moreover, the body of science has made it abundantly clear that human activities are warming Earth's atmosphere and oceans and changing its climate in ways that are enormously consequential for south Louisiana, including accelerated sea-level rise, intensification of precipitation, and more powerful tropical cyclones.

This chapter sets the biophysical stage for the case studies and perspectives on social resilience that follow in this volume. First, I provide an overview of the geomorphic fabric of coastal Louisiana, how it affects human society, and how humans have modified it. I then summarize the kinds of flooding threats, the notable disasters that have occurred, and the flood protection systems that have been created. From there I move to the strategic coastal protection and restoration that is being planned and implemented in Louisiana, before considering global climate change as a threat multiplier that will also have to be addressed. Finally, I conclude with some perspectives on the implications of the rapidly changing coastal landscape for social resilience within these other coastal regions of the United States.

2.2 Geological and Human Development

2.2.1 Creation and Evolution of Coastal Landscapes

The people of south Louisiana live on the youngest land in the United States, except for a few small purchases built on barrier islands or filled shallows. As the massive glaciers rapidly melted at the end of the last ice age about 20,000 years ago, the level of the world's oceans rose by about 120 m (400 feet) over 12,000 years (Stanford et al. 2010). Large areas of coastal land were submerged becoming continental shelves, and shorelines retreated until sea level reached a relatively stable point about 7000 years before the present. The level of the world's oceans was nearly constant or slowly declining during the period of European settlement of North America (Kemp et al. 2011). Today, residents of most US coastal areas today live along those same shorelines. But in Louisiana the escarpments marking those 7000-year-old shorelines are now far inland from the Gulf Coast, north of Lake Pontchartrain, and just below Baton Rouge and Lafayette (Saucier 1994).

When the rapid rise in sea level finally slowed, a large marine embayment stood between Baton Rouge and Lafayette into which the Mississippi and other great rivers flowed. With the inland march of the sea finally stalled, sediments discharged by these rivers began to fill up the embayment and then reclaim the shallow Gulf of Mexico by protruding successive delta lobes (Blum and Roberts 2012; Bentley et al. 2016). As a delta lobe grew through the deposition of river-borne sediments, it created branching distributaries, some of which left remnants as today's bayous. Sediments were deposited at river mouths and via overbank flooding, crevasse formation, and infilling of older distributaries (Roberts 1997). As flow gradients diminished, the river sought a quicker path to the sea, breaking out to begin a new delta

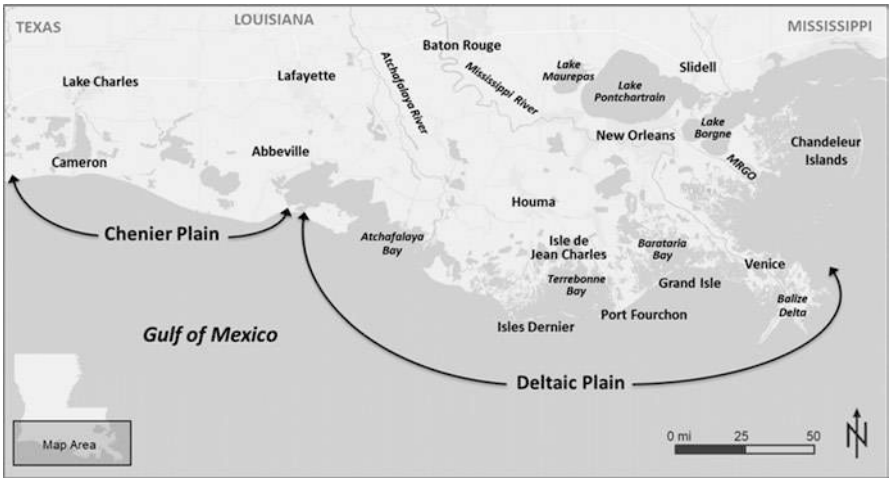

Fig. 2.1 Map of southern Louisiana showing important cities, water bodies, and geologic provinces. (Base map courtesy of Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community)

lobe. The river's flow did not switch all at once, and the flow was often conveyed down both the old and the new delta.

Eventually, five or six major deltas – depending on how they are distinguished – were formed over the past 4600 years (Roberts 1997; Bentley et al. 2016) with their remnants constituting the landscapes of the Mississippi Deltaic Plain (Fig. 2.1) from Abbeville in the west to the border of the state of Mississippi in the east. The easternmost St. Bernard Delta was active between 2800 and 1000 years ago, extending beyond today's Chandeleur Islands and enclosing large coastal embayments, creating today's lakes Maurepas, Pontchartrain, and Borgne (Fig. 2.2). The earlier Teche Delta (3500–2800 years before present) and Lafourche Delta (1000–300 years ago) filled in the landscapes between the present Atchafalaya and Mississippi rivers. The towns lying along today's bayous Teche and Lafourche sit on natural levee deposits of the past main channels of the great river. The presently active Plaquemines Delta below New Orleans is only 750 years old, and its iconic extension to the edge of the continental shelf in the form of a bird's foot (the Balize Delta) has only existed for about 550 years or since shortly before Columbus discovered America.

A new delta complex began to emerge in Atchafalaya Bay with the 1973 flood (Roberts et al. 2003), more than 20 years after the Atchafalaya River had captured more than 30% of the flow of the Mississippi and Red rivers and its vast swamp basin filled with sediments (Piazza 2014). With the flow since 1963 regulated under law at 30% of water of the lower Mississippi, two delta lobes have been building in the Atchafalaya Bay along central coastal Louisiana.

As the Mississippi river deltas switched back and forth to build southeastern Louisiana, sediments discharged into the Gulf or released from eroding shorelines drifted to the west along the coast under the influence of currents and waves.

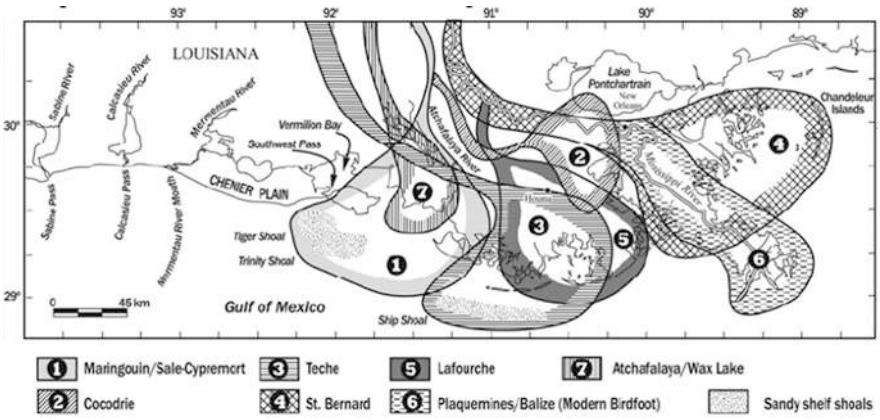

Fig. 2.2 Delta lobes of the Lower Mississippi River Deltaic Plain numbered in chronological order of formation. (Image source: McBride et al. 2007)

This also resulted in the development of new land in the form of a strandplain characterized by old sandy or shelly beach ridges running parallel to the coast and separated by marshes and swamps (Penland and Suter 1989; Bentley et al. 2016). This Chenier Plain (Fig. 2.1), referring to the oak (chêne in French) trees growing on the ridges, extends for 200 miles along the Louisiana coast from Vermillion Bay to Galveston, Texas. Throughout much of southwestern Louisiana, the Chenier Plain extends inland about 30 miles from the coast.

Once deprived of the river sediments that nourish them, the landforms of both the Mississippi Deltaic Plain and Chenier Plain deteriorate under the effects of geological subsidence caused by compaction of the accumulated sediments and the exposure to forces of the waves, tides, and surges of the Gulf of Mexico. The outer edge of the delta erodes, and the sand deposits remaining are reshaped as flanking barrier islands and the inter-distributary wetlands open up as estuarine bays, such as present-day Barataria and Terrebonne bays (Blum and Roberts 2012). Still, tidal wetlands are sustained for centuries by trapping eroding sediments and growing upward as the soil beneath them subsides (Reed 1989). The skeletal framework of distributary ridges and barrier islands protect interior wetlands from marine forces and saltwater intrusion (Salinas et al. 1986). Coastal ecosystems, consisting of tidal wetlands and channels and shallow bays, are enormously productive of fish and wildlife during this phase (Twilley et al. 2016). Eventually, the barrier island arc becomes detached from land by a broad sound, such as is the present condition for the Chandeleur Islands to the east (Fig. 2.1). Finally, all that remains of the barrier islands are submerged sandy shoals located miles offshore on the inner continental shelf of the Gulf of Mexico. Subsiding and eroding, the deterioration of landforms is exorable until a subsequent delta revisits the area.

The Chenier Plain also underwent periods of land building, when the river delta had moved toward the west, and then erosion, when the delta shifted farther away toward the east (Penland and Suter 1989; Bentley et al. 2016). The beach ridges

consisting of coarser sediments were formed during these erosional periods. Deprived of delta sediments, wetlands in the Chenier Plain are currently subsiding at a much faster rate that they are able to vertically accrete soils (Jankowski et al. 2017). In contrast, sediment supplies to the Deltaic Plain wetlands allow them to accrete more soil.

Since human habitation, the expansive coastal zone of Louisiana has always been young, low lying, wet, and highly dynamic, thus posing challenges to human survival, health, prosperity, and social fabric.

2.2.2 Human Settlement and Its Risks

Native Americans first occupied the dynamic Mississippi Deltaic Plain about 2000 years ago (McIntire 1958). They left remnants of their occupation in the form of shell middens and earthen mounds located near river channels or distributaries or on barrier ridges. The mounds accommodated their refuge during occasional river and estuarine flooding, providing the community resilience required for living in this bountiful but challenging wet landscape.

Although the establishment of the outpost of Natchitoches preceded it by 4 years, the site of New Orleans was selected for the first French settlement in south Louisiana in 1718 because it controlled the lower Mississippi River and also afforded access via Bayou St. John to Lake Pontchartrain (Colton 2005). In making this decision, Sieur de Bienville was well aware of the frequent risks of river flooding, but, as geographer Peirce Lewis noted, New Orleans was the "inevitable city" in the "impossible" site. The early city was built on the natural levees of the Mississippi River that rose no more than 12 feet above sea level. The colonists did not have to wait long as floods the next spring slowed construction (Campanella 2008). Then, in September 1722, hurricane winds knocked down shoddily built structures, wiping the haphazard slate clean for laying out the street grid that exists in the Vieux Carré today.

Also that year, construction of the first artificial levees to protect from river floods began. Still, frequent floods inundated farms that were spreading along the banks of the river above New Orleans, destroying crops and damaging homes. Moreover, floodwaters reaching the backswamps beyond the natural levees cause backwater flooding of relatively developed areas otherwise protected by river levees. Colonial laws in 1728 and 1743 required landowners to build and maintain levees along their properties fronting the river. By 1763 these stretched 50 miles above the city (Colton 2005). By the time Louisiana became a state in 1812, artificial levees extended from as far north as the Red River to below New Orleans along the west bank and from Baton Rouge to below New Orleans on the east bank. Still, there were occasional urban inundations during the late eighteenth and early nineteenth century due to breaches in the levees fronting the city or its suburbs or resulting from crevasses farther upriver that filled the backswamp and inundated the city from the rear. The most notable example was the 1849 crevasse at Sauvé Plantation that

displaced 12,000 of New Orleans' 116,000 residents, the city's worst flood until Hurricane Katrina in 2005 (Campanella 2008).

Nonetheless, the increasing effectiveness of artificial levees along the lower river provided security that allowed expanded development of New Orleans and across the river along the west bank. Paradoxically, it also elevated the threat of river flooding by reducing outlets for floodwaters either over the levees or through natural channels, thus raising the stage of the river for a given flow rate. This realization initiated a nearly century-long debate over whether flood protection should continue to rely on a levee-only strategy or also incorporate floodways to lower the river levels (Barry 1997).

This debate came to a head following the Great Mississippi River Flood of 1927 that inundated 26,000 square miles from Cairo, Illinois, to the Gulf, displacing a half-million people and threatening New Orleans (Barry 1997). The Flood Control Act of 1928 shifted policies from levees- only to include not only massive levees and floodwalls but also control structures and spillways, all under the responsibility of the federal government. Today, high stages in the lower Mississippi are constrained by opening the Bonnet Carré Spillway, sending water to Lake Pontchartrain, or the West Atchafalaya or Morganza floodways, sending water down the Atchafalaya Basin.

As human settlements expanded from along the Mississippi River, across the Atchafalaya Basin to the land of the Attakapas in southwestern Louisiana, and down the bayous of the Mississippi Deltaic Plain, occasional river floods also threatened them. Settlements along Bayou Teche were often flooded, particularly during the 1927 flood (Bernard 2016). Bayou Lafourche carried a portion of the Mississippi flow until it was dammed in 1904. However, there are only modest, if any, artificial levees along these waterways; flooding has been mitigated through various flow control structures.

As development began to extend into the backswamps, canals and levees were constructed to facilitate drainage. Eventually, this required the removal of rainwater by perpetually operated pumps. The dewatering of the highly organic soils of these former swamps resulted in the loss of soil volume due to oxidation and enhanced subsidence (Colten 2005; Dixon et al. 2006; Campanella 2008). Consequently, much of the inhabited area of New Orleans and its suburban parishes lies below sea level, although that land was originally at or slightly above sea level when development began. Similar loss in elevation occurred where there were failed attempts to drain wetlands for conversion to agricultural polders. The resulting urban and agricultural bowls became more susceptible to rainfall-driven flooding and reliant on large-capacity pumps that can keep up with heavy rainfall.

Even before wetland drainage and development, bald cypress and other swamp and bottomland trees were mostly cut down for timber. The loss of tree cover, coupled with drainage and navigation canals (such as the Carondelet and New Basin canals through which commodities were transported into New Orleans), increased the susceptibility of urban areas to winds, tidal incursions, and storm surges. Many of these older canals were filled in or fitted with gates to reduce the risk of flooding resulting from tidal and storm surges; however, massive navigational channels were constructed perpendicular to the coast during the latter half of the twentieth century

(Gulf Intracoastal Waterway, Mississippi River-Gulf Outlet or MRGO, Houma Navigation Canal, and Calcasieu Ship Channel to Lake Charles). They have hastened saltwater intrusion and the resulting loss of cypress swamps and facilitated propagation of tropical storm surges toward population centers distant from the coast (Freudenburg et al. 2009b).

2.2.3 Broader Coastal Deterioration

The area of land, including wetlands, in the coastal zone of Louisiana more or less continuously expanded after sea level stabilized about 7000 years ago. Surely, abandoned delta lobes subsided and eroded, but new lands created in newly active delta lobes countered the resulting losses. The Chenier Plain lost ground when eastern delta lobes were most active but gained ground when the river switched it course to the west. The multi-millennial trend in slow net land gain was dramatically reversed during the twentieth century, with best estimates of land losses during the late 1970s of 32 square miles per year (83 km^2/y), now slowed to 11 square miles per year (28 km^2/y). Altogether, over 2000 square miles of land were lost between 1932 and 2016 (Couvillion et al. 2017).

Changes in the Mississippi-Atchafalaya River Basin are responsible for some of the losses. The present Balize Delta is perched on the edge of the continental shelf and deposits much of its terminal load of alluvial sediments into deep waters of the Gulf of Mexico, bypassing the coastal zone where these sediments could be held in wetlands and on shorelines. Erosion associated with land clearing within the Basin during European expansion increased the river's sediment load during the nineteenth century, but then dams constructed throughout the catchment by the middle of the twentieth century trapped sediments upstream. That, coupled with improved soil conservation practices, has resulted in a reduction by half of the suspended sediment of the lower Mississippi since the 1950s (Meade and Moody 2010; Heimann et al. 2011) to loads probably less than those occurring when major delta lobes were being built (Chamberlain et al. 2018). More of the combined river flow began to travel down through the Atchafalaya Basin after Henry Shreve cleared the Great Raft of logs clogging the Red and Atchafalaya rivers in the 1830s. This extensive basin trapped a large share of the riverine sediments transported such that a new delta did not begin to emerge in Atchafalaya Bay until 1973 (Piazza 2014).

Additionally, constraining the flow of the lower Mississippi with its channel by effective flood protection levees and closure of distributary channels almost all the way to its mouth have prevented the broad contribution of riverine sediments to the subsiding wetlands and shallow waters. Indeed, this was foreseen back as far as 1897, when an article on the Mississippi River Delta published in the *National Geographic* (Corthell 1897) stated: "no doubt the great benefit to the present and two or three following generations accruing from a complete system of absolutely protective levees excluding the flood waters entirely from the great areas of the lower delta country, far outweighs the disadvantages to future generations from the subsidence of the Gulf delta lands below the level of the sea and their gradual aban-

donment due to this cause." Unfortunately, we have already reached the fourth generation without a Plan B.

In addition to changes in the supply and distribution of sediment subsidies required to sustain the coastal plain landscapes, other human activities have resulted in land, and particularly wetland, losses. These include the kind of wetland "reclamation" and dredge and fill activities that caused wetland losses elsewhere, but particularly notable in Louisiana have been the extensive dredging of canals through the coastal wetlands. This includes not only the larger canals constructed for commercial or industrial navigation mentioned earlier but also myriad smaller canals mainly dredged for access to drilling sites and laying pipelines associated with oil and gas production. Dredged canals were seldom backfilled and generally do not fill in naturally by themselves. The spoil banks left interfere with the tidal water-level fluctuations needed for healthy, accreting wetland soils. The wetland losses associated with these indirect hydrological effects may be several times greater than the direct dredge and fill effects, potentially accounting for most of the observed wetland loss (Turner 1997), although this has been questioned (Day et al. 2000). Independent estimates suggest that the net effect of oil and gas canals has been responsible for at least 30% and possibly 50% of the wetland losses during the second half of the twentieth century (Penland et al. 1996). Needless to say, these estimates were strongly contested by the oil and gas industry, and the industry's responsibility has been caught up in political debates and judicial cases concerning liability for the costs of addressing the coastal wetland crisis.

Scientific evidence is also compelling that withdrawals of oil, gas, and associated briny water have increased subsidence rates and thus wetland loss rates in the vicinity of shallow oil and gas fields, such as those in Terrebonne Parish (Morton et al. 2006). The slowdown in fluid withdrawals from these old fields may be the principal cause of the reduction in the rate of subsidence as evidenced in the Grand Isle tide gauge record (Kolker et al. 2011). Similarly, the substantial reduction in new oil and gas canal dredging may have contributed to the lower rates of coastal wetland loss in recent decades (Couvillion et al. 2017).

In aggregate, the multiple consequences of human activities have resulted in deltaic deterioration over less than a century that would take a millennium due to natural processes, such as subsidence, delta lobe abandonment, and erosion due to winds and hurricanes. After the scale and rapidity of coastal wetland loss became apparent in the early 1980s, a succession of plans and programs were developed to slow, if not reverse, the losses. The primary motivation was the restoration of the unique coastal environments and the important natural resources they produce. Protection of coastal communities from flood risks proceeded on a separate, and sometimes competitive, or even antagonistic, track. The disastrous effects of Hurricane Katrina and Rita in 2005 made it clear that deterioration of coastal environments had increased storm surge risks and threatened the very existence of many coastal communities. This realization has required a more integrated and simultaneous approach to planning and implementation of the protection of society and restoration of the environment (Day et al. 2007). Projections of future land losses (Fig. 2.3) and increased flood risks as coastal landscapes continue to degrade (Fig. 2.4) have prompted the integrated planning discussed in Sect. 2.6.

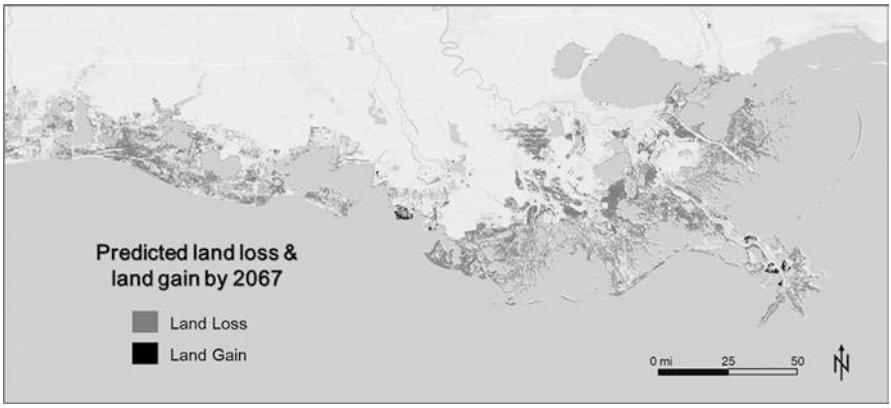

Fig. 2.3 Predicted land change by 2067 along the Louisiana coast. (Land change data retrieved from the Coastal Restoration & Protection Authority [CPRA]; base map courtesy of Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community)

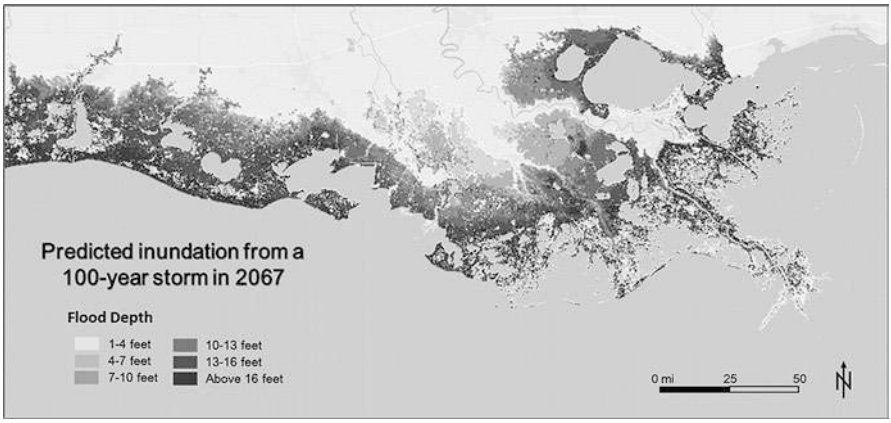

Fig. 2.4 Predicted inundation depths along the Louisiana coast resulting from a 100-year storm in 2067. (Flood depth data retrieved from CPRA Master Plan Data Viewer)

2.3 Extreme Weather Risks

2.3.1 South Louisiana's Climate

Beyond the risks of flooding from the Mississippi and Atchafalaya rivers, there are extreme weather risks associated with coastal Louisiana's climate. South Louisiana has a humid subtropical climate in large part due to the influence of the warm Gulf of Mexico. It has long, hot, humid summers and short, mild winters. Average annual rainfall increases from west to east, from 57 inches (145 cm) in Lake Charles to 64

inches (163 cm) in New Orleans. Rainfall is prevalent during all months, with somewhat higher precipitation in the summer and winter. In summer the prevailing southerly winds provide moist, subtropical weather often favorable for afternoon thunderstorms, sometimes resulting in flooding risks caused by extreme rainfall.

Typically, the most extreme rainfall (as much as 20 inches in a day) has been associated with tropical storms. Even greater rainfall amounts (40–60 inches) occurred in the Houston area when Hurricane Harvey stalled offshore in late summer of 2017 (van Oldenborgh et al. 2017). A similarly stalled depression dumped up to 31 inches of rain in the Amite and Comite river basins near Baton Rouge just a year earlier (van der Wiel et al. 2017). The devastation of these two flood events acted as a wake-up call that, in addition to river floods and tropical storm surges, Gulf Coast communities might be increasingly vulnerable to more extreme rainfall events caused by global warming. The connection with climate change is discussed later but has called into question the adequacy of existing floodplain management and drainage infrastructure for present and future conditions of extreme precipitation. Areas under forced drainage are particularly vulnerable. In August 2017 almost 10 inches of rain resulted in extensive flooding, damage, and inconvenience in New Orleans, which worsened because some of the city's drainage pumps were offline and the drains and catch basins had not be adequately maintained.

Extreme temperatures also pose both social and environmental risks. Historically, New Orleans experiences an average of 75 days per year with temperatures 90 °F or above. Prolonged heat waves or very warm and humid conditions that coincide with power outages caused by tropical storms, such as happened in New Orleans after Hurricane Katrina, pose very serious human health risks. Periods of very hot and dry conditions have been associated with sudden dieback of salt marsh, the so-called Brown Marsh phenomenon that affected over 100,000 ha of salt marsh in the Mississippi Deltaic Plain in the year 2000 (Visser et al. 2002). On the other hand, hard freezes during the winter can kill or stress black mangrove shrubs that characterize some tidal wetlands very near the Gulf of Mexico. Conversely, expansion of mangroves into salt marsh vegetation has been observed following a succession of years without killing freezes (Perry and Mendelssohn 2009).

2.3.2 Tropical Cyclones

Of course, coastal Louisiana is notoriously at risk from the storm surges and damaging winds of tropical cyclones, including depressions, tropical storms, and hurricanes. As was mentioned earlier, the first residents of New Orleans were introduced to the ferocity of a hurricane just 4 years after the city's founding. Over the period of record, an average of about one tropical storm or hurricane per year met landfall along the Louisiana coast (Roth 2010), but there have been periods where there are none (recently 2014, 2015 and 2016) and other years where have been two or more in a year. The occurrence of two powerful storms each in 2005 (Katrina and Rita) and in 2008 (Gustav and Ike) is etched in the memory of many south Louisiana residents.

A strong hurricane hit New Orleans in 1837. While it flooded marshes adjacent to Lake Pontchartrain, the city itself was buffered from the storm surge because of the largely intact marshes and swamps separating it from the lake, except around the two navigation canal basins (Campanella 2008). Another notable hurricane struck the Isles Derniers in Terrebonne Parish in 1856, killing more than 218 vacationers enjoying the relief of beach breezes without any warning of the approaching storm (Dixon 2009). Another hurricane in 1893 killed more than 2000 residents of Cheniere Caminada, between Grand Isle and Port Fourchon. Survivors abandoned that settlement, moving north to other communities farther up Bayou Lafourche (Brasseaux and Davis 2017).

In 1947 a late summer hurricane struck New Orleans with over 100-mile-per-hour winds, pushing modest storm surges inundating outlying areas to the east and in Jefferson Parish (Roth 2010). In response to this storm and one the following year, there was additional levee construction along the Lake Pontchartrain shore and adjacent marshes. In June 1957, Hurricane Audrey came ashore near the Sabine Pass, creating a 12-foot storm surge that destroyed the town of Cameron, causing damage 25 miles inland and killing 526 people in Louisiana alone.

In 1965, Hurricane Betsy had its landfall at Grand Isle with 160-mile-per-hour winds. Facilitated by the Gulf Intracoastal Waterway and the recently completed Mississippi River Gulf Outlet, its large storm surge reached Lake Pontchartrain and breached floodwalls to inundate much of the Gentilly, the Ninth Ward of New Orleans, and the neighboring suburbs in St. Bernard Parish. In response, Congress enacted the Flood Control Act of 1965 that put the federal government in the business of storm protection by raising and constructing levees and strengthening floodwalls to provide Category 3-level storm protection (Campanella 2008). Now protected, areas of New Orleans East subsequently experienced an explosive growth in residences and businesses, in a "levee effect" that paradoxically increases future damages by luring homebuyers into floodplains (Freudenburg et al. 2009a). Despite the protection by levees, the newly developed areas were not protected adequately from interior flooding due to poorly designed drainage (Baxter 2014).

Hurricane Katrina in 2005 had effects that in many ways mirrored those of Betsy, with a massive storm surge on the east side of the river assisted by the navigation canals and meeting little resistance from the by now nearly nonexistent cypresses swamps and deteriorated marshes. Post-Betsy levees in St. Bernard Parish and New Orleans East were overtopped, and floodwalls failed along the Inner Harbor Navigation Canal and the ungated drainage outfall canals penetrating into the city. This inundated not only the Ninth Ward, including post-Betsy developments in New Orleans East, and St. Bernard Parish but also the 80% of the city beyond the high ground along the Mississippi River (McQuaid and Schleifstein 2006). Because of the extent, persistence and devastation of the saltwater flooding and loss of power and other services, most New Orleans residents had to relocate away from the city. Many never returned. Altogether, 1836 people died directly as a result of Hurricane Katrina (Bevan et al. 2008), 1577 of them in Louisiana, and Katrina's total property losses have been estimated at $125 billion (Vigdor 2008).

There is a very voluminous literature on the events, effects, causes, responses, and lingering impacts of the Hurricane Katrina disaster. To the audience of this volume, I recommend books by the veteran reporters McQuaid and Schleifstein (2006) and the deeply experienced social scientists Freudenburg, Grambling, Laska, and Erikson (2009a). Both books emphasize that the disaster was as much human-caused as natural.

Less than a month after Katrina in 2005, a second highly powerful storm struck coastal Louisiana when Hurricane Rita came ashore near the Texas border. It caused major damage to communities in Cameron Parish and elsewhere along the southwest Louisiana coast, damaged freshwater wetlands in the Chenier Plain by inundating them with saltwater, and resulted in storm surge felt along the entire Louisiana coast. Some areas affected by Katrina were flooded again.

During September 2008 Hurricane Gustav came ashore in Terrebonne Parish, and Hurricane Ike had its landfall near the mouth of Galveston Bay just 2 weeks later, flooding and re-flooding many coastal Louisiana communities from Cameron to Plaquemines parishes. Two million people evacuated from south Louisiana in advance of Gustav's arrival, with its storm surge even splashing over newly installed floodwalls in eastern New Orleans.

During the decade of 2000s, Louisiana experienced the effects of a record number of tropical cyclones, including six hurricanes and six tropical storms. These disasters, particularly the Hurricane Katrina disaster, prompted national and regional responses to strengthen storm surge protection and to integrate protection with the rehabilitation of the degrading landscape. These responses are reviewed in the next two sections, starting first with the congenital Louisiana challenge of flood protection.

2.4 Flood Protection and Its Limits

2.4.1 Mississippi and Atchafalaya Rivers

The lower Mississippi River flood protection system developed after the Great Mississippi River Flood of 1927 has remained secure and effective despite some challenges. The biggest test came during the 1973 flood when Old River Control Structure was very close to failing when a scour hole developed under the Low Sill structure, causing part of the structure to collapse.

That year the Corps of Engineers opened the nearby Morganza Floodway for the first time since its construction in 1954, and up to 300,000 cubic feet per second (8500 m^3/s) of flow was diverted down the Atchafalaya Basin to reduce the flood risks for Baton Rouge and New Orleans. The Morganza Floodway was not opened again until 2011, when up to 173,000 cubic feet per second (4900 m^3/s) of flow was diverted. Opening the Morganza Floodway was also seriously considered in 2017. The Corps has had to open the Bonnet Carré Spillway more frequently after Hurricane Katrina than was typical since it was built in 1934: in 2008, 2011, 2016, 2018, and 2019 (twice).

Whether more extreme Mississippi River flows will be experienced with the changing climate remains to be seen, but multiple lines of evidence indicate that artificial channelization upstream has been the predominant cause of the amplification of flood magnitudes over the past century (Munoz et al. 2018). As the Plaquemines-Balize Delta rapidly subsides at rates exceeding 1 cm per year and the level of the Gulf rises, the elevation gradient of the river decreases, slowing flows and inducing sedimentation that further constrains the channel cross-section (Blum and Roberts 2009; Little and Biedenharn 2014). Conversely, because of the diminished elevation gradient, higher storm surges from the Gulf can propagate farther upstream.

During Hurricane Katrina, storm surges overtopped not only the levees intended to protect lower riverside communities in Plaquemines Parish all the way to Venice from hurricane storm surges but also the taller levees protecting from river flooding. With continued subsidence and accelerating sea-level rise, the ability to protect these lower river communities will diminish. The iconic bird-foot distributary system that has characterized the mouth of the Mississippi River over the last 500 years will at some point cease to exist, thus requiring the engineering of a new navigational access to America's great inland waterway. Already, an increasing proportion of the river's flow is being lost above the head of the passes that constitute the toes of the bird's foot, complicating the challenge of maintaining the main navigational entrance by high-velocity flows.

While planning for the eventuality of a new navigational entrance to the river has been put off by the Corps of Engineers and State pending completion of scientific and engineering investigations of lowermost river, a design competition called Changing Course (2016) produced some intriguing concepts, all of which would be expensive and require substantial changes in where and how people live downriver from New Orleans.

2.4.2 Greater New Orleans

Informed by extensive forensic analyses of Hurricane Katrina, the Corps of Engineers launched an ambitious effort to repair and enhance the flood protection system for greater New Orleans with a network of storm surge levees, strengthened floodwalls, surge barriers, and pumps. Constructed at a cost of $14.5 billion, the system is designed to provide near-complete protection from 100-year storm surge events and to significantly reduce flooding from a 500-year event. The levees were designed to be resilient in that they would not wash away as they did during Katrina, thus overtopping would only last a few hours rather than days. The new system includes a massive barrier east of the city to block storm surges coming from Lake Borgne and the Gulf Intracoastal Waterway and Mississippi River-Gulf Outlet (MRGO). MRGO was also closed to traffic and an armored, earthen dam placed across it.

2.4.3 Exurban Coastal Regions

The exurban areas around greater New Orleans and smaller cities throughout coastal Louisiana have not been afforded that same level of protection. Storm surge from Hurricane Isaac in 2012 raised water levels in Lake Pontchartrain, causing flooding in parts of LaPlace, upriver from New Orleans, and Slidell, across Lake Pontchartrain. Many former residents of New Orleans and St. Bernard Parish had moved to these communities after Hurricane Katrina and were flooded a second time. Extensions of levees, floodwalls, and gates to enhance the protection of communities along the east bank of the Mississippi from Lake Pontchartrain storm surge and communities on the west bank from Barataria Basin storm surge are proposed, but only one has been funded after decades of seeking funding, a $760-million project to protect the east bank of St. John the Baptist Parish and parts of neighboring St. Charles and St. James parishes (Bacon-Blood 2018). Even more expensive are the Morganza-to-the-Gulf system and the Lake Pontchartrain Barrier discussed in the next section on protection and restoration planning.

2.5 Coastal Protection and Restoration Planning

2.5.1 Evolution of Comprehensive Planning

Although there had been some earlier legislative or policy efforts to address the degradation of Louisiana's coastal environments, public and political attention to the problem began to be galvanized with the 1980 assessment that the state may be losing as much as 50 square miles per year of its coastal lands (Gagliano et al. 1981). In 1990, Louisiana members of Congress succeeded in enacting the Coastal Wetland Planning, Protection, and Restoration Act (CWPPRA) that produces a relatively modest, but steady, source of dedicated funding for wetland restoration. An implementation plan was developed, but it was clear that a more comprehensive framework was required that takes into account the dynamic geologic realities of the Louisiana coast (Boesch et al. 1994). In 1998 a state task force produced a strategic plan entitled *Coast 2050: Toward a Sustainable Coastal Louisiana* (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1998).

The year prior to Hurricane Katrina, the Corps of Engineers and the State released the Louisiana Coastal Area (LCA) Ecosystem Restoration Study (USACE 2004), and in 2007 the Congress authorized an overarching program that is, much like the Everglades Restoration Program, comprised of an array of separately authorized projects and the first of the intended specific projects. However, the effects of Hurricane Katrina made it clear that coastal restoration and storm surge protection had henceforth to be evaluated, planned, and executed in consort (Day et al. 2007). In response, the Corps of Engineers undertook the Louisiana Coastal Protection and Restoration Study (USACE 2009), and the State formed the Coastal Protection and

Restoration Authority (CPRA). CPRA produced its first Coastal Master Plan in 2007 and refined the plan in 2012 and again in 2017.

2.5.2 *Louisiana's Comprehensive Master Plan for a Sustainable Coast*

The latest Louisiana Comprehensive Master Plan for a Sustainable Coast (CPRA 2017; also referred to as the Coastal Master Plan) was approved by the state legislature in June of 2017. The Coastal Master Plan is the product of an extraordinary array of technical and economic analyses that considered varying assumptions about future conditions, resource constraints, and a multitude of project proposals. There was also extensive public consultation throughout its development and after its release prior to its ratification.

The Coastal Master Plan is intended to serve as a blueprint for the State's efforts both in flood protection and ecosystem restoration over the next 50 years. The Plan recognizes the reality of a smaller footprint of coastal lands in the future; thus "restoration" in this context is more of the rehabilitation of functions that sustain the ecosystem and maintain as much land as possible than the return to some previous condition. Implementation of the component projects would require $50 billion both from state resources and through federal appropriations and partnerships. The plan includes some 124 projects that could build or maintain more than 800 square miles of land and reduce expected damages from storm surges and other flooding by a purported $83 billion annually by the year 2067 and by more than $150 billion over the full 50 years. These projects include restoration of barrier islands and headlands, sediment diversions from the two major rivers, hydrological restoration, marsh creation using dredged sediment, ridge restoration, cultivating oyster barrier reefs, shoreline protection, structural protection from floods, and nonstructural risk reduction.

The Coastal Master Plan recognizes that not all needs are addressed by its current array of projects. More will be learned through further investigation and adaptive management of projects that are implemented. In particular, the Plan does not address the challenging questions related to lowermost Mississippi River management and how to maintain navigational access while using more of the river's water and sediment resources for restoration. Nor does it address changes in the allocation of river flow between the Atchafalaya and Mississippi river. These are issues of truly national importance that will have to be resolved.

The 2017 Coastal Master Plan places greater emphasis on coastal communities, incorporating understanding of "the cost of continued land loss and the potential effects of restoration projects on local communities, local businesses, and regional and national economies." In particular, there is a greater focus on flood risk reduction and resilience, including different types of nonstructural options and policies to help communities become more resilient.

2.5.3 Nonstructural Adaptation and Relocation

Nonstructural projects included in the Coastal Master Plan have the objective of reducing risks by floodproofing nonresidential structures, raising the elevation of residential structures, and acquisition of residential property. Although it is anticipated that some funding would be provided, all nonstructural projects are considered voluntary. Nonresidential structures in areas with projected 100-year flood depths of 3 feet or less could be renovated so they can be resistant to flood damage. Residential structures located in areas with a projected 100-year flood depth of between 3 and 14 feet could be elevated so that their lowest floors are higher than projected flood depths. Residential acquisition would be offered in areas where projected 100-year flood depths make elevation or floodproofing infeasible. The Coastal Master Plan does not contain specific relocation projects.

Residential acquisition and relocation are obviously very sensitive issues. In coastal Louisiana many residents have multigenerational ties to the places they live and extensive contemporary family and social networks. Still, the reality is that retreat of coastal inhabitants inland has been occurring for a long time, going back at least as far as the relocation of Cheniere Camanada families farther up Bayou Lafourche after the 1893 hurricane. New Orleanians relocated north of Lake Pontchartrain, to upriver communities, or to other parts of the country after Hurricanes Betsy and Katrina. Even less devastating tropical storms prompted movement away from the coast as a result of property damage, insurance settlements, and the cost of complying with new flood insurance requirements. Can this retreat be managed in a more considered manner that maintains the social fabric of communities remaining in the coastal zone or as communities move en masse? In particular, can this be accomplished for marginalized communities that are particularly vulnerable but lack financial resources and political voice?

A current test case is the planned resettlement of a community of Biloxi-Chitimacha-Choctaw people at Isle de Jean Charles, located on a shrinking ridge south of Houma, to a new location 35 miles inland near Shriever. Subsidence attributable to oil and gas withdrawals had hastened the loss of land around Isle de Jean Charles (Morton et al. 2006). The Louisiana Office of Community Development is managing the resettlement with the assistance of a $48 million grant from the US Department of Housing and Urban Development (HUD), with construction beginning in 2019. While the resettlement allows the prospect of keeping the community intact, the residents, while retaining access, will be far removed from the fishing, oyster cultivation, and trapping that have been traditionally the basis of their sustenance.

On a broader front, the State has created, from the same HUD resilience competition as the Isle de Jean resettlement, the Louisiana Strategic Adaptations for Future Environments (LA SAFE) program to assist communities to take proactive steps for adaptation to the rapidly changing coastal environments and risks (Louisiana Office of Community Development Disaster Recovery Unit 2017). The project expressly accepts that some of the most vulnerable communities will need to contemplate

resettlement over the next 50 years and that migration is already occurring. Funding thus far is for community engagement and co-design, and sources have not been identified for the significant resources required for residential acquisitions and resettlement nor for the $6.1 billion specified in the Coastal Master Plan for non-structural risk reduction.

2.5.4 Implementation and Controversies

Of course, the Coastal Master Plan will require the funding, public acceptance, legal sufficiency, and engineering feasibility of its component projects. After Hurricane Katrina the federal government provided over $14.5 billion to repair and improve structural defenses against storm surge, and the State and local government have invested heavily in improving drainage. At the same time, despite the federal authorization of the LCA Ecosystem Restoration Program, only modest funding has been made available for environmental restoration. However, as a result of payments, penalties, and damage compensation stemming from the BP Deepwater Horizon oil spill that occurred in 2010, the situation has now been reversed. Approximately $8 billion is likely to be provided from these sources for use in restoration in coastal Louisiana over the next decade or so. As a consequence, the State is now advancing planning and implementation of restoration projects without federal appropriations. Meanwhile, even many Congressionally authorized structural protection projects are slowed because of the lack of federal appropriations and limited state and local funding.

Paramount among these authorized but underfunded structural protection projects is the Morganza-to-the-Gulf array of levees, floodwalls, gates, locks and pump stations stretching 98 miles across Terrebonne Parish from to Gibson to Lockport. Intended to protect population center around Houma, the project is proceeding incrementally using State and local funding. At $8.3 billion, the Morganza-to-the-Gulf protection system is the single most expensive project in the $50 billion Coastal Master Plan. However, it confronts significant challenges with regard to the level of risk reduction that would be provided and the sustainability of wetlands enclosed by the levees (Twilley et al. 2008), as well as the engineering feasibility and cost of constructing significant earthen levees across the soft and subsiding substrates of the Terrebonne Basin.

The Lake Pontchartrain Barrier at a cost of $2.4 billion faces its own challenges, including the environmental effects of constraining tidal flows into Lake Pontchartrain and increased storm surge likely to be felt along the Mississippi coast as storm surges are prevented from entering the lake. If structural protection projects are not completed, significant population centers around Houma and Slidell would face increasing risks.

While the concept of coastal restoration enjoys substantial public support, individual projects face opposition from some members of the public or confront issues raised in environmental reviews for permits. Prominent among these projects are

diversions of sediment from the rivers to slow the loss and even build new wetlands by recreating the processes that built the Mississippi Deltaic Plain in the first place. Sediment diversions are thought by most coastal scientists to be foundational elements of any credible restoration strategy (Boesch et al. 1994; Day et al. 2007). However, some shrimpers, oyster growers, and sport fishermen have raised opposition because the river flows would freshen brackish estuaries and change the distribution of targeted animals (Muth 2014). Local landowners and residents have raised concerns about increased backwater flooding risks, and shipping interests have objected to potential shoaling of shipping channels as river flows are reduced below diversions.

Federal resource agencies have also raised concerns about the effects of estuarine freshening on essential fish habitat and populations of protected bottlenose dolphins, despite the fact that the present estuarine bays are relatively fleeting features resulting from coastal degradation and may be eventually converted to open Gulf waters without intervention for restoration. Nonetheless, planning and engineering for the Mid-Barataria Sediment Diversion at Myrtle Grove are proceeding, armed with funding from oil spill revenues, state political support, and federal commitments for fast-tracking of environmental permits.

Not only might sediment diversions from the river impact the interests of some stakeholders, but they also will likely take decades to build wetlands. Consequently, there are strong proponents of marsh creation using dredged sediments. The costs of marsh creation projects in the Coastal Master Plan total an estimated $17.9 billion of the $50 billion total costs. Not only will funding be a limiting factor but also will the supply of suitable sediment, at least for marsh creation projects located far from the resources of the Mississippi and Atchafalaya rivers. These will require long-distance pipelines, accessing sand resources from shoals on the continental shelf, or dredging nearby bays, raising questions of the high energy as well as financial costs (Day et al. 2005). Furthermore, marshes created by dredged material require periodic renourishment with dredged sediment to counteract subsidence and relative sea-level rise. Marsh creation may be accomplished more quickly than land building by sediment diversions, but is less sustainable.

2.6 Climate Change as a Threat Multiplier

2.6.1 Change Is Happening: Human-Caused and Dangerous

According to an overwhelming scientific consensus, global warming is occurring and is virtually all the result of human activities (USGCRP 2017). The six warmest years on record, in terms of global mean annual temperature, have come in the decade of the 2010s. Natural forces, such as solar activity, have played an inconsequential role in the observed warming since the mid-twentieth century. At current rates of growth in emissions of carbon dioxide and other greenhouse gases, dangerous climate changes would result before the end of this century, threatening the world's

biodiversity, acidifying the oceans, amplifying extreme weather events, causing economic hardship, and accelerating sea-level rise to the extent that it would render many low-lying islands and densely populated coastal regions uninhabitable.

These are mainstream scientific assertions (IPCC 2014; USGCRP 2017) that, while widely accepted around the world, are not as widely accepted within Louisiana's political leadership and the south Louisiana citizenry. There are various reasons why this is the case, including perceived economic dependence on the fossil fuel industry, mistrust in government solutions, resentment of the intellectual class, and the fear of cultural eclipse and economic decline about which sociologist Arlie Russell Hochschild (2016) wrote in her book *Strangers in Their Own Lands*. Enigmatically, she argues, those most at risk reject the needed solutions for these reasons. Furthermore, even well-informed Louisianans perceive the current crises as far more the result of natural processes and other human activities than of global climate change in a distant future. In any case, the unwillingness to address the reality and causes of global climate change presents a significant challenge in how its consequences can be brought into planning and action for coastal resilience in coastal Louisiana, both for the environment and for society.

While coastal Louisiana has long had to confront high rates of relative sea-level rise as a result of subsidence, the oceans themselves began to rise beginning only in the late nineteenth century (Kemp et al. 2011). The rise in global mean sea level accelerated through the twentieth century (Dangendorf et al. 2017) and has averaged about 3 mm/year since 1993, when satellite-born altimeters have allowed us to measure the level of entire oceans (Nerem et al. 2018). In addition to the expansion of warming ocean waters and melting of glaciers, the melting of ice sheets perched on Greenland and Antarctica is now contributing to global sea-level rise. Simply projecting the acceleration of rate of rise observed in the satellite record would result in a rise in global sea level of about 65 cm (2.1 feet) by 2100 compared with 2005. On top of subsidence, such a rise would be very challenging for the Louisiana coast but, as will be discussed in the next section, should probably be regarded as the minimum that will likely be experienced.

The scientific consensus at this time is that climate change is unlikely to increase the frequency of tropical cyclones but is very likely to increase the intensity of those that do occur (Knutson et al. 2010). This may particularly be the case on the Gulf Coast as the waters of the Gulf of Mexico continue to warm. A greater percentage of hurricanes are likely to reach Category 4 or Category 5 level on the Safir-Simpson scale. There are many other factors that will influence the trajectories of Atlantic hurricanes, making it impossible to forecast whether the Louisiana coast will experience more or fewer in the coming decades, but those that do impact this coast will probably become stronger.

Climate change also presents risk of increased flooding from extreme rainfall events. Over the last century, precipitation has increased along the northern Gulf Coast, both annually and in the summer (Kunkel et al. 2013). The frequency of rainfall events of 1 inch or more is projected to increase by mid-century and, at the same time, dry spells are likely to become more frequent.

As mentioned earlier, climate change has been implicated in two record-breaking rainfall events and resulting floods, in the Louisiana deluge in the Baton Rouge area in August of 2016 and with Hurricane Harvey around Houston in 2017. Both events occurred when low-pressure systems that developed in the Gulf of Mexico stalled near the coast – consistent with slowdown in tropical storm speeds that has been linked to global warming (Kossin 2018) – allowing them to continue to draw energy and moisture from the anomalously warm waters of the Gulf. Based on observational data and models, researchers found that an event like the Louisiana 2016 deluge is now likely to occur at least 40% more often than prior to the year 1900 and that their precipitation intensity has increased by roughly 10% as a result of human-caused climate change (van der Wiel et al. 2017). For the Houston flood, one study estimated that the chances of observed precipitation accumulations had increased by a factor of 3 and precipitation intensity increased by 15% (van Oldenborgh et al. 2017), while another placed these as a factor of 3.5 and 37%, respectively (Risser and Wehner 2017).

While air temperatures in coastal Louisiana have not increased as much as many other parts of the United States, warmer temperatures later this century are very likely and will pose additional challenges to inhabitants of coastal Louisiana. While there will be fewer killing freezes, an increase in the number of days with temperatures exceeding 95 degrees Fahrenheit (35 degrees Celsius) is projected (Kunkel et al. 2013). Cooling degree days (a measure of how much and for how long outside air temperature is above 65 degrees Fahrenheit) are also projected to increase substantially, placing additional burdens on the poor who may have limited access to air conditioning and on the well-being of the broader population when confronted by power disruptions that result from major storms.

2.6.2 Avoiding the Unmanageable

At the end of 2015, virtually all nations of the world endorsed the United Nations Paris Agreement, the guiding objective of which is to reduce net emissions of greenhouse gases from human activities in order to keep global warming well below an increase of 2 degrees Celsius in global mean temperature above preindustrial levels, with an ambition to limit it to 1.5 degrees Celsius (Rogelj et al. 2016). We are at about 1 degree Celsius above the preindustrial level today. The Paris Agreement recognizes that substantial adaptation to the changing climate will be still required but that as these levels of warming are exceeded, it will be very challenging for human society to adapt. In short, humankind must avoid the unmanageable, while managing the unavoidable.

Limiting global warming to less than 2 degrees Celsius will require the rapid reduction of global greenhouse gas emissions beginning very soon and reaching net zero emissions by mid-century or soon thereafter (Figueres et al. 2017). Absent dramatic breakthroughs in carbon capture and storage technologies, such large and rapid emission reductions would necessitate a transition from a fossil fuel-based

economy far more quickly than the citizens and political leadership of south Louisiana may be ready to consider. And yet the fundamental conundrum is that such a global transition is as essential for the future habitation of coastal Louisiana as it is for an imperiled Pacific island nation.

The existential threat to future habitation in coastal Louisiana is global sea-level rise. First, keep in mind that the relative rate of sea-level rise there, half or more due to subsidence, already poses substantial adaptation challenges. To its credit, the 2017 Coastal Master Plan considers three scenarios of environmental changes over the next 50 years, representing sea-level rise (in addition to variable rates of subsidence) of 43, 63 and 83 cm by 2067 for the low, medium, and high scenarios (CPRA 2017). Although the Plan does not link these scenarios to greenhouse emission pathways, it should be obvious that the greater the greenhouse gas concentrations realized, the greater the warming of the atmosphere and oceans and the greater the sea-level rise.

If greenhouse gas emissions continue to grow through the century (the Representative Concentration Pathway 8.5 of the 2014 IPCC assessment), it is increasingly apparent that a very substantial and unstoppable loss of Antarctic ice would probably be triggered with dramatic effects on sea level later in the twenty-first century and beyond (Kopp et al. 2017). This would result in a range of possible sea-level rise by the end of the century that includes the 200 cm (6.6 feet) by 2100 on which Coastal Master Plan's high scenario is based. That would be just the beginning, as the likely sea-level rise during the next century would range between 600 and 900 cm (20–30 feet). The Gulf of Mexico shoreline would retreat to where it was 7000 years ago. Moreover, we would not be able to forecast this with great certainty until it is too late to slow the rate of ice loss by reducing our emissions.

If, on the other hand, global society were to rapidly reduce greenhouse gas emissions to meet the goals of the Paris Climate Agreement to keep the increase in global mean temperature below 2 degrees Celsius (RCP 2.6), catastrophic loss of Antarctic ice mass could be avoided. According to the recent probabilistic projections (Kopp et al. 2017), sea-level rise over the next 50 years would likely be less than what even the low scenario of the Coastal Master Plan assumes and substantially less than the 198 cm by 2100 on which scenario is based. In fact, there would be a 50/50 chance of sea-level rise being less than 100 cm even in 2200, giving the embattled Louisiana coast a fighting chance for adaptation that leads to "essential" social resilience (Laska 2012).

2.7 Implications for Social Resilience

2.7.1 Transient and Secular Disasters

The people, families, communities, and institutions of coastal Louisiana will continue to be confronted by transient disasters caused by river flooding, storm surges, and deluges. Within limits, they have been proudly resilient in the past, but many steps can yet be taken to improve social resilience in the future. However, now society is confronted with substantial secular (long duration) changes in the natural

environment and their attendant risks in the form of rapid coastal disintegration of this geologically young territory, compounded by global climate change. These "slow motion disasters" require a different kind of approach to social resilience, one that fundamentally takes an intergenerational perspective but with substantial changes even happening fast enough to be experienced within a lifetime.

Enhancing intergenerational social resilience will require that the people of coastal Louisiana have a greater awareness and acceptance of the biophysical changes that will be confronting them. They will have to understand the accommodations and solutions that are possible and their limits in order to effectively participate in civil society. The people of coastal Louisiana can no longer afford to remain "strangers in their own land" as Hochshield (2016) framed the dilemma. While Louisiana's Coastal Protection and Restoration Authority has expended considerable effort to engage the public and has secured political support for the Coastal Master Plan to this point, much more extensive understanding by the public and incorporation of community concerns will be required. Because of the intergenerational nature of the challenge, there should be concerted efforts to raise the socio-environmental literacy of school children about their unique and dynamic coastal landscape and how and why it is being altered, including by climate change.

Enhancing resilience to disasters during an era of rapid change will also require a strategically developed capacity of natural and social scientists, engineers, designers and planners, and social workers. Higher education institutions should focus faculty development and research and training programs with this in mind. New kinds of boundary organizations (Cash et al. 2003) will have to evolve that link knowledge with practice, transcend public and private enterprises, and engage both citizens and decision makers.

2.7.2 Role of Natural Systems in Resilience

The concept of ecosystem services (Carpenter et al. 2009) has emerged with the growing recognition of the importance of natural environments to human well-being. The values of coastal wetlands for protection from hurricane waves and storm surges have been specifically assessed (Costanza et al. 2008; Barbier et al. 2013) and are among the many ecosystem services that support the socio-economy of coastal Louisiana. The natural ecosystem resilience of coastal Louisiana is increasingly recognized as an important contributor to social resilience.

Louisiana's consecutive Coastal Master Plans have taken major steps in the right direction by incorporating the benefits of coastal ecosystems in moderating wave and storm surge risks and in integrating protection and restoration. There is clearly much more work to be done on this front for project-specific design and integration. Future efforts will have to navigate the institutional obstacles regarding matching of funding sources, typically restricted to protection or to restoration, and coordination among disparate responsible agencies.

2.7.3 Limiting Climate Change Inseparable from Adaptation

While not expressly linked to global warming and greenhouse gas emissions, the sea-level rise rates embedded in the future scenarios of the Coastal Master Plan, together with their logical extensions beyond 2067 as discussed earlier, make it clear that the single most effective action to ensure the future well-being of people in coastal Louisiana is the rapid reduction in global greenhouse gas emissions consistent with the Paris Climate Agreement. This is urgent: with each 5-year delay in near-term peaking of carbon dioxide emissions, sea level in 2300 would increase by an estimated 20 cm (Mengel et al. 2018). From the perspective of people desiring to live in coastal Louisiana beyond the next 50 years, it is not an exaggeration to say that effective mitigation to limit climate change is a sine qua non. The benefits of most of the protection and restoration we have undertaken or are planning over the next 50 years would be rendered moot by 2 meters or more of sea-level rise. Climate change adaptation and mitigation are not separate issues but must go hand in hand in order to manage the unavoidable while avoiding the unmanageable.

Recognition of this reality by the public and political leadership in Louisiana is a challenging obstacle. Although there are some exceptions, many of those currently in political leadership at the state and federal level are stationed somewhere between denial (climate change is not happening or is mostly natural) and "lukewarmerism" (it will not be that bad or there is not much we can do about it). Improved public awareness of the scientific realities and the technological possibilities will be required to change this much.

Contributing to this reticence are concerns about impacts on jobs and the regional economy of a phase out in the use of oil and gas as fuels. Production of petroleum hydrocarbons would still be required as feedstocks for chemicals and products that society would use. Existing industrial and technological capacities could be useful in developing renewable energy or in carbon sequestration in the vast deep saline aquifers lying under the northern Gulf of Mexico (DeSilva et al. 2015). For example, the support structures for offshore wind turbines recently installed off Rhode Island were built in an oil platform fabrication yard in Houma, Louisiana. Moving away from energy and transportation systems that rely on fossil fuels also opens up opportunities for creative approaches to coastal restoration and community resilience by the strategic brain trust mentioned above.

2.7.4 Defend, Adapt, or Relocate?

Difficult decisions are already here today regarding whether to structurally protect, improve resilience where structural protection is infeasible, or relocate vulnerable homes and communities (Bailey et al. 2014). Inclusive efforts that plan for the future such as LA SAFE are critical, and there is much that social scientists can contribute to and learn from these efforts and from planned relocations such as for

Isle de Jean Charles. After all, in coastal Louisiana the challenge is not just resilience to extreme weather events but also rational responses to substantial long-term biophysical changes that ensure human well-being and sustain the sociocultural fabric of communities.

2.7.5 Coastal Louisiana as a Harbinger

The Deltaic and Chenier plains that characterize the Louisiana coastal zone differ in many important ways from other coastal zones of the United States. They are younger, exceptionally low lying, and generally subsiding more rapidly than most coastal landforms. Yet, with relative sea-level rise accelerating and ocean storms and extreme precipitation likely to intensify along most of US coasts, Louisiana serves as a harbinger for the challenges to be faced in risk management for coastal communities elsewhere.

From the increase in the frequency of high tide or so-called nuisance flooding, even on sunny days, in cities such as Atlantic City, Annapolis, Norfolk, Charleston, and Miami (Sweet et al. 2018), to the damages associated with the exceptional storm surge of Superstorm Sandy (Halverson and Rabenhorst 2013), increased risks to communities are more evident, and planning is beginning to take this into account. Even California, which one does not usually think of having a low-lying coast, has updated its sea-level rise guidance (California Natural Resources Agency 2018) based on a rigorous scientific assessment (Griggs et al. 2017). With Louisiana's still massive, if underused, supplies of river-borne sediments, Louisiana might even have some advantages in contending with sea-level rise. South Florida, where huge populations and economies are at risk, has no muddy rivers, and the porous limestone platform that underlies it can render earthen levees ineffective.

What coastal Louisiana is confronting today defines challenges surely to be faced in other coastal regions around the globe. How can cities and towns contend with more regular tidal water flooding, as well as greater storm surges, while at the same time remove precipitation-driven stormwater? How can tidal wetlands be maintained not only for their natural resource values but also as a buffer to storm surges, during the coming period of more rapidly rising seas? How can state governments effectively integrate community hazard protection and coastal ecosystem restoration? How do communities and governments make rational and effective choices among structural storm surge protection, nonstructural adaptation, and relocation?

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Part II
Climate Adaptation Challenges and Solutions

Chapter 3
Connecting the Dots: The Origins, Evolutions, and Implications of the Map that Changed Post-Katrina Recovery Planning in New Orleans

Zachary Lamb

3.1 Introduction

On January 11, 2006, a little more than 4 months after the Hurricane Katrina-induced levee failures flooded New Orleans, the city's major newspaper, the *Times-Picayune*, published a front-page story with the arresting headline, "4 MONTHS TO DECIDE". Sub-headlines announced that the "City's Footprint May Shrink" and that "full buyouts proposed for those forced to move if the 'hardest hit areas' could not 'prove viability'" (Donze and Russel 2006). Directly beneath these words lay a map (Fig. 3.1) showing a sea of yellow over much of the city indicating the flood-damaged neighborhoods that would be subject to a proposed building permit moratorium and therefore temporarily off-limits to rebuilding. The map showed six areas of the city overlaid with solid bright green circles indicating areas designated for "future parkland" and 12 red-outlined zones identified for prioritized reconstruction. In text and in words, the map laid out a classification system for the reconstruction of New Orleans and the radical restructuring of land use in the city.

For thousands of displaced New Orleanians, scattered across the country, these headlines and this map represented a graphic manifestation of their worst fears of losing their homes and the right to return to their neighborhoods. In both the popular press and among the urban planning academy, the "green dot map," as the newspaper's map came to be known, occupies a near-mythical status for the role that it played in changing the political landscape of post-Katrina planning in New Orleans. The popularly understood story is that "with the publication of this map, entire neighborhoods were instantly mobilized to protect their homes and communities from environmental expropriation" (Fields 2009). The map was identified as a pivotal moment when "recovery planning power shifted decisively to neighborhood"-based planning and away from a "heavy-handed" technocratic approach (Wooten

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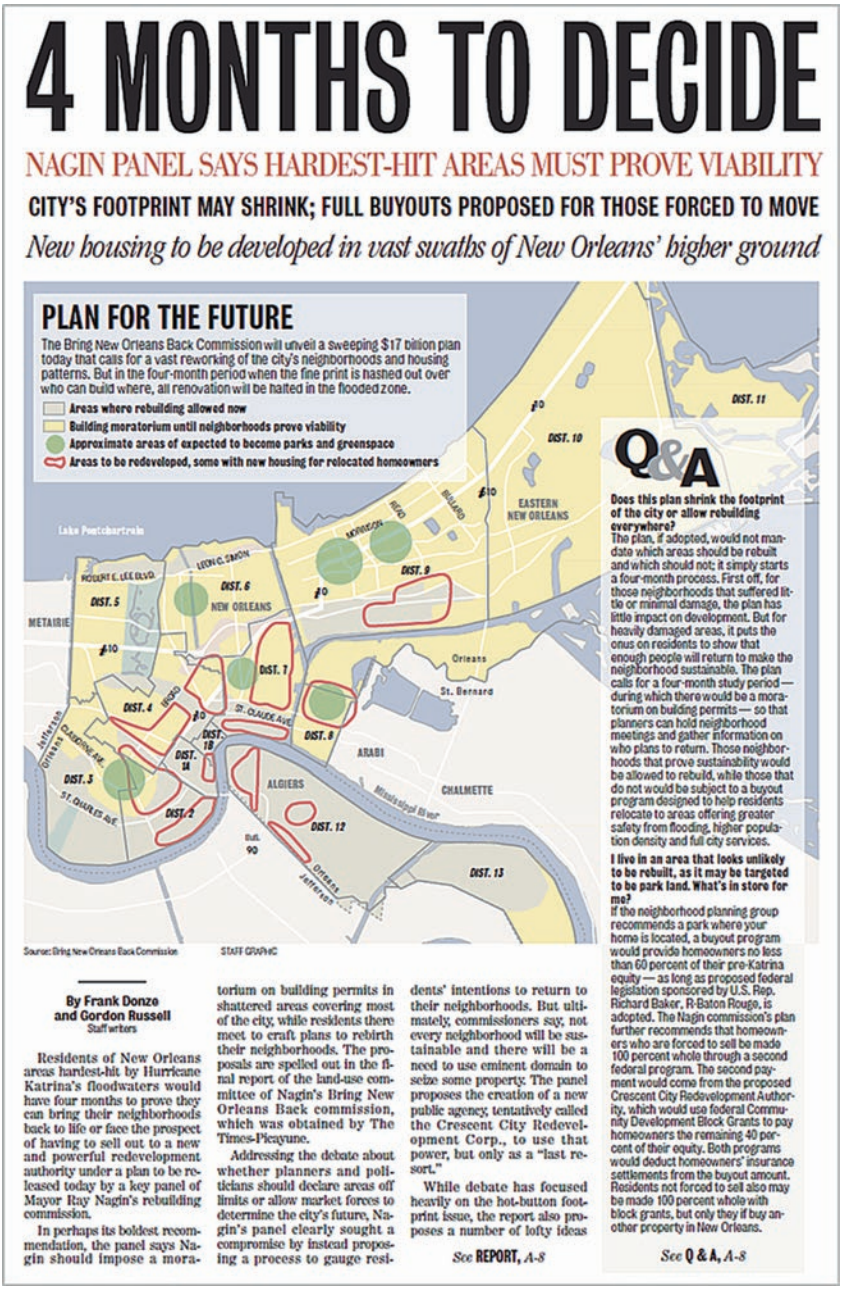

4 MONTHS TO DECIDE

NAGIN PANEL SAYS HARDEST-HIT AREAS MUST PROVE VIABILITY

CITY'S FOOTPRINT MAY SHRINK; FULL BUYOUTS PROPOSED FOR THOSE FORCED TO MOVE

New housing to be developed in vast swaths of New Orleans' higher ground

PLAN FOR THE FUTURE

The Bring New Orleans Back Commission will unveil a sweeping $17 billion plan today that calls for a vast reworking of the city's neighborhoods and housing patterns. But in the four-month period when the fine print is hashed out over who can build where, all renovation will be halted in the flooded zone.

- Areas where rebuilding allowed now
- Building moratorium until neighborhoods prove viability
- Approximate areas of expected to become parks and greenspace
- Areas to be redeveloped, some with new housing for relocated homeowners

Lake Pontchartrain
ROBERT E. LEE BLVD
LEON C. SIMON
DIST. 6
NEW ORLEANS
DIST. 5
METAIRIE
DIST. 11
DIST. 10
EASTERN NEW ORLEANS
MORICEAU
ALVAR
BOLIVAR
DIST. 9
DIST. 7
Orleans
St. Bernard
DIST. 4
ST. CLAUDE AVE
DIST. 8
DIST. 1B
DIST. 1A
ARABI
DIST. 3
CLAIBORNE AVE
ST. CHARLES AVE
ALGIERS
CHALMETTE
Mississippi River
DIST. 2
DIST. 12
DIST. 13
Source: Bring New Orleans Back Commission
STAFF GRAPHIC

Q&A

Does this plan shrink the footprint of the city or allow rebuilding everywhere?

The plan, if adopted, would not mandate which areas should be rebuilt and which should not; it simply starts a four-month process. First off, for those neighborhoods that suffered little or minimal damage, the plan has little impact on development. But for heavily damaged areas, it puts the onus on residents to show that enough people will return to make the neighborhood sustainable. The plan calls for a four-month study period — during which there would be a moratorium on building permits — so that planners can hold neighborhood meetings and gather information on who plans to return. Those neighborhoods that prove sustainability would be allowed to rebuild, while those that do not would be subject to a buyout program designed to help residents relocate to areas offering greater safety from flooding, higher population density and full city services.

I live in an area that looks unlikely to be rebuilt, as it may be targeted to be park land. What's in store for me?

If the neighborhood planning group recommends a park where your home is located, a buyout program would provide homeowners no less than 60 percent of their pre-Katrina equity — as long as proposed federal legislation sponsored by U.S. Rep. Richard Baker, R-Baton Rouge, is adopted. The Nagin commission's plan further recommends that homeowners who are forced to sell be made 100 percent whole through a second federal program. The second payment would come from the proposed Crescent City Redevelopment Authority, which would use federal Community Development Block Grants to pay homeowners the remaining 40 percent of their equity. Both programs would deduct homeowners' insurance settlements from the buyout amount. Residents not forced to sell also may be made 100 percent whole with block grants, but only they if buy another property in New Orleans.

See Q & A, A-8

By Frank Donze and Gordon Russell
Staff writers

Residents of New Orleans areas hardest-hit by Hurricane Katrina's floodwaters would have four months to prove they can bring their neighborhoods back to life or face the prospect of having to sell out to a new and powerful redevelopment authority under a plan to be released today by a key panel of Mayor Ray Nagin's rebuilding commission.

In perhaps its boldest recommendation, the panel says Nagin should impose a moratorium on building permits in shattered areas covering most of the city, while residents there meet to craft plans to rebirth their neighborhoods. The proposals are spelled out in the final report of the land-use committee of Nagin's Bring New Orleans Back commission, which was obtained by The Times-Picayune.

Addressing the debate about whether planners and politicians should declare areas off limits or allow market forces to determine the city's future, Nagin's panel clearly sought a compromise by instead proposing a process to gauge residents' intentions to return to their neighborhoods. But ultimately, commissioners say, not every neighborhood will be sustainable and there will be a need to use eminent domain to seize some property. The panel proposes the creation of a new public agency, tentatively called the Crescent City Redevelopment Corp., to use that power, but only as a "last resort."

While debate has focused heavily on the hot-button footprint issue, the report also proposes a number of lofty ideas

See REPORT, A-8

Fig. 3.1 "The Green Dot Map" as published in the *Times-Picayune*, January 11, 2006. (© 2006 NOLA Media Group, L.L.C. All rights reserved. Used with permission of The Times-Picayune & NOLA.com)

2012). In the months and years after its publication, the map provided a unifying enemy around which devastated neighborhoods could organize their resistance. People spoke of their houses and neighborhoods being "green dotted," wore green dots made of paper plates around their necks at neighborhood rallies, and adopted the color of the map's dots in the logos of new community organizations (Wooten 2012; Nelson et al. 2007; Olshansky et al. 2010). Seven years after the map's publication, the symbol retained such potency for the Broadmoor neighborhood (one of the neighborhoods marked for "future parkland") that, when the neighborhood's public library branch reopened in 2012, the coffee shop inside was defiantly christened the "The Green Dot Café." While the intergovernmental power struggles and politics of early post-Katrina planning efforts have been well researched and reported (Olshansky et al. 2010; Nelson et al. 2007; Olshansky 2006), there has been relatively little attention paid to the origins, evolution, and implications of the map that is seen as playing such a pivotal role in this history.

The now infamous green dot map is widely regarded as having been the product of the Urban Planning Committee of the Bring New Orleans Back Commission (BNOBC), a group convened by then Mayor C. Ray Nagin in the fall of 2005 to set the agenda for the city's recovery. In fact, the map that appeared in the *Times-Picayune* that day in January 2006 was the newspaper staff's synthesis and reinterpretation of maps and texts that the BNOBC presented in a press conference earlier that same day. The maps and plans produced for the BNOBC by the landscape and planning firm of Wallace, Roberts, and Todd were, in turn, substantially based on an earlier report produced by a panel of national experts convened in November 2005 by the Urban Land Institute (ULI), a national research and advocacy organization that is closely associated with the real estate development industry. Though the green dot map did become a powerful symbol, most discussions treat the map in the abstract and take its catalytic power for granted. To better understand the role of the map in reshaping the contours of post-Katrina decision-making, this chapter investigates where it came from, what power relations underlay its creation, what values are expressed in its spatial classifications, and, finally, how the map and its reception have shaped planning for water management in New Orleans in the years since.

3.2 Literature and Theoretical Context

Though the three primary documents of interest in the story of the green dot map include only a single indirect reference to climate change (a reference to "relative sea level rise" in the ULI report (Urban Land Institute 2005)), this chapter treats the episode as an attempt at de facto climate adaptation. The Intergovernmental Panel on Climate Change (IPCC) defines climate adaptation as "The process of adjustment to actual or expected climate and its effects" by seeking "to moderate or avoid harm"(IPCC 2014). As such, the early planning efforts to restructure New Orleans' post-Katrina urban land uses to reduce flood vulnerability clearly meet the IPCC's definition of adaptation. Viewed as an attempt at climate adaptation, the

development and dissemination of the green dot map provide insights into challenges facing more and more cities around the world as they attempt to adapt their historically evolved urban patterns in the face of mounting flood hazards. To develop a fuller understanding of how the green dot map episode might inform future urban climate adaptation, this paper draws from a broad body of literature including work on climate change adaptation, natural hazards research, and critical cartography.

3.2.1 Land Use Planning for Hazard Mitigation

Following pioneering work by geographer Gilbert White, natural hazards scholars from a range of disciplines have produced research on the social and political components of vulnerability to flooding and other natural hazards (White 1945; Wisner et al. 2004; Cutter et al. 2003; Adger 2006). Planning scholars have contributed significantly to exploring how various tools for land use planning and regulation can play a role in reducing hazard exposure (Burby 1998; Burby et al. 2000; Godschalk et al. 1998). Much of this work has advocated for more hazard-informed land use patterns to reduce exposure through a range of federal, state, and municipal policy and planning tools (Olshansky and Kartez 1998; Burby et al. 1999; Beatley 2012). Using Burby et al.'s (1999) schema, the green dot proposal represented a shift in New Orleans' flood hazard mitigation strategy, away from the previous model combining "risk reduction" via levees and building elevation and "risk sharing" via insurance and toward a new model emphasizing "risk elimination," through targeted buyouts and green space preservation in some of the city's most low-lying neighborhoods.

While the natural hazards literature does consider the ways in which planning for natural hazard mitigation can facilitate consensus building (Burby et al. 2000), it largely does not focus on the politics of disaster or land use change or on the distributive implications of such processes. The uneven production and distribution of vulnerability are at the core of much research in human ecology and political ecology (Collins 2008; Pelling 1999, 2003; Gustafson 2015; Hewitt 1983; Wisner et al. 2004). Vale and Campanella's *The Resilient City* explicitly assesses the political and distributive issues that shape how cities recover from disasters (Vale and Campanella 2005).

Of particular interest in this case, authors from a number of different perspectives have addressed the question of to what extent substantial changes in land use are possible or desirable during post-disaster "windows of opportunity"? Much of the early natural hazards planning literature regarded such "windows" as ideal times for "targeting households and business firms to retrofit or relocate"(Olshansky and Kartez 1998). Vale and Campanella, with their emphasis on the politics of resilience, are skeptical of the possibility of substantial change after disasters, observing that it is very rare for post-disaster cities to adopt "visionary new city plans aimed

at correcting long-enduring deficiencies or limiting the risk of future destruction" (Vale and Campanella 2005). Like Naomi Klein, who warns against "disaster capitalism" (Klein 2008), Vale and Campanella go further, questioning the desirability of dramatic post-disaster change given the track record of public and private interests "using devastation as a cover for more opportunistic agendas yielding less obvious public benefit" (Vale and Campanella 2005). Writing in the wake of the post-Katrina levee failures, Berke and Campanella (2006) suggest something of a middle ground, arguing that "Hurricane Katrina opened a window of opportunity for creating more resilient communities" but pointing out that taking advantage of such windows may require pre-disaster planning that actively seeks out the viewpoints of often marginalized communities (Berke and Campanella 2006). This tension – between viewing post-disaster planning as a "window of opportunity" for urban restructuring and concerns over post-disaster opportunism and land grabbing – is central to understanding the political conflict arising from the divergent readings of the green dot map.

3.2.2 Climate Change Adaptation Through Land Use Planning

The recent increase in critical attention to climate adaptation has invited renewed attention to the relationship between flood hazards and land use planning. Whereas many previous efforts to reduce flood vulnerability through land use planning were seen as "fighting the last war" by reacting to the most recent disaster event (Godschalk et al. 1998), climate adaptation planning holds promise in inviting approaches to land use planning that are more holistic, forward-looking, and cross-scalar (Adger et al. 2005; Hallegatte and Corfee-Morlot 2011). With little substantial progress from higher levels of government, public and private entities acting at the local and regional levels have taken the lead in local adaptation planning in many areas around the word (Measham et al. 2011; Rosenzweig 2010). Land use planning and regulation are central to many climate adaptation efforts, and they are primarily the responsibility of local government entities in most jurisdictions (Measham et al. 2011). Research on climate adaptation planning has also focused considerable attention on the equity implications of hazard mitigation and other forms of adaptation (Wilson 2006; Hamin and Gurran 2009; Paavola and Adger 2006; Bulkeley et al. 2013). The concerns of poor and marginalized populations of cities are too often underrepresented in climate adaptation planning given the disproportionate vulnerability of such groups to the impacts of climate change (Measham et al. 2011; Bulkeley 2006). Researchers have found that socially and economically vulnerable groups are often directly and indirectly harmed by adaptation efforts (Anguelovski et al. 2016; Sovacool et al. 2015). A range of efforts, including those labeled community-based adaptation, have sought to increase

participation and inclusion in climate planning and adaptation (Aylett et al. 2010; Archer et al. 2014; Paavola and Adger 2006).

Adger et al. (2005) proposed four key normative criteria for assessing climate adaptation efforts: *effectiveness*, *efficiency*, *equity*, and *legitimacy* (Adger et al. 2005). These four criteria provide a useful lens through which to understand the conflict which developed surrounding the green dot map, in which different actors placed radically different levels of importance on each of the four criteria.

3.2.3 Planning Representation, Maps, and the Shaping of Social and Spatial Reality

This paper takes as a starting assumption that "maps are knowledge claims that are inherently political"(Kim 2015). This is also the premise at the heart of emerging studies of "critical cartography." Critical cartography includes both analytical and projective tools for questioning the underlying assumptions and power relations behind cartography and developing new ways of using those tools to support alternative claims to knowledge and power (Crampton and Krygier 2005). Arthur Robinson focused early attention on how maps function as *communication* devices that operated through three distinct but related phenomena: sender (mapmaker), medium (map), and receiver (map user) (Robinson and Petchenik 1976; Pickles 2003; Crampton 2001). In "Deconstructing the Map" (1989), J.B. Harley applies the tools of social critique (Foucault and Derrida principally) to cartography (Harley 1989). Harley's work primarily focused on exposing the socially constructed nature of maps and their embeddedness in the power relations of their place and time. While Harley's analysis was largely historical and principally focused on the use of maps as tools of domination, subsequent scholars have gone beyond identifying where maps come from to examine and critique how maps operate to shape social life and power relations (Pickles 2003; Turnbull et al. 1993; Wood and Fels 2009; Crampton and Krygier 2005). This second generation of scholars developed a more complex view of power as "multivocal" and in a constant state of contestation (Pickles 2003). Much of this later critique draws heavily on the critical tools developed by Derrida, Habermas, and Barthes and tends to see maps as narratives or texts that must be read (Crampton 2001). Wood and Fels widened the frame of analysis to consider what they labeled the "paramap," or "everything that surrounds and extends a map" (Wood and Fels 2009). This paramap material includes what they call "perimap," the titles, labels, charts, and borders that frame and situate a map. It also includes "epimap" materials such as any texts or articles to which maps are appended (Wood and Fels 2009).

To date, there has been relatively little attention paid to critical assessment of maps, like the green dot map, which are intended as projective tools for reshaping land use according to changing hazard conditions. While Wood and Fels (2009) do address what they call maps of "threatening nature," they focus more on popular

cartography of hazards than on hazard assessment maps or maps for land use planning. In several books, Mark Monmonier has analyzed how the representational tools used in mapping floodplains and coastlines shape perceptions of hazard vulnerability (Monmonier 1997, 2014; Monmonier 2008). However, compared to other critical cartographers, Monmonier tends to deemphasize the political implications of mapping and representation.

Maps are among the most important tools of analysis and communication used by planners and urban designers. John Forester's *Planning in the Face of Power* (Forester 1988) and subsequent work on "communicative planning" (Healey 2012; Innes 1995) highlight the ways in which planners control communication and information to shape power relations. Scholars have long recognized that visual representation used in planning can powerfully shape how practitioners, policy-makers, and the public perceive of planning challenges and proposals. Lisa Peattie analyzed and critiqued the "representations of reality" deployed by planners and other professionals in planning Ciudad Guayana in Venezuela (Peattie 1987). Like Peattie, Raphael Fischler recognized that planners "understand and represent the world in certain ways" that are "necessarily selective and partial" (Fischler 1995). Annette Kim has used the interpretive strategies of critical cartography to analyze how maps and other visual representations created by planners and designer reflected and shaped changing conceptualizations of property in Ho Chi Minh City (Kim 2012, 2015). These and other analyses of visual representation in planning provide useful precedents for interpreting the production and popular reception of the green dot map.

While much of the literature treats critical cartography as an interpretive activity undertaken by scholars to decode the hidden social meaning and politics of maps, some recent work has articulated a variant labeled "lay critical cartography" (Cidell 2008) that shifts the locus of critical analysis to consider explicitly the "social life of maps, the political responses they elicit, and the political possibilities they enable and disable" (Gustafson 2015). Seth Gustafson, a geographer rooted in urban political ecology, has considered the lay critical cartography of landslide hazard maps in North Carolina which ignited intense political opposition from pro-development forces (Gustafson 2015). Such analysis of how a map "provokes new political activities and environmental changes" is a useful precedent in making sense of the response to green dot map.

3.3 Methods

The green dot map came to hold tremendous symbolic power because of the immediate context of its production, the chain of interpretation and reinterpretation from which it emerged, and the broader social and historical conditions into which it was projected. In seeking to make sense of this broader context, this chapter traces the creation of the map through three different generations, each of which took different approaches to classifying space and communicating through text and graphics. This

chapter uses critical cartography and lay critical cartography to analyze the green dot map and its precedents. It seeks to unearth the "design politics" of the maps to reveal how "social and political preferences are expressed and manipulated" (Vale 2013). As such, it considers how the maps' graphics as well as the "paramap" materials, such as the texts within and surrounding the maps, convey the values of the makers. The analysis of each iteration of the map will address what Bowker and Star call the "practical politics of classifying," by which the maps "arriv(e) at categories" of redevelopment land use and "what (is) visible or invisible" within the categorizations and abstractions of each map (Bowker and Star 1999). The chapter also draws on contemporary media accounts and secondary literature to analyze how the maps were received, both among planners and the public at large. Finally, the chapter includes a brief discussion of the implications and impacts of the green dot map on land use planning and water management in New Orleans. This section is based on interviews with planners, designers, and decision-makers involved in recent and ongoing planning activity in the city.

3.4 Analysis

Each of the three generations of plans and maps that lead to the green dot map assumed that New Orleans' post-Katrina population would be significantly reduced and that some degree of "shrinking the footprint" or "neighborhood consolidation" would be necessary to reduce the city's exposure to future flooding (Olshansky et al. 2010). These policies were seen as necessary to ensuring that urban densities in the city would be high enough to allow for efficient and safe delivery of municipal services. While all three presentations called for a smaller New Orleans, they differed in crucial ways, including the composition of the drafting bodies and their claims to authority, their intended audiences, and the graphical and text language deployed to communicate their classification schemes for future land use. The following sections analyze the evolutions and changes through which the green dot map developed.

3.4.1 The ULI Plan: "New Orleans, Louisiana: A Strategy for Rebuilding"

The ULI plan that was released in November of 2005 was the product of a convening of national experts on urban development and planning (Urban Land Institute 2005). Reflecting the professional positioning of the members of the panel and the ULI more generally, the report tends to frame the task of rebuilding in the language of urban real estate development, finance, and administrative efficiency. The report holds that "the city should be rebuilt in a strategic manner" in which the "feasibility of investment" in damaged neighborhoods will be evaluated before public or private

funds will be used to rebuild. While the report recognizes that such a strategic reinvestment approach will inevitably impinge on some residents' property rights, they propose a market-based remedy, stating that where property is deemed "unusable," people "should be given fair compensation for their property." Expressing the importance of "government effectiveness," the report calls for the creation of a new body, the Crescent City Rebuilding Corporation (CCRC) that would "provide expeditious compensation for those unable to build."

While the overriding theme of the ULI report is a call for efficient redevelopment that would avoid "scattered, uncoordinated, dysfunctional redevelopment," the report connects these notions of efficient redevelopment to values of security, aesthetic beauty, and environmental balance. The plan calls for reducing the urban footprint of New Orleans in order to "ensure the health and safety of the residents of each neighborhood," to create "functional and aesthetically pleasing neighborhoods," and ultimately to create a city that is "in harmony with the natural environment," particularly with respect to the relationship between urban space and the surrounding waters.

Though the ULI report calls for a radical reconfiguration of the city to accommodate a smaller population on more flood-safe territory, the report does go to great lengths to emphasize the importance of conducting inclusive planning processes to ensure equitable results. Among the report's "Key Findings" are a number of items related to the importance of retaining the city's unique culture. The report goes further to say that "planning for the rebuilding of each neighborhood must involve the citizens from that neighborhood."

Although the panel emphasizes the importance of equity and inclusive planning, they also make clear that, in the cause of reconstruction, diversity and pluralism may have to give way to functional demands. The panel uses the language of equity and security to justify the realignment of residents in saying, "every citizen has a right to return to a *safe* neighborhood" [emphasis added]. Implied in this formulation is that if a neighborhood is deemed unsafe, it may not be rebuilt. Similarly, the report deemphasizes critical conversations about racial justice, an issue of deep resonance in a city and region where planning has long been seen as a tool for enforcing racial hierarchy and systematic prejudice. Though it states that "diversity, equity, and cooperation are of critical importance," the panel's report holds that "the recovery must not be held back by the racial issues that have slowed progress in the past." In this phrase, the panel vaguely blames the contentious history of "racial issues" for impeding progress, ignoring the enormous racial inequities in previous planning actions and arguing for a recovery process freed from the impediments of racial politics.

The only image in the ULI report that puts forward any form of spatial proposal is a single map outlining a "proposed rebuilding framework."[1] The graphics and text of the map, like the larger report, is characterized by a focus on finance and development. The map places the tourist-oriented French Quarter and central busi-

[1] It has not been possible to include the ULI map in this manuscript. It is available at http://uli.org/wp-content/uploads/ULI-Documents/2005NewOrleansPPT.pdf

ness district at its center and is cropped to exclude a sizeable portion of New Orleans East, a primarily African-American suburban neighborhood that sustained heavy flood damages. The map includes very few streets or other landmarks by which one might locate a specific site within the city to see how it might be affected by the proposal. The territory that is included in the map is divided into three "investment zones," zones A, B, and C. The text that accompanies the map states that the investment zone classification should be done according to a broad suite of criteria including the extent of flooding damage, physical vulnerability, infrastructure capacity, historical significance, and housing occupancy and vacancy. In spite of the holistic intention, the ULI map appears to define zones primarily on the basis of flooding depths or topography, ignoring all of the other issues of existing adaptation, infrastructure, and vulnerability that they previously defined as critical. Even if one were to accept topography as a suitable single criterion on which to define investment zones, it is unclear how the panel determined what elevations or depths of flooding constituted logical thresholds for zone classifications.

The panel makes strategic use of the passive voice and technocratic language of urban hydrology to de-emphasize the impacts of their zone classification scheme on residents and neighborhoods. The report indicates that, in Zone A, the most heavily damaged areas, "open space (will) be programmed to reach its greatest capacity to manage storm water retention, treatment, and flow." Though such a statement suggests the replacement of residential areas with functional green space, the panel emphasizes that:

> In these areas, great care must be taken to work closely with residents to determine the exact patterns of reinvestment necessary to restore and create a functional and aesthetically pleasing neighborhood.

Again employing vague, passive, and functionalist language, the report states that, in Zone B, the areas that are moderately damaged and presumably moderately vulnerable to repeated flooding:

> some reprogramming of open space probably will be needed to mitigate the impact of flooding and account for space that may not be rebuilt for any number of reasons.

According to the panel's recommendations, only in Zone C areas, those areas with little or no damage, would building be allowed on a "parcel-by-parcel" basis.

In both text and graphics, the panel employs strategic imprecision to make clear the preliminary nature of their recommendations. The fuzziness and low contrast with which the three zones are rendered in the map are appropriate to the provisional nature of the plan. The accompanying text also expresses uncertainty regarding the spatial classification in saying,

> The precise edges of the respective zones and their transitions cannot be established without detailed on-the-ground surveys, which have yet to occur.

While it is wholly appropriate that such a preliminary report should leave room for revision and refinement, this statement suggests that the missing data necessary to solidify the investment zone classification could be gleaned by a physical survey,

without consideration of the range of social, political, and economic factors that would be invisible to such a survey.

In addition to the designation of investment zones, the ULI map indicates "Development Sites" and a network of new proposed "Open Spaces." The map designates sites for "economic development" and "mixed use housing," using red and orange ovoid shapes. While neither the map nor the accompanying report provides insights into how these zones were selected or what their designation would mean for future development, they were intended to be what Monmonier calls "green-lined" zones in which the government would target investment and deploy special incentives for development (Monmonier 2010). The network of designated open space includes new greenways located along the city's canals as well as a major linear green space following the path of Interstate-10. Though the accompanying text provides no clues as to the rationale for the configuration of the open space network, indications elsewhere in the report suggest that the panel advocates the expansion of open space in the city for functional, recreational, and aesthetic purposes.

Though the ULI map and the report in which it is embedded lay out an agenda that would have sweeping implications for reorganizing the city, they also maintain a tone of strategic imprecision and deference to equitable and inclusive planning processes. The plan takes for granted that a radical spatial reorganization of the city will be necessary for reasons of efficiency and security. It uses the language of development, finance, and investment and treats the city as an abstract administrative and financial institution first and foremost. The preliminary map categorizes urban space according to development and investment potential with a mix of appropriate fuzziness and unexplained precision.

3.4.2 The BNOBC Plan: "Action Plan for New Orleans: The New American City"

Building on the recommendations made in the ULI report, the Urban Planning Committee of the BNOBC issued their proposed plan and maps in a presentation delivered in January 2006. If the ULI map and plan showed a degree of imprecision and deference to inclusive planning processes yet to come, the BNOBC plan and maps were less constrained by such signs of professional humility. From the very name of the presentation, with its emphasis on "action" and "new"-ness, the commission's report took on many of the ULI report's recommendation and stripped away the layers of uncertainty and deference to process. Where the ULI panel was composed of national technical experts, the BNOBC was made up of "knowledgeable community members and professionals" (Ehrenfeucht and Nelson 2011) with a strong bias toward "business and developers"(Allen 2013). The New York Times referred to Joseph Canizaro, the local developer and financier appointed to head the group, as "the mogul who would rebuild New Orleans" (Rivlin 2005a). Both Canizaro himself and many commentators emphasized his ties to both President

George W. Bush and Mayor Nagin (Olshansky et al. 2010; Rivlin 2005a). Where the ULI panel drew its authority from academic and technical credentials, the BNOBC's claim to legitimacy was rooted in financial and political resources.

From early in the formation of the commission, BNOBC members demonstrated the more problematic side of the post-disaster "windows of opportunity," issuing public comments that emphasized the view that the devastation and mass evacuation of New Orleans was an opportunity to reshape the city. Less than a month after Hurricane Katrina made landfall, Mr. Canizaro told the *New York Times*, "I think we have a clean sheet to start again…And with that clean sheet we have some very big opportunities" (Rivlin 2005a). Another commission member, James Reiss, the chairman of the Business Council of New Orleans, went further, explicitly linking the spatial restructuring of the city to the creation of a new social order, telling the *Wall Street Journal* that the rebuilding effort was an opportunity to rebuild the city "in a completely different way: demographically, geographically, and politically" (Wooten 2012). While the ULI report appealed to a sense of unity, smoothing over New Orleans' history of racial divisions and distrust, the final BNOBC presentation makes no mention of race at all. To the extent that issues of racial justice or inclusion were discussed at all, they appear to have taken the form of pragmatic business concern. Canizaro was quoted as expressing the need for the "business community" to work with "our African-American associates" to develop the plan, a phrase that suggests that African-Americans were not a part of the business community (Rivlin 2005a).

Drawing on the ULI plan that had been issued 2 months before, the BNOBC plan frames the reconstruction of the city as, first and foremost, a problem of real estate development and finance. Where the ULI map and report uses the language of investment, the BNOBC presentation focuses on property ownership, site control, and acquisition. The report again assumes that the reconstruction of the city will require a massive reshuffling of land use patterns and establishes categories of redevelopment according to levels of damage, vulnerability, and development potential. Echoing the language of efficiency and equity used in the ULI discussion of planned shrinkage, the BNOBC presentation emphasizes the need to "consolidate neighborhoods with insufficient population to support equitable and efficient service delivery" (Bring New Orleans Back Commission, Urban Planning Committee 2006). Thus, in the BNOBC plan, equity is redefined as a matter of service delivery after a spatial reconfiguration of the city that may or may not be equitable.

The presentation given by the BNOBC on January 11, 2006, included several maps along with accompanying text slides that lay out a four-part categorization of the city's lands. Though the scheme is based on the ULI report's categorization of investment and development zones, it differs in ways that came to be important both substantively and symbolically. Where the ULI panel identified and categorized spaces according to the level of "investment" and "development" that should be targeted for them, the BNOBC presentation added explicit consideration of property acquisition and administrative authority in the form of the city's authority to issue building permits.

The commission identifies "Immediate Opportunity Areas" as those areas with "little or no flood damage." These areas, which roughly correspond to the ULI report's Zone C, are to have "expedite(d) permits for repairs and construction of new housing." The maps call for the "areas contain(ing) deeply flooded and heavily damaged properties," roughly corresponding to the ULI's Zones A and B, to be collapsed into a single category known as "Neighborhood Planning Areas." The name of these zones emphasizes the "neighborhood planning process" that the commission urged be started immediately to "determine the future of the areas." In spite of this emphasis on planning, the recommendation repeated elsewhere in the presentation that the city should "not issue building permits in heavily flooded/damaged areas" led to fear of land grabs and redlining (Olshansky et al. 2010). The BNOBC's focus on *properties* rather than *households* or *people* as the most important unit of analysis for the determination of a neighborhood's fate reinforced the impression that the Commission was primarily concerned with urban land as a legal and financial phenomenon substantially devoid of social importance. When the presentation later gives recommendations for who should be involved in the neighborhood planning processes, "neighborhood residents" constitute only one of the eight named groups identified for participation, with the other seven slots occupied by technical experts of various kinds. Treating people who lived in impacted neighborhoods as just one among several relevant constituencies fits with the broader perception that the planning process was insufficiently attentive to the wishes of residents.

Again emphasizing the commission's focus on development, the BNOBC identified both "Infill Development Areas" and "Targeted Development Areas." The former are defined as those "underutilized sites on high ground" or areas "requiring demolition and clearance that can be developed with houses, commercial, and institutional uses" to accommodate uses relocated from more flood-prone areas. On these sites, marked by bright pink shapes on the maps, the commission recommends an expedited course of development including "consolidat(ion) (of) public and private ownership," "prepar(ation) (of) development plans," and "issu(ing) (of) developer requests for proposals."

Similarly, for the "Targeted Development Areas," the commission recommends that the city, "identify and facilitate financially responsible developers to develop large numbers of houses quickly," suggesting that financial capacity was the primary criteria of importance. While these sites are marked as numbered points on the BNOBC maps, their exact location appears to be somewhat arbitrary; some lie in heavily flooded former residential zones, others in the city's central business district, and still another in a largely industrial zone. The fact that the report does not explain any rationale for the location of these sites raises the question of whether this is a case of "the substitution of precision for validity"(Bowker and Star 1999) or if members of the commission had specific, unstated reasons to target these particular sites.

As in the case of the inexplicably precise locations of the "Targeted Development Areas," the BNOBC employed unexplained spatial and graphical specificity in what would become the group's most infamous map. The "Parks and Open Space" map (Fig. 3.2) drew from the ULI map the idea that the city should develop a network of

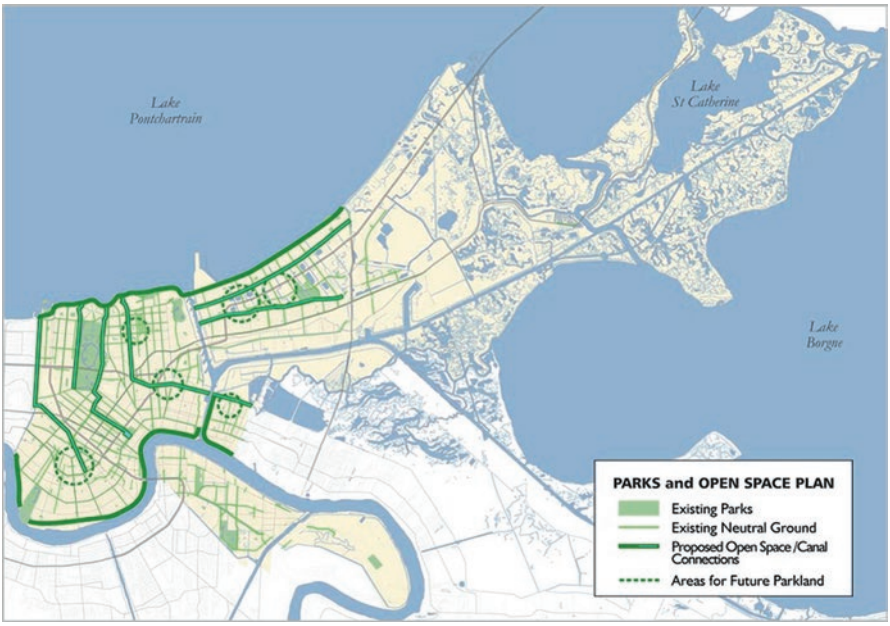

Fig. 3.2 The "Parks & Open Space Plan" as presented in *Action Plan for New Orleans: The New American City* by the Bring New Orleans Back Commission, Urban Planning Committee in January 2006. (Used with permission of the Bring New Orleans Back Commission)

green spaces that roughly corresponded to the city's drainage canals. In addition to these linear green spaces, the map indicates, with six green dashed, but unfilled, circles, "Areas for Future Parkland."[2] Text elsewhere in the presentation describes the "Parks and Open Space Plan" employing the same functionalist language of systems and real estate acquisition that is favored throughout the document in directing the city to "identify properties that can become part of the system and begin assembly."

To facilitate the assembly of the land necessary for the BNOBC's ambitious green space plan, as in the other development activities included in the plan, the commission recommended the immediate creation of the CCRC. Like the ULI panel, the BNOBC's consideration of homeowners in areas slated for depopulation was largely restricted to the administration of financial transactions. The presentation calls for the city to "aggressively support" legislation to "accommodate buyout of homeowners in heavily flooded and damaged areas" including through the use of eminent domain.

The BNOBC plan, like the ULI plan before it, presumed a radical realignment of the city's population and land use. This plan deemphasized the role of inclusive

[2] Perhaps on account of the furor that this map later generated, the word "potential" was amended to the designation for these circled areas on a later version of the map that appeared in *Architect* Magazine in 2007.

planning processes and called for the immediate enactment of aggressive redlining and greenlining to halt reconstruction in some areas and jumpstart development in others. While the categorization schemes in both plans allude to the need to account for a wide range of criteria, both defaulted to "elevational determinism," wherein topography is the dominant driver of rebuilding decision-making (Wagner and Frisch 2009). The green space map that would become the commission's most recognizable artifact combines the language of systems and functionalism with highly diagrammatic abstract geometries. In all of these classifications, the BNOBC treats the project of urban disaster recovery as a problem of efficiently maximizing real estate finance and public administration virtually devoid of considerations of public consensus or pre-Katrina cultural, social, and economic conditions.

3.4.3 The Times-Picayune Map: The Green Dots

On the same day that the BNOBC presented their plan, the city's largest newspaper ran extensive coverage of the plan along with their own interpretation of the accompanying graphics. The *Times-Picayune*'s coverage, like the BNOBC plan itself, emphasized the plan's sweep and ambition, but it also took several critical steps to reframe the plan in order to address the concerns of readers and residents. The main story's writers, Frank Donze and Gordon Russell, characterize the plan as a "vast reworking of the city's neighborhoods and housing patterns." Rather than presenting this process through the lens of real estate opportunity or civic administration as the previous framings had, the reporters recast the plan as victimizing a traumatized population through powerful new bureaucracy. The story begins:

> Residents of New Orleans areas hardest-hit by Hurricane Katrina's floodwaters would have four months to prove they can bring their neighborhoods back to life or face the prospect of having to sell out to a new and powerful redevelopment authority. (Donze and Russel 2006)

The map that occupied the majority of the front page that morning included several critical reinterpretations of the BNOBC's graphics and text, which shaped the reception of the plan in powerful ways (Fig. 3.1; see the "Introduction" of this chapter). First, the map cropped some of the furthest reaches of the eastern portion of the city in order to zoom in on the more densely populated areas. It also included and labeled major streets, allowing readers to more readily locate specific sites in the city. Though the map includes most of the categorization scheme indicated in the BNOBC maps, it does make some significant changes. Most importantly, the tentatively dash-outlined circles indicating future parkland on the BNOBC map here appear as solid green dots, lending them more graphical prominence and visually associating these areas with the existing parks indicated on the map. The linear green spaces indicated in the ULI and BNOBC maps are omitted in the newspaper's version. Divorced from the "system" of functional greenways, the green dots appear to be arbitrarily sited around the city. Presented in this more solidified form, among the red outlined areas for intensified redevelopment, the green dots came to be seen

as a harsh form of "prohibitive cartography" demarking spaces that would be off limits for return and reconstruction (Monmonier 2010).

While the graphical form of the newspaper's map accentuated its prohibitive character, the text that appeared in the map's key and the accompanying story reinforced the conflicting values embedded in the map. With the labeling of each of the plan's land use categories, the writers recast the BNOBC's language of real estate opportunity in terms of the impact on individual homeowners and residents. The BNOBC's "Immediate Opportunity Areas" are rendered as "areas where rebuilding allowed now." "Neighborhood Planning Areas" are labeled as zones where the city will enact a "building moratorium until neighborhoods prove viability," accentuating the prohibition and the proposed process of administrative viability testing. The BNOBC's "Infill Development Areas" are recast as "areas to be redeveloped, some with new housing for relocated homeowners," raising the specter of social reshuffling and intensive infill development.

The story that accompanied the map further reframes the plan, viewing its proposals from the point of view of homeowners. It includes a "Q&A" format that poses and answers such questions as: "I live in an area that looks unlikely to be rebuilt as it may be targeted to be park land. What's in store for me?" In its direct address and use of first-person pronouns, the story lifts the veil of abstraction and technical language that had characterized both the ULI and BNOBC plans to make concrete the impacts of this sweeping proposal for neighborhoods and residents.

3.5 Discussion

Proto-critical cartographer Arthur Robinson proposed that maps operate as communication devices through the interaction of three distinct, but related, phenomena: the mapmaker (sender), the map (medium), and the map viewer (receiver) (Pickles 2003). To the extent that the story of the green dot map has been told in the years since its release, it has largely been a story about how the map was received, the transformative impact that it had on the post-Katrina planning process, and, to a lesser extent, the realities and perceptions of who was responsible for the maps. The preceding analysis has clearly shown that, rather than viewing the *Times-Picayune* map as a singular medium of communication that passed from sender to receiver, it is critical to understand the map's creation as an iterative, stepwise process shaped by at least three sets of institutional actors, each with their own vision, values, and priorities for the reconstruction of the city. In the successive reinterpretation of the green dot map, first from the ULI plan to the BNOBC and then from the BNOBC to the *Times-Picayune*, Robinson's three-part schema becomes elongated and shifts from a relatively simple, unidirectional linearity to a series of interpretive tangents. To better understand the impact of the maps, it is important to consider all three of these components: the power structures and institutions that lay behind the creation of the maps, how each set of actors reinterpreted the ideas and images produced by

the preceding mapmakers, and finally, the social and political conditions in which the process and products were ultimately received.

3.5.1 The Mapmakers

Crampton and Krygier's premise that maps "actively construct knowledge," "exercise power," and "can be a powerful means of promoting social change" highlights the need to interrogate the identities and interests of the people and institutions responsible for mapmaking (Crampton and Krygier 2005). In the case of the green dot map, there are at least three sets of relevant mapmaking actors: the ULI expert panel, the Mayor's BNOB Commission and their consultants, and the reporters and staff of the *Times-Picayune*.

According to the ULI report, in the autumn after Hurricane Katrina:

> ULI assembled expert teams and an advisory panel of economic development, financial, design, redevelopment, land use, and urban planning professionals to work with Mayor C. Ray Nagin's Bring New Orleans Back Commission. (Urban Land Institute 2005)

As this statement indicates, the ULI report and the BNOBC plan lean on one another for their authority and legitimacy. The ULI draws its claims of authority largely from the technical expertise of the assembled panel and then grounds its local legitimacy in the group's political connection to the Mayor of New Orleans and the BNOBC. The 41 experts listed as contributing to the ULI report include a range of respected public and private sector leaders in real estate finance, law, development, construction, and planning, but none of the ULI experts listed New Orleans as their base of operations. While the outsider status of the assembled panel might be seen as beneficial in some settings, in the context of New Orleans, a city whose residents guard their distinctiveness with near-religious zeal, it made the panel and their recommendations immediately suspect.

Where the ULI report and maps drew their authority from the urban real estate, planning, and redevelopment expertise of the assembled group of national experts, the BNOB Commission appointed by the mayor was firmly rooted in New Orleans. The composition of the central committee of the BNOBC was clearly intended to address the city's long-standing racial tensions; it was composed of 17 people, 8 white, 8 black, and 1 Latino. In spite of this superficial diversity, before the group's work had substantially begun, Barbara Major, an African-American activist and the Commission's co-chair expressed skepticism, saying "I think some people don't understand that an equal number of black and white isn't the same as equity" (Rivlin 2005b).

Reflecting Mayor Nagin's long focus on improving the city's business climate, the group's membership was skewed toward business and development interests. The prevalence of business interests on the Commission served as a signal that the city was pursuing a largely privatized reconstruction that would be in line with the neoliberal policy preferences of the federal administration at the time. J. Stephen

Perry, president of the New Orleans Convention and Visitors Bureau at the time, told reporters, "I think the importance of this group is that it will give the federal government the confidence that the city is harnessing the private sector to do a lot of its work" (Rivlin 2005b). Though the group's business affiliations were seen as a strength by some, among many displaced residents and activists, they fueled suspicion that the Commission's recommendations for recovery would not adequately address the concerns of the city's poor citizens (Nelson et al. 2007; Olshansky et al. 2010). Over the course of the fall of 2005, as the Commission undertook its work, quotes from members alluding to the opportunity of the city's post-Katrina "clean sheet" and their desire for demographic restructuring only reinforced these suspicions (Rivlin 2005a; Wooten 2012; Gotham and Greenberg 2014).

While the ULI panel spoke from a position of technical expertise and outside detachment and the BNOBC drew its authority from the wealth, political connections, and business acumen of its members, the *Times-Picayune* maps and accompanying text drew their legitimacy from the position of the newspaper and its reporters as embedded members of the local community. With its urgent headlines and personal tone, the paramap text surrounding the published green dot map reinterpreted the optimism and technical language of the earlier plans to reflect the fears and suspicions of readers. In spite of the technical expertise and superficial diversity of the ULI and BNOBC, the fact that the two groups were widely perceived as not representing the viewpoint of the majority of displaced New Orleanians meant that their plans failed to establish their legitimacy in the eyes of the city's residents.

3.5.2 Reinterpretations

The preceding analysis of the three maps considers how each successive generation of maps and plans leading up to the green dot map communicated the values and interests of its makers through graphics and text. The final map reflects a process that began with a deliberately imprecise and highly qualified preliminary planning map produced by the ULI panel. While the ULI plan included recommendations for a planning process that would take account of equity and inclusion, their map and accompanying texts categorized space primarily according to *investment potential*. The ULI recommendations were then reinterpreted by the BNOBC as a real estate development proposal, largely stripped of the ULI's language on race, equity, and participation. The graphics and texts of the BNOBC plan presented a reconstruction process guided by a classification of *real estate acquisition activities*. The BNOBC's plans and maps were then finally recast by journalists and graphic designers at the *Times-Picayune* to focus on the *impacts on people and neighborhoods*.

While the BNOBC proposal draws heavily on the ULI policy and design recommendations, the proposal does not reference the ULI directly anywhere in the text or graphics. The omission of any reference to the ULI panel may have been an attempt by the Mayor's Commission to distance itself from the earlier report, which had drawn local suspicion and resistance (Olshansky et al. 2010). On the other hand,

though the map that appeared on the front page of the *Times-Picayune* on January 11, 2006, was substantially different in text and graphics from the BNOBC's maps, it includes a citation in the lower left below the map that reads, "Source: Bring New Orleans Back Commission." By presenting their editorially manipulated map as the product of the Commission, the paper blurred the line between re-presentation and commentary, exacerbating the already widespread distrust of the planning process.

3.5.3 Map Receivers

While the reception of and reaction to the green dot map have been by far the most discussed aspects of the entire episode, it is nonetheless worth considering these reactions systematically through the lenses of lay critical cartography. The map and the categorization system that it represented were roundly rejected and attacked on a number of different fronts. The negative public reactions to the green dot map included critiques of the plan on the basis of all four of the normative criteria for climate adaptation laid out by Adger et al. (2005): *efficiency*, *effectiveness*, *equity*, and *legitimacy*.

Though the BNOBC maps and plan were presented as "a rational path to recovery," they were widely critiqued as both rigid and arbitrary, attacking their claims to *efficiency* and *effectiveness* (Nelson et al. 2007). Many regarded the BNOBC map and plans as overly rigid and formulaic in their use of a logic of "elevational determinism" to condemn low-lying neighborhoods (Wagner and Frisch 2009). Others criticized the BNOBC proposals for arbitrarily condemning some neighborhoods and not others even though virtually the entire metropolitan area is at risk of flooding (Nelson et al. 2007). Calling into question the factual basis on which the plans were based, one Gentilly resident told reporters:

> Unless they could prove to us unequivocally that we were placing ourselves and our children in danger – and they couldn't – then we were not going to allow anyone to unilaterally dictate where we couldn't live. (Krupa 2010)

With its combination of schematic abstraction and unexplained precision, the graphics and paramap text of the *Times-Picayune* map played a significant role in shaping the perception of the plan as both rigid and arbitrary.

While some critiques focused on issues of efficiency and effectiveness, most of the critiques of the green dot map centered on issues of equity and legitimacy. The ULI and BNOBC plans were widely seen as having been the product of "top-down process[es]" (Nelson et al. 2007; Wooten 2012) by "closed-door" committees with "little input from communities" (Irazábal and Neville 2007). Wade Rathke, a leading local activist and founder of ACORN, directly impugned the legitimacy of the process, decrying the "arrogance" of the recommendations and labeling the ULI and BNOBC "unelected and unaccountable"(Rathke 2006). One Ninth Ward resident voiced a distrust of the municipal authorities more broadly in attacking the legitimacy of the city's planning process, saying "I was not going to let a corrupt city government deny my right to return" (Gotham and Greenberg 2014).

Charitable critiques of the green dot map and the plans behind it regarded the plans as naïve to the political realities of the city and inadequate in addressing the interests of the historically victimized low-income and African-American populations of the city. Less charitably minded critiques saw the plans as deliberately hostile to those vulnerable populations. For many critics, the perceived lack of *legitimacy* of the plans went hand in hand with their failure on the *equity* criteria. Political distrust and social division between white and black populations in New Orleans are deeply rooted, and they significantly shaped the response to the early post-Katrina planning processes (Olshansky et al. 2010; Gotham and Greenberg 2014). As in many disasters, the flooding of New Orleans disproportionately harmed African-American and low-income populations in the city due to the heightened physical and social vulnerability of some areas (Tierney 2006).

These same populations and neighborhoods had also suffered disproportionately during previous infrastructure and urban renewal projects in the city (Breunlin and Regis 2006; Nelson et al. 2007). This history of displacement and victimization at the hands of planners and developers led many in New Orleans to harbor a deep distrust of both public and private sector powers seeking to remake the city after the flooding. Given the city's history of racial animus and the racially tinged opportunism of statements from members of the BNOBC, the plan's calls for targeted prohibitions on building permits and buyouts in heavily flooded neighborhoods raised fears that the plan was an elaborate attempt to "keep many African Americans from returning" to the city (Nelson et al. 2007). So charged was the discussion of racial inequality in the proposed land use restructuring that activists labeled it an attempt at "ethnic cleansing" (Nelson et al. 2007) and "class and racial redlining" (Gotham and Greenberg 2014).

3.6 The Lasting Impacts of the Green Dot Map

More than a decade after the initial controversy surrounding the green dot map, the episode still looms large in discussions about water management in New Orleans. The swift and overwhelmingly negative response to the proposals presented in the *Times-Picayune* in January 2006 decisively ended official discussions of large-scale reshuffling of land uses to make way for stormwater-absorbing green space. Nonetheless, city leaders and planning and design professionals in New Orleans have continued to pursue "green infrastructure" strategies as one component in the "multiple lines of defense" against urban flooding (City of New Orleans 2015). A series of convenings, plans, and pilot projects have sought to demonstrate the utility of landscape-based stormwater retention and infiltration strategies. Key projects include the Dutch Dialogues series (2006–2009), The Greater New Orleans Water Plan (2013), the New Orleans Resilience Strategy (2015), and the Gentilly Resilience District pilot projects supported by funds from the US Department of Housing and Urban Development's National Disaster Resilience Competition (NDRC) (ongoing). While these projects have made progress in bringing green infrastructure into

the mainstream of flood mitigation discussions, many observers cite the green dot map episode as having created an atmosphere of suspicion and distrust, against post-Katrina planning generally and against green infrastructure specifically. This section recounts common themes regarding the lasting implications of the green dot map episode as they emerged from interviews with government officials and planning and design practitioners who have been active in the city's recent green infrastructure efforts. The interviews took place in 2016 and 2017.

While some responded to questions about the ongoing impacts of the green dot map by saying that the city has moved "past it" (New Orleans-based landscape architect 2017) or that "you don't hear much about it as much now" (Senior city official 2017), even those who minimized the ongoing importance of the episode regarded it as having substantially shaped planning over the last decade in New Orleans. One New Orleans-based planning practitioner reported that the episode confirmed the preexisting suspicions that New Orleanians had regarding heavy-handed planning, saying:

> The green dots really just cemented people's skepticism about planning. It was that way before, but it really just cemented it in people's minds. (New Orleans-based planner 2017)

While the episode may have heightened preexisting suspicions of planning generally, it had an especially pronounced impact on efforts to advance green infrastructure flood mitigation strategies. One local designer involved in these efforts reported that "everyone is super conscious of the green dot fiasco" (New Orleans-based designer 2017). A planner working with the city said that when their agency recently initiated several green infrastructure pilot projects, residents asked suspiciously "If you are doing this (green infrastructure), does that mean that you are not going to build more houses in the neighborhood?" (City official 2017). After the early post-Katrina conflicts over green infrastructure, Dutch urban designers who have been involved in water planning in New Orleans reported a wariness of proposals that might get entangled in "local politics" (Dutch water planner 2017). Another Dutch designer said that they avoided becoming involved in discussions of projects that would involve substantial displacement since, "As a Dutch firm, for us to be involved in these society issues … didn't feel safe… or appropriate" (Dutch urban designer 2017).

While there was widespread agreement that the green dot map episode had negatively colored the public perception of post-Katrina planning generally and green infrastructure specifically, interviewees reported a range of different ways that they perceived the episode as having shaped planning processes and projects in the years since. Some described the failures of the green dot map as failures of communication and translation. One urban designer pointed to the episode as "a good example of the danger of visualizations" and said that the major problem was that a map that "was intended as a discussion… was interpreted as against the lower economic status people" (Dutch water planner 2017). Recognizing that the green dot map emerged from a process of translation as described above, a senior city official pointed out that the harsh reaction was to the map that "the *Times-Picayune* showed in the paper, which was not what the ULI actually showed" (Senior city official 2017).

Reflecting this understanding, that the problems with the green dot map were attributable to failures of communication and representation, one urban designer reported that in their subsequent work, they have "tried to be more specific than dashed circles" in their representation of new green infrastructure. They went on to say that, to avoid the appearance of bias or arbitrariness, they base their recommendations on the "fundamentals of how soil and water interact" so as "to be more defensible" (New Orleans-based designer 2017). Another city planner reported that, in making the case for more green infrastructure investment in a neighborhood, they make a great effort in "connecting [the projects] to economic development and neighborhood revitalization," "forefronting those goals with flood protection subsequent to that" to make the point that these new projects are "very different from the green dot scenario" (City official 2017).

In addition to the ways that the green dot map episode has changed how planners and designers communicate green infrastructure proposals, the experience has also substantively informed planning processes and projects in the years since. A senior city official reported that the BNOBC plan "was done in isolation, with no one in the city." From that experience, they reported that "everyone learned… how to engage with people" and that, "the engagement has gotten much better… partially because of the green dot debacle" (Senior city official 2017).

Several practitioners and officials reported that, after the green dot episode, green infrastructure projects have been more opportunistic and smaller in scale. Designers and planners said that the efforts to institute landscape-based stormwater management have focused on using existing open space rather than advocating for large-scale projects that would require displacement of houses and neighborhoods. A senior planner with the city remarked that:

> Many of the places where we are prioritizing these kinds of projects are in areas that were under the green dots. Without displacing people and without all of the negative connotations of the green dots.

They explained that, "where there is vacancy, you can use that [space]" for green infrastructure. They went on to say, "This is not about taking something away. This is about adding to. We aren't taking houses away, we are adding parks." (Senior city official 2017) These sentiments reflect both the strategic shift to an opportunistic approach to green infrastructure that has characterized recent efforts in New Orleans and the recognition that the legacy of the green dot map has required a reframing of the communication surrounding these projects to address not only their effectiveness and efficiency but also their equity and legitimacy. It is important to note that, in some cases, the open space for this opportunistic green infrastructure approach was made available for those purposes by leaving empty lots on which flooded homes were purchased and demolished by the New Orleans Redevelopment Authority with the decline and movements of New Orleans' population following Hurricane Katrina.

3.7 Conclusions

The catalytic impact of the green dot map in shaping post-Katrina planning in New Orleans has been widely recognized. However, scholars and other commentators have paid little attention to where the map came from and how it communicated through graphics and text. With analysis of the maps' makers, the text-based and graphical reinterpretations they employed, and the political and social context of the community they meant to restructure, the story of the green dot map yields deeper insights for future planning and adaptation research and practice. The map was a product of multiple reinterpretations, each undertaken by different groups with distinct values and interests. Each of these iterations reflects a particular design politics colored by the values and interests of its makers. The version of the map presented to the public in the *Times-Picayune* in January of 2006 contains a confounding combination of deliberate abstraction and misplaced precision that, when paired with radical policy prescriptions for reorganizing property and land use, became highly inflammatory.

While public and scholarly critiques of the green dot proposal included concerns related to all four of Adger et al.'s (2005) criteria for successful climate adaptation, issues of the legitimacy and equity were especially central. These equity and legitimacy critiques were rooted in decades of well-earned racialized suspicion and distrust of top-down planning intervention in New Orleans. These suspicions were reinforced by the composition of the planning bodies responsible for the ULI and BNOBC proposals: outsider technocrats and representatives of the city's white-dominated business elite, respectively.

Apologists tend to describe the failure of the BNOBC as a problem of communication. Such a reading of the episode overlooks the fact that the reception of the maps as communication media was deeply shaped by the sociopolitical context into which the maps were released. The communication failings of the green dot map are tightly intertwined with the substantive critiques of the proposals and the preceding process. John Forester points out that the "technical problem-solving" functions of planning are inextricably linked to "planning as a means of processing information and feedback" (Forester 1988). While the ULI and BNOBC experts regarded their plans as reasonable attempts at effective and efficient technical problem-solving, for critics steeped in the history of problematic planning interventions in New Orleans, the green dot map was visual confirmation of their suspicions that the planning process was illegitimate and inequitable. For suspicious residents and critics, the map, with its bewildering combination of hard-edged geometric precision and high levels of abstraction, reflected a top-down process that appeared at once arbitrary and inequitable.

Though the problems with the green dot map run deeper than a benign failure of communication, the particular form of the graphics and text of the map and paramap materials presented in the *Times-Picayune* do matter. In the case of the explosive "green spacing" proposals, the ULI map's fuzzy shapes, the BNOBC's open dotted circles, and the *Times-Picayune*'s solid green dots each communicate different lev-

els of resolution and finality to the plans. Similarly, the shift from the ULI and BNOBC's language of administrative and financial efficiency to the *Times-Picayune's* resident-eye view of radical urban restructuring substantially colored the reception of the proposal. The green dot map episode makes clear that advocates of such urban adaptation projects must be attentive to how their graphics and texts will be reinterpreted, represented, and consumed. These processes are deeply place-specific and historically contingent and, thus, frequently may not be immediately comprehensible to outside technical experts.

Perhaps more than any other episode in the recent history of planning in America, the development and response to the green dot map demonstrate the need for greater sensitivity to the design politics of maps and planning representations among scholars, practitioners, and decision-makers. Skillful graphic communication cannot overcome deep substantive flaws in a planning process or proposal. However, by understanding how planning graphics and texts relate to the specific historically imbedded contexts of a place, planners can communicate with the public and decision-makers in ways that facilitate rather than destroy the potential for effective, efficient, equitable, and legitimate adaptation.

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Chapter 4
Antagonisms of Adaptation: Climate Change Adaptation Measures in New Orleans and New York City

Kevin Fox Gotham and Megan Faust

4.1 Introduction

Scientists increasingly point to the possibility of multiple abrupt negative consequences associated with anthropogenic climate change. Climate change poses risks to many environmental and economic systems—including agriculture, public infrastructure, ecosystems, and human health—and presents a significant financial risk to federal, state, and local governments (US Global Change Research Program 2011; National Research Council 2012a, b). Scientists expect climate change to threaten coastal cities and ecosystems with rising sea levels, elevated tidal inundation, increased storm and flood frequency and intensity, and accelerated erosion and saltwater intrusion (Blum and Roberts 2009; Intergovernmental Panel on Climate Change [IPCC] 2014; Karl et al. 2009). As observed by the US Global Change Research Program (USGCRP), the impacts and costliness of weather disasters resulting from floods, drought, and other events such as tropical cyclones will increase in significance as what are considered "rare" events become more common and intense due to climate change (Karl et al. 2009). Overall, according to the National Research Council and the US Global Change Research Program, changes in Earth's climate—including higher temperatures, changes in precipitation, rising sea levels, and more intense and frequent severe weather events—are underway and expected to grow over time. These risks not only imperil the long-term sustainability of cities and communities, but they could create significant fiscal problems for local, state, and federal governments.

This chapter identifies climate change adaptation measures implemented in post-Sandy New York City and post-Katrina New Orleans and examines their conflictual and contradictory dynamics and impacts. Climate change adaptation measures are an amalgam of government policies, socio-legal regulations, statutes, and laws to

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reduce current and future vulnerability to the negative impacts of climate change (e.g., global warming and sea-level rise) and strengthen social resilience (IPCC 2014). As a risk management strategy, climate change adaptation represents adjustments to natural or human systems in response to actual or expected climate change. The broad goal is to help protect vulnerable sectors and communities that might be affected by changes in the climate (GAO 2013). For example, adaptation measures include raising river or coastal dikes to protect infrastructure from sea-level rise, building higher bridges, and increasing the capacity of storm water systems. State and local authorities are responsible for the planning and implementation of many types of infrastructure projects, and decisions at these levels of government can affect insurance rates for businesses and homeowners as well as influence patterns of economic development. While implementing adaptive measures may be costly, policy-makers and elected leaders are increasingly recognizing that the cost of inaction could be greater as damage from weather-related events becomes more expensive (GAO 2009, 2016).

This paper addresses the ways in which the decentralized and fragmented structure of policy-making and implementation in the United States both constrains the process of formulating and implementing comprehensive climate change adaptation measures and encourages cities to respond to climate change using their own distinctive policy measures. Much social science research has focused on the uneven manner in which climate change adaptation agendas are unfolding in a diverse set of urban contexts (Dunlap and Brulle 2015; Bulkeley and Castán Broto 2013; Bulkeley and Betsill 2013; Burch et al. 2014; Dale et al. 2018; Morrison et al. 2017; McCann 2017). In this paper, we adopt an "encompassing" comparative approach to explain how local climate change developments in New York City and New Orleans reflect, share characteristics with, and contribute to broader socioeconomic and political trends in the United States. Encompassing comparison seeks to understand how local actions and events express the interaction of local-global forces and relations including institutional forms, regulatory strategies, and governance projects. We conceptualize the pairing of climate change adaptation measures as an encompassing comparison, which, according to Charles Tilly (1984, p. 83), "places different instances at various locations within the same system, on the way to explaining their characteristics as a function of their varying relationships to the system as a whole." While our comparison of two cities may lack sufficient scope for statistical generalization, we believe our encompassing mode of comparative analysis provides for breadth of generalization and depth of description that is not possible in quantitative analyses. Our comparison provides an opportunity to reflect upon how decisions surrounding climate change adaptation measures take place in a larger political economy of policy-making that shapes and constraints local actions.

4.2 Risk, Resilience, Mitigation, and Adaptation

Over the last decade or so, scholars and policy-makers have debated the steps governments can take to reduce risk of extreme events through climate change adaptation and align such adaptation with broader resilience efforts (Gotham et al. 2011; Gotham and Campanella 2010, 2011). Risk refers to situations or conditions that pose a threat to human health, quality of life, and community well-being (for an overview, see Tierney 2014). Risk is a relational term that is closely connected to the notion of resilience, which the National Research Council (2012b, p. 5) defines as the "ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events." In the scholarship on climate change, resilience implies regulatory and policy actions to *reduce* vulnerabilities to the effects of severe weather and to *adapt* to the effects of climate change. Scholars theorize that two related sets of actions—climate change mitigation and climate change adaptation—may be able to enhance resilience by reducing risk. Mitigation refers to human actions to reduce the sources of greenhouse gases (GHGs) that contribute to global warming and, in turn, sea-level rise.

We follow climate change scientists in viewing climate change mitigation and adaptation as conceptually separate and analytically distinct. We recognize that federal agencies such as FEMA and the Army Corps of Engineers have used the term hazard "mitigation" for decades to refer to activities designed to reduce hazard risks. Flood risk reduction, for example, involves a combination of structural—focusing on reducing the *probability* of flooding—and physical and nonphysical nonstructural measures that focus on reducing the *consequences* of flooding (US Army Corps of Engineers 2018). At the individual property level, nonstructural mitigation options include elevating a building to or above the area's base flood elevation, relocating the building to an area with less flood risk, or purchasing and demolishing the building and turning the property into green space. In addition, nonstructural risk reduction measures would include flood insurance, floodplain mapping, improving response capacity, improving post-disaster assessment and communication capacity, and developing more effective strategies to communicate risk and mitigation activities to various stakeholders. Nonstructural mitigation is akin to adaptation. FEMA supports a variety of nonstructural flood mitigation activities to reduce flood risk.

Because mitigation is intended to reduce the harmful effects of climate change, it is part of a broader policy framework that also includes adaptation to climate impacts. Climate change adaptation refers to actions taken by governments, nonprofit organizations, and private firms to reduce the loss of life and property by lessening the impacts of adverse climate change events such as weather-related disasters. Climate change adaptations can also be classed as either *process-oriented* measures—aimed at developing information systems, social structures, and governance needed to support adaptation—or *outcome-oriented* actions, measures taken to reduce vulnerability and exploit opportunities that arise from a changing climate. Climate change adaptation measures can be *effect-oriented* in the sense of

building flood protection or *cause-oriented* by adopting approaches such as changing the location of areas for new housing development. Climate change adaptation includes activities such as restoring wetlands and coastal areas to control erosion, improving the quality of road surfaces to withstand hotter temperatures, protecting critical facilities against the negative effects (e.g., inundation) of sea-level rise, and creating permeable surfaces and "green roofs," or roofs partially or completely covered with vegetation, in cities to absorb excess rainfall, provide insulation, and help lower urban air temperatures (Wise et al. 2014; for an overview, see IPCC 2014). Climate change adaptation measures can be proactive and/or reactive. Governments may plan and adopt adaptation measures in advance, establish them in the aftermath of a major disaster, or create them in response to local pressures. In addition to large-scale infrastructure measures to adapt to climate change, governments may also implement policies and regulations to incentivize people to change their behaviors. This approach includes motivating them to use less water, encouraging farmers to plant different crops, and urging more households and businesses to purchase flood insurance.

Many researchers and policy-makers consider climate change a global problem that demands international action and global solutions. But sociologists and others have documented that the effects of global climate change will not be equally distributed around the world, for "many of the countries least responsible for the rise in greenhouse gases will be most likely to feel its impacts in changes in weather, sea-levels, human health costs, and economic hardships" (Nagel et al. 2010, p. 17). The unequal burdens inflicted by climate-related disasters and limited disaster response capacities will exacerbate these inequalities and likely generate unforeseen consequences. Variations in individual, community, and national vulnerability to the impacts of climate change are only part of this global structure of inequality. As the 2007 Intergovernmental Panel on Climate Change (IPCC) report notes, there is an unequal distribution of impacts and vulnerabilities to climate change associated with social class and age in both developed and developing countries: "vulnerability to climate change can be exacerbated by other stresses. These arise from, for example, current climate hazards, poverty and unequal access to resources, food insecurity, trends in economic globalization, conflict and incidence of diseases such as HIV/AIDS" (2007, p. 14). Thus, the impacts of climate change are not spread evenly, and its effects will be felt by different social groups in radically different ways.

The ways in which climate change is closely intertwined with state policy-making, institutional arrangements, and political economy is one of the reasons why it has proven so unique an issue to address internationally as a global problem. Conceptualizing climate change as a global-local issue and using comparative analyses draws attention to different socio-spatial inequalities, local and regional histories and geographies, and their implications for communities. These concerns bring explicit temporal and spatial dimensions to our understanding of the local impacts of global climate change. Climate change adaptation measures are activated and reproduced through the concrete actions taken by state actors, elected leaders, economic elites, and other powerful organized interests. A core assumption of this

agent-centric approach is that the adoption of climate change adaptation actions does not develop out of an inevitable and unalterable structural necessity but rather in a contingent manner; it results from the conscious actions taken by individual decision-makers in various institutions, organizations, and communities acting under particular historical circumstances. This emphasis on contingency and agency compels us to examine the actions of human agents, organizations, and interest groups in an effort to grasp how larger climate change dynamics and effects occur at the local level. Underscoring the importance of space and time in climate change research means that any explanation of *why* and *how* climate change policy actions develop will need to take account of *where* and *when* they develop.

In the sections below, we address the obstacles to climate change adaptation by focusing on the dynamic ways in which antagonisms—incongruences and inconsistencies between goals, implementation strategies, and outcomes—develop and persist. Scholars have used terms such as "barriers," "obstacles," "tensions," and "contradictions" to describe the difficulties that hinder the formulation and implementation of climate change adaptation actions (Eakin et al. 2014). Lack of resources to meet the costs of adaptation can be a financial barrier. Lack of administrative and/or political capacity can be an institutional barrier to adaptation. Collective opposition and political mobilization against adaptation can be a social-cultural barrier. Finally, gaps in climate change knowledge and the transmission of information can create an information barrier. Eisenack et al. (2014, p. 867) suggest that the "growing literature on barriers to adaptation reveals not only commonly reported barriers, but also conflicting evidence, and few explanations of why barriers exist and change."

In attempt to move beyond debates over discrete barriers to climate change adaptation, Pelling et al. (2015) have developed the concept of transformation "as an adaptive response to climate change" that can open a range of novel policy options. In their work, transformative adaptation is a multifaceted concept that researchers can use to describe responses that produce nonlinear changes in systems or their host social and ecological environments. The concept also raises distinct ethical and procedural questions for decision-makers and "foregrounds questions of power and preference that have so far been underdeveloped in adaptation theory and practice" (p. 113). The concept of transformative adaptation dovetails with the notion of transformative resilience developed by Gotham and Campanella (2011) and suggests that we view climate change adaptation in a multidimensional fashion, for example, as a political decision point, an opportunity for socio-spatial change, and a prospect for resistance to dominant developmental pathways.

Through a comparison of New Orleans and New York, our research helps to explain the major antagonisms of adaptation and provides insights on how to overcome them to enhance societal resilience to climate change risks. Following the logic of encompassing comparison, we analytically juxtapose policy trajectories and institutional arrangements rather than compare discrete units or fixed variables. The chapter offers a sociological critique of the dominant approaches to adaptation and highlights the institutional and social antagonisms that are shaping the implementation of climate change policy in each city.

Our theorization of the facilitative and discouraging power of state action in the development of climate change adaptation measures focuses on the state as an actor and as an institutional structure. The state comprises many actors that can formulate and implement different policies and socio-legal regulations to respond to climate change. State governments have special charters and can make property rights decisions to alter the organization of firms and corporate hierarchies. Through legislative debate and compromise, the US Congress makes laws, holds hearings to inform the legislative process, conducts investigations to oversee the executive branch, and represents voting constituencies and states in the federal government. Courts can determine the meaning and effect of laws passed by the state legislatures. Over the decades, US judges have played aggressive roles in interpreting policy-making and economic governance (Campbell and Lindberg 1990).

As an institutional structure, the state power and authority are fragmented and restricted to the extent that state and local governments exercise political authority within their own geographical areas. The existence of 50 separate governments combined with hundreds of municipalities in metropolitan areas has played an important role in the development of different markets, real estate financing, and land-use policies and regulatory strategies. For the most part, laws and regulations pertaining to economic activity and investment are locally based. These laws and regulations include, among many others, recording regulations, banking laws, zoning laws, subdivision regulations, private deed restrictions, land-use regulations, building codes, insurance laws, and property tax law (Feagin and Parker 2002; Gotham 2006, 2009). At the same time, local laws and socio-legal regulations establish institutional practices and rules of exchange that coordinate local economic activity among organizations in a particular economic sector (residential, commercial, or industrial activity) and, more importantly, create distinctive locations for policy-making, investment, and economic activity. The implication is that the decentralized and fragmented institutional structure of the state has influenced the development of legal forms that reinforce the place specificity of climate change adaptation measures thereby fostering local uniqueness and innovation (Gotham 2006).

4.3 Global Climate Change Risk in New York City and New Orleans

The New York City metropolitan area, with 23 million residents and approximately 3700 miles of tidal coastline, faces a severe social-ecological threat from climate change-driven warming and sea-level rise. The New York City Panel on Climate Change (NPCC), an organization that examines climate change vulnerability and prepares projections for the City and metropolitan region, contends that extreme weather will increase in frequency and severity and that the climate will become more variable. Climate projections encompass a wide range of possible outcomes:

mean annual temperature is projected to increase between 4.1 and 6.6 °F by the 2050s and between 5.3 and 10.3 °F by the 2080s; frequency of heat waves is projected to triple by the 2050s to 5 to 7 heat waves per year; sea level is expected to continue rising by 11 to 21 inches by the 2050s and by 18 to 39 inches by the 2080s, a rate that exceeds the global average in relative sea-level rise. New York City has experienced the devastating effects of coastal storms, most recently during Hurricane Sandy, as well as flooding in low-lying areas during high tides. Sea-level rise is projected to increase the depth, extent, and frequency of flooding from storm surge and during high tides (Horton et al. 2015; New York City Mayor's Office 2015).

Like New York, the New Orleans metropolitan area constitutes a highly cited example of a region experiencing the leading edge of climate-related stresses that are widely anticipated to affect coastal regions worldwide (Hallegatte et al. 2013). Given its low elevation and susceptibility to storm surge, extreme storm events and sea-level rise stand out as two of the most severe consequences of climate change in New Orleans and much of southern Louisiana. González and Törnqvist (2006, 2009) show that the preindustrial millennium (600 to 1600 AD) witnessed a rate of sea-level rise of −0.55 mm $yr.^{-1}$ in coastal Louisiana. In contrast, the past century has seen rates of at least 2 mm $yr.^{-1}$, roughly in line with the global average and a fourfold increase in the rate of relative sea-level rise (IPCC 2013). Moreover, modeling assessments consistently point toward an increase in hurricane intensity with global warming. Hurricanes strike the Louisiana coast with a mean frequency of 2 every 3 years (Kolb and Saucier 1982). In 2005, Hurricane Katrina forced the largest and most abrupt displacement in US history with approximately 1.5 million people evacuated from the Gulf Coast region. Using storm surge models, scientists predict a doubling of Hurricane Katrina-magnitude events over the next century (Grinsted et al. 2013; Holland 2012).

For New Orleans, climate-related environmental change coalesces with other non-climate stressors such as wetland loss and land subsidence. Louisiana harbors approximately 40 percent of the contiguous United States' coastal wetlands yet accounts for almost 80 percent of wetland loss. Louisiana has been losing coastal wetlands since at least the 1930s, but the long-term rate of land loss has slowed since its peak in the 1970s, according to the Department of the Interior's US Geological Survey (Couvillion 2017). In addition to subsidence and accelerated sea-level rise, the dredging of about 15,000 km of canals in the Mississippi River Delta area, primarily for oil and gas infrastructure, has led to widespread saltwater intrusion and ecosystem degradation. However, the fundamental cause of wetland loss is the isolation of the delta plain from sediment input due to the embankment of the Mississippi and Atchafalaya Rivers by artificial levees. Since embankment was completed in the 1930s, the majority of the Mississippi River sediment load has been lost to the deeper waters of the Gulf of Mexico, where the mouth of the river debouches at the shelf edge rather than near shore and inland areas that would replenish the delta plain (Campanella 2017).

Our comparative analysis of climate change adaptation measures in New York and New Orleans suggets two sets of intersecting factors that pose interesting

conditions for studying climate change responses. On the one hand, both urban regions represent global climate change's "canaries in the coal mine" in the United States. These highly sensitive regions face a future of rising relative sea level, increased frequency and destructiveness of storm events, extreme vulnerability to flood trauma, and potential for major displacement. Scientists view the two regions as harbingers of climate change impacts to come for coastal ecosystems worldwide (Kent 2012; Reed et al. 2015; Wang et al. 2011). On the other hand, both cities constitute the leading edge of socio-legal experimentation, regulatory inventiveness, and policy innovation that will likely offer new approaches and strategies to help other cities adapt to climate change. Currently, planners and policy-makers debate various policies to reduce coastal risk, and major coastal restoration projects, climate change adaptation, and mitigation efforts are currently underway (Gotham 2016a, b; Gotham and Cheek 2017; Gotham and Cannon 2018; Gotham and Powers 2017; Peyronnin et al. 2013; Fischbach et al. 2012). Yet the level at which elected leaders and policy-makers understand the causes and consequences of climate change, as well as the extent to which they regard climate change as harmful to the ecological and economic sustainability of the two cities and regions, is not known. These concerns underpin the need to examine the local and regional dynamics of climate adaptation policy-making and implementation in detail.

4.4 Long-Term Sustainability Challenges Facing New York City and New Orleans

Both New York City and New Orleans face long-term sustainability challenges related to the distinctive and peculiar system of local, state, and federal relationships and financing arrangements in the United States (Gotham and Greenberg 2014). As a distinctive configuration of organizations, the agencies of the different branches of the federal government, as well as agencies at the state and local government levels, are predisposed to struggle and conflict over funding amounts and mechanisms of financing. Insofar as the different parts of local, state, and federal governments have overlapping responsibilities for policy-making, contradictory policy actions and political stalemate are possible. Indeed, the institutionally fragmented nature of US federalism has systematically produced a variety of conflicts and contradictions in many areas of policy-making including economic policy, defense policy, transportation policy, housing policy, regulatory policy, hazard mitigation and disaster response policy, and so on (Campbell and Pedersen 2014; Gotham 2012; Gotham and Wright 2009; Hogan and Howlett 2015). As long as different parts of local, state, and federal governments provide different arenas of access to political actors and organized interests, then political conflict and struggle are possible. Moreover, we can expect conflicting policy actions and policy outcomes to the extent that these actors pursue their interests in different arenas.

Over the last decade, the US federal government has developed a number of climate change adaptation plans that have intersected with local efforts to address urban resilience. In June 2013, President Obama issued the Climate Action Plan, which describes the federal government's existing and planned efforts to prepare for the impacts of climate change and set strategic priorities for the country. For example, the plan directs federal agencies to take appropriate actions to reduce risk to federal investments, specifically calling on them to update their flood risk reduction standards. The plan also established a federal flood risk management standard in January 2015, and implementation guidelines were issued in October 2015 (Executive Order No. 13690). In November 2013, President Obama also issued Executive Order 13653, which directed federal agencies to develop or update comprehensive adaptation plans by describing how they would consider improving climate change adaptation and resilience measures. By 2014, almost 40 federal agencies had created climate change adaptation plans. In addition, several crosscutting interagency plans had been developed to address challenges and improve resilience to climate impacts (Interagency Climate Change Adaptation Task Force 2011).

One example of the antagonistic nature of the formulation and implementation of climate change adaptation measures is the efforts the Trump Administration took to rescind the two Obama Administration executive orders mentioned above. On March 28, 2017, President Trump revoked Executive Order 13653 that aimed to promote (1) engaged and strong partnerships and information sharing at all levels of government; (2) risk-informed decision-making and the tools to facilitate it; (3) adaptive learning, in which experiences serve as opportunities to inform and adjust future actions; and (4) preparedness planning. On August 15, 2017, President Trump revoked Executive Order 13690 in an effort to streamline federal environmental review and approval of major infrastructure projects located in flood-prone areas. The Obama Administration's Executive Order 13690 (2015) required federally funded projects to incorporate flood risk management standards that account for sea-level rise. By revoking this executive order, the Trump Administration adopts a new floodplain risk management strategy that restricts the definition of floodplain, thereby allowing more real estate development in flood-prone areas, rejects determinations of risk based on "a climate-informed science approach," and no longer requires federal agencies to incorporate climate science into the analysis. The decisions of the Trump Administration are not only inconsistent with past decisions of the Obama Administration on climate change adaptation but are at odds with prevailing science-based risk management measures advocated by scientists and policy-makers.

During the Obama Administration, the President's Climate Action Plan directed federal agencies to support climate-resilient investments. For example, the plan directed the Department of Housing and Urban Development (HUD) to require grant recipients funded with supplemental appropriations for Hurricane Sandy response to take sea-level rise into account in their projects and activities. Federal agencies have made other climate-resilient investments. HUD, for example, initiated the Rebuild by Design competition and provided $930 million to fund projects that

enhance disaster resilience in areas affected by Hurricane Sandy. One such project proposed building deployable walls attached to the underside of roads that could be used during flood events in Manhattan. In addition, several Federal Emergency Management Authority (FEMA) programs fund hazard mitigation measures to assist states and local governments in their efforts to enhance disaster resilience before disasters occur. Activities eligible for grants include property acquisition, elevation, and retrofitting. Programs such as the Hazard Mitigation Grant Program, Hazard Mitigation Assistance, Pre-disaster Mitigation Grant Program, Flood Mitigation Assistance, Repetitive Flood Claims, and Severe Repetitive Loss undertake these projects (Gotham 2012).

Several federal agencies and funding sources have played major roles in post-Katrina and post-Sandy rebuilding efforts in New Orleans and New York. Following Hurricane Katrina, Congress authorized the US Army Corps of Engineers ("Corps") to design and construct the $14.6 billion Hurricane and Storm Damage Risk Reduction System (HSDRRS) for southeast Louisiana. Over the past 10 years, the Corps has strengthened the levees, floodwalls, gated structures, and pump stations that form the 133-mile Greater New Orleans perimeter system in addition to improving approximately 70 miles of interior risk reduction structures (Gotham 2018). In Louisiana, state officials used $10.5 billion in HUD funds from the Community Development Block Grant (CDBG) program to create the Road Home program, which provided homeowners with up to $150,000 to repair or rebuild damaged homes. Other Road Home funds were used to elevate homes (for a critical overview, see Gotham 2014a). Like FEMA's Hazard Mitigation Grant program, policy-makers designed the Road Home as a resilience-enhancing program, though scholars have raised questions about the overall effectiveness of the Road Home program in achieving resilience goals and outcomes (Gotham 2014b).

Other federal funding sources including the Water Resources Development Act (WRDA) and the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) (authorized by Congress in 1990) have been instrumental in funding coastal restoration and protection efforts in southern Louisiana. Following Hurricanes Gustav and Ike in 2008, the federal government provided $27.4 million to Louisiana for coastal protection and restoration projects that help communities recover from the storms and better withstand future hurricanes. The CDBG funds went to the Louisiana Office of Community Development's Disaster Recovery Unit, which has partnered with the Coastal Protection and Restoration Authority (CPRA) to identify potential flood protection projects such as levee construction or improvements, floodgate installation, critical infrastructure, and shoreline protection. Through Fiscal Year 2015, the CPRA built or improved approximately 250 miles of levees, moved over 150 projects into design and construction phases, approved constructed projects in 20 parishes, and approved construction of 45 miles of barrier islands and berms. These projects represent a total state government investment of nearly $477 million in FY 2015 (CPRA 2017).

In New York, the US Army Corps of Engineers and the State of New York raised $450 million to construct new armored levees and other infrastructure along Midland Beach and Staten Island's East Shore. Funds were also allocated to invest in coastal

protection in the Rockaways and the communities surrounding the Jamaica Bay area. In addition, HUD allocated $4.21 billion in disaster aid through the Community Development Block Grant-Disaster Recovery (CDBG-DR) to create to the Business PREP (Preparedness and Resiliency Program). This was a new program to help small businesses better prepare for emergencies and enhance the resiliency of their operations, assets, and physical space. The $4.21 billion in disaster aid helped spur new investment in several urban neighborhoods including the Rockaways, Staten Island, Coney Island, and Hunts Point (New York City Mayor's Office 2014). In 2015, New York City announced that it was using funds from HUD's Rebuild by Design, referred to above, to begin preliminary design work on the Lower East Side to implement a $335 million integrated, neighborhood-sensitive flood protection system to mitigate risk. This project is "intended to be just the first phase of a larger project that will ultimately provide coastal resiliency for all of Lower Manhattan," according to the New York City Mayor's Office (2015).

The generation and distribution of climate change adaptation resources are mediated by the decentralized, fragmented structure of American federalism. This decentralized and fragmented structure localizes the funding mechanisms to generate the monetary resources to support climate change adaptation measures. State governments and localities have historically remained responsible for generating funds for urban revitalization. Consequently, uneven metropolitan development has been a permanent feature throughout US history (Gotham 2014c; Gotham 2001). Moreover, for most people, climate change is distant and remote compared to the everyday concerns of urban health, crime and safety, education, and housing. Governments have typically not included adaptive measures in their planning because they tend to focus their attention and resources on competing, shorter-term priorities like sustaining government services and raising funds to deal with infrastructure upkeep, repair, and long-term challenges. Adaptation is a relatively low priority compared with more traditional and immediate concerns such as managing aging infrastructure systems, sustaining current levels of service, protecting public health and safety, and maintaining service affordability (GAO 2013). Short-term competing priorities make it difficult for decision-makers to address the impacts of climate change, especially since many state and local governments responsible for infrastructure investment face immediate funding and staffing challenges. Given these institutional challenges, the formulation of coherent climate change adaptation policy remains elusive and extraordinarily difficult.

4.5 Contradictory Roles of the Federal Government

Recent years have witnessed three ominous developments that threatened to obstruct progress on reducing climate change risks. First, in March 2017, President Donald Trump, as part of his Fiscal Year 2018 budget request, introduced plans to eliminate the National Oceanic and Atmospheric Administration's (NOAA) National Sea Grant College Program, a 50-year old program that funds scientific research focused

on climate change adaptation initiatives that will prepare coastal communities for the predicted impacts of climate change. In prior years, the program received $73 million per year. Under the Trump budget, the program would have received no funding at all. The Sea Grant program oversees a network that includes the National Sea Grant Office, 33 university-based state programs, the National Sea Grant Advisory Board, the National Sea Grant Law Center, the National Sea Grant Library, and hundreds of other participating institutions. Also in his budget, Trump announced major cuts to NOAA's Office of Oceanic and Atmospheric Research, where climate research programs are housed. The office would see a $150 million, or 19 percent, budget cut. Other NOAA programs to be zeroed out as part of the administration's budget request included the National Estuarine Research Reserve System, Coastal Zone Management Program grants, and the Pacific Coastal Salmon Recovery Fund. Over the past year, Congress has followed President Trump's lead by pushing for major budget cuts to the Environmental Protection Agency (EPA), such as $513 million in cuts that would effectively terminate climate change adaptation programs such as the Climate Resilience Fund as well as broader environmental programs and management (Meade 2018; Thwaites 2018). While the House ignored the President's budget request, rather increasing funding for Sea Grant and NOAA, the examples continue to be relevant because they reflect a lack of consensus between the legislative and executive branches on funding for climate change mitigation and adaptation.

Second, in President Trump's first budget proposal for Fiscal Year 2018, he proposed major cuts in federal funding for coastal restoration and protection efforts in Louisiana. The proposal upends the Gulf of Mexico Energy Security Act (GOMESA), which is a commitment from Congress to share offshore energy revenues with four of the Gulf states that are impacted by its production. GOMESA is projected to provide approximately $100 million per year beginning in 2017. Congress has dictated that GOMESA funds be used for projects and activities for the purposes of coastal protection, including conservation, coastal restoration, hurricane protection, and infrastructure directly affected by coastal wetland losses. President Trump's proposal follows Obama Administration 2016 and 2017 budgets for the Department of Interior that contained language to redirect GOMESA revenue to broader national programs. GOMESA is a revenue-sharing program that, while estimated to provide substantial long-term funding for climate change adaptation, is not guaranteed across a multi-decade time horizon. A major contradiction in relying on GOMESA to fund climate change adaptation efforts is that GOMESA revenues depend on the continued profitability of offshore oil and gas production, a major producer of GHGs that are the source of global warming and subsequent sea-level rise (Mogensen 2018; Reardon et al. 2017; Selby n.d.).

Third, closely related to recent executive branch efforts to erect roadblocks to climate change adaptation has been a strong political consensus among elected leaders to deny or dismiss the scientific consensus on the extent of climate driven sea-level rise, its significance, and its connection to coastal erosion. In Louisiana, many elected officials have been prominent climate change deniers, calling into question the science behind global warming and adamantly opposing legislation to

reduce GHGs that contribute to rising sea levels. Over the years, Louisiana's congressional delegation has voted against legislation that would have factored global warming into federal project planning; voted in favor of barring the EPA from regulating GHGs; voted against enforcing limits on CO2 global warming pollution; voted against tax credits for renewable electricity; voted for tax incentives for fossil fuel energy production; voted against tax incentives for renewable energy; voted against removing oil and gas exploration subsidies and against keeping a moratorium on drilling for oil offshore (outside of Louisiana); voted for authorizing construction of new oil refineries; voted for barring GHGs from Clean Air Act rules; voted for letting the wind energy production tax credit expire; voted against reducing oil usage by 40 percent by 2025 (instead of 5 percent); voted against factoring global warming into federal project planning; voted against implementation of the Kyoto Protocol; voted against including oil and gas smokestacks in mercury regulations (September 2005); and voted to appoint Scott Pruitt—a climate change denier who has sued the EPA over emission regulations—to head that agency (Marshall 2017).

In 2011, US House of Representative member Steve Scalise helped pass an amendment to the Agriculture Appropriations Bill prohibiting funds from being used to implement a new US Department of Agriculture (USDA) regulation requiring agencies to spend taxpayer dollars to study and implement climate change policies and initiatives. The amendment passed by a vote of 238 to 179. Senator Scalise signed the No Climate Tax Pledge and voted for amending the Clean Air Act to prohibit the EPA from promulgating any regulation on the emission of a greenhouse gas to address climate change. He also voted against proposed legislation to require utilities to supply an increasing percentage of their demand from a combination of energy efficiency savings and renewable energy. In 2009, he signed HR 391 to amend the Clean Air Act to declare that nothing in the Act shall be treated as authorizing or requiring the regulation of climate change or global warming. As one journalist put it:

> No landscape in the nation is more threatened by global warming, yet our delegation has consistently voted against carbon legislation at the urging of industry and have voted for bills that would prohibit federal agencies from even studying global warming. Naturally, that has congress people in other states asking the question: Why should we pour billions into rebuilding Louisiana's coast, if their own delegation isn't going to address one of the main causes of its loss? (Marshall 2012)

Climate change denial expresses the mounting political and economic stakes of dealing with the risks of anthropogenic climate change. Conservative think tanks, conservative media, corporations, and industry associations (especially for the fossil fuels industry)—domains dominated by conservative white males—have spearheaded the attacks on climate science and policy from the late 1980s to the present (Dunlap and McCright 2011; Freudenburg and Muselli 2010; Lahsen 2008; McCright and Dunlap 2003, 2010, 2011a, b; Oreskes and Conway 2010). Organized climate change denial has an elective affinity with established conservative think tanks that promote free-market conservatism and front groups promoting industry interests. Sustained climate change denial, promoted largely by the American

conservative movement (Dunlap and McCright 2011; McCright and Dunlap 2003, 2010), contributes to political polarization on climate change beliefs (McCright and Dunlap 2011b). This organized "climate change denial movement" has mobilized to undercut public belief in climate science and discourage political support for climate change risk reduction measures and adaptation measures (Dunlap and McCright 2011; Oreskes and Conway 2010; McCright and Dunlap 2010; Powell 2011). The political effect of climate change denial is to off-load the cost of paying for climate change risk reduction to other more vulnerable groups while simultaneously protecting the profiteering interests of the GHG production economy.

4.6 Conclusions

Since the establishment of the Intergovernmental Panel on Climate Change in 1988, the potential impacts of global climate change have captured the attention of the natural and physical scientists, the international research community, and the policy-makers around the world. As the human causes and consequences of climate change have become increasingly apparent, scholars and government leaders have called on social scientists to contribute to the scientific understanding of the role of humans in global climate change (for overviews, see Dunlap and Brulle 2015; Nagel et al. 2010). Social scientists debate the short-term and long-term climate impacts on cities and communities around the world. Different nations will have to balance a variety of value-laden considerations related to the impacts of climate change itself, potential costs of mitigation and adaptation, and collective struggles over the appropriate societal response. The difficulty of these tasks is compounded by the need to develop a consensus on fundamental issues such as the level of risk that societies are willing to accept and impose on others, strategies for sharing costs, and planning for unforeseen consequences. These tasks and issues are intertwined with relations of domination and subordination. Different actors and organized interests have varied political-economic prerogatives, and the political system offers differential and unequal access to decision-making power. Thus, any examination of the global social problem of climate change must address the question of adaptation "for whom" and "for what purpose."

In spite of the federal disaster resources directed to New York and New Orleans, the federal government has an inherently limited role in the project-level planning processes central to adapting infrastructure to climate change because these are typically the responsibility of state and local governments. That is, state and local authorities are primarily responsible for prioritizing and supervising the implementation of climate change adaptation measures and projects. Therefore, for the foreseeable future, both New York and New Orleans as well as US cities in general face a constrained situation of poor funding and limited options for raising money. On the one hand, different communities can use a variety of sources to fund capital projects, pay for operations and maintenance costs, and sustain programs. These funding sources can include (1) taxes such as property, sales, and income

levies; (2) fees such as charges for inspections and permits; (3) state and federal grants such as those that support improvements to drinking water, wastewater, and storm water systems; (4) bonds which enable communities to borrow money to pay for projects; (5) loans to pay for projects and programs; and (6) public-private partnerships that entail contractual agreements between a public agency and a private sector entity allowing for cooperation and collaboration in the financing, planning, design, construction, and maintenance of water infrastructure.

On the other hand, the particular mix of funding sources and the amount they are capable of generating varies across communities depend on the level of wealth of the tax base, environmental circumstances, and specific community needs. In the United States, the formulation and implementation of climate change adaptation measures work through a complex system of multilevel governance that involves a plethora of statutes, laws, financing mechanisms, administrative capacities, and multiple overlapping and interconnected horizontal and vertical lines of authority. According to a 2010 National Research Council study, no one-size-fits-all adaptation option exists for a particular climate impact because climate change vulnerabilities can vary significantly by infrastructure category, region, community, or institution. Thus, the scale of the urban is of central importance in understanding similarities and differences in the process and patterns of climate change policy-making as well as the outcomes of climate adaptation measures (Bulkeley and Betsill 2013). That is, cities are not only the targets of climate change policy-making but are the locus of political conflicts over the nature and character of climate change adaptation. Cities are creatures of state governments, and state governments are, in turn, constituted by the laws and statutes of the US federal government. Conflicts and struggles over climate change policy and action do not take place in discrete local, national, and international arenas. Rather, climate change politics and policy outcomes express changing cross-scale interactions and complex vertical linkages between local actions, state government institutions, and the higher levels of the US federal government.

Today, many cities in the United States face a situation of chronic fiscal retrenchment, declining federal resources to fund climate change adaptation efforts, and broad hostility to the science of climate change. What the cases of New York and New Orleans show us is that taking steps to implement climate change adaptation measures is difficult for several reasons. Adaptation efforts tend to be expensive and require long-term, concerted planning and consensus building. More important, political and economic elites and elected officials typically oppose adaptation investments until faced with response and recovery expenditures once a disaster has occurred. Additionally, of critical importance is the fact that within the US federal system, the adoption and implementation of many adaptation activities fall within the purview of local governments, and those governmental units are typically influenced by powerful and organized economic development interests that are most likely to oppose adaptation. Moreover, it has only been in the last decade or so that federal funds for adaptation became available to communities, but the future of those funds is uncertain. Consequently, the current US climate change adaptation landscape is a patchwork of differing approaches in which some communities and

regions are afforded some protection from some climate risks (but not others), while others remain highly vulnerable to the negative impacts of global climate change.

We conclude with several policy recommendations to facilitate and enable more informed decisions about adaptation. Current efforts include raising public awareness of the adverse impacts of climate change, improving infrastructure decision-makers' access to and use of available climate-related information, providing increased access to local assistance, and considering climate change in existing planning processes (for overviews, see GAO 2013; Dunlap and Brulle 2015). These are important, but we think policy recommendations should embrace an equity-oriented and social justice-based focus. That is, the goal of climate change adaptation cannot lie just in consciousness raising through public awareness campaigns or in the implementation of conventional systems of financing (bond programs, tax incentives, etc.). Rather, climate change adaptation requires an effort to integrate and coordinate housing, infrastructure, and economic development programs with comprehensive, publically financed, and democratically run programs with clear accountability systems. Cross-scale, collaborative governance could enhance the flexibility and spatial targeting of incentives to reduce vulnerability and also provide an institutional foundation for direct participation of community residents in program design, implementation, and oversight responsibilities. The creation of jobs that pay a living wage, adequate benefits for those who cannot work, access to affordable health care, and increased supply of affordable housing might also improve the effectiveness of climate change adaptation programs, especially for low-income and moderate-income communities that face the highest levels of vulnerability to climate change impacts. Developing public and private sector funding criteria to match communities' evolving vulnerability pressures, combined with public works programs, could enhance prospects for achieving equitable climate change adaptation for communities.

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Chapter 5
Adapting to a Smaller Coast: Restoration, Protection, and Social Justice in Coastal Louisiana

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5.1 Introduction

Louisiana's coastal zone (Fig. 5.1) is a naturally dynamic area that has undergone many changes over the past 8000 years coinciding with the shifting deltaic lobes of the Mississippi River (see Fig. 2.2 in Boesch). Recent decades, however, have seen a rapid acceleration of rates of land loss and transitions of habitat types resulting from increasing sea level rise and land subsidence, saltwater intrusion, reduced sediment flow, increasing eutrophication, large storm events, and habitat clearing and alteration due to infrastructure development along the coast (Carruthers et al. 2017). Over this same time period, coastal residents have become increasingly and disproportionately dependent on the coastal zone for living space and recreation, ports and harbors, oil and gas production, commercial and recreational fisheries, marine construction, ship and boat manufacturing, tourism and recreation, and marine transportation (Hemmerling et al. 2016; Weinstein et al. 2007). Most of these economic activities are based on local renewable and nonrenewable natural resources and are therefore largely immovable and highly sensitive to natural and human-induced changes, including fluctuating global economic conditions, environmental stress, climate change impacts, coastal habitat destruction, and increasing social and economic pressures. Shoreline erosion and coastal land loss also threaten the onshore infrastructure that supports these activities, including the

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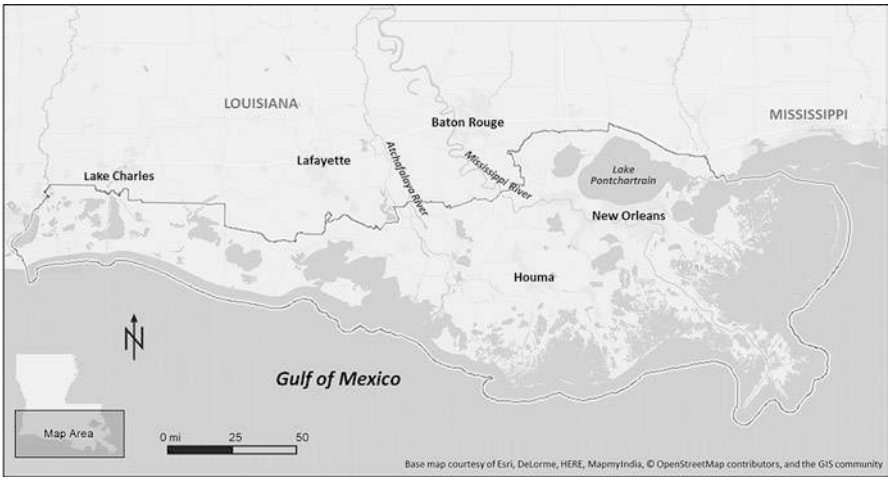

Fig. 5.1 Map of southern Louisiana showing major cities and the coastal zone. Base map courtesy of Esri, DeLorme, HERE, MapmyIndia, © OpenStreetMap contributors and the GIS community. (Data retrieved from Louisiana Department of Natural Resources)

extensive network of oil and gas infrastructure and pipelines that cross the coastal zone (Hemmerling et al. 2016).

The extent of societal dependency on these activities in the face of increased levels of environmental, economic, and social vulnerability has made managing coastal resources for the public good more challenging than at any time in the past (Weinstein et al. 2007). Recent decades have seen a number of shifts in coastal management priorities: from local problem-solution approaches to broader ecological restoration strategies and, most recently, to large-scale, unified restoration plans that are no longer constrained by political boundaries, embracing multiple jurisdictions and watershed-ocean gradients (Reed 2009). Each of these regimes has a strong science or engineering foundation and seeks to produce predetermined ecological outcomes (Colten 2017) and ultimately results in a shifting of the distribution of the benefits of protection and restoration to greater spatial and temporal scales. In the case of Louisiana's Coastal Master Plan, a science-driven restoration plan that relies heavily on numerical models to optimize project selection and location, the benefits of restoration and protection are anticipated to be widely distributed among a larger, but more abstract, coastal population. Further, numerical model results are able to examine the expected distribution of benefits to future populations.

State policy makers acknowledge that the restoration and protection benefits derived from the numerical model results are spatially variable, owing to both funding and biogeophysical constraints. In some locations of the coast, even with full implementation of the Master Plan, land area is expected to greatly diminish, while in others the land area will be largely maintained. Further, planners acknowledge that implementation of structural protection projects may not be feasible for some

coastal communities and areas outside the major levee systems. In some cases, residents of these areas will require nonstructural protection, while in others the adverse future environmental conditions may ultimately displace people, infrastructure, and possibly even the entire communities. With these consequences in mind, coastal planning in Louisiana raises several issues of social justice, many of which arise from the techniques and practices state coastal policy makers use to select restoration and protection projects. The main concern is the extent to which the voices and values of residents bearing the greatest burden of coastal restoration are integrated into planning practices.

This chapter traces the history of coastal planning and the social justice implications of the shift from piecemeal to comprehensive, coastwide planning. It tackles these questions through a close examination of several key topics. First, it traces the emergence and evolution of coastal planning processes, focusing on the shift toward science-driven, numerical models and how and to what extent public engagement contributed to planning processes and the development of conceptual frameworks. Next, the chapter examines three different aspects of social justice – distributive, procedural, and contextual – asking how each might or might not be impacted by the activities of coastal restoration planning in Louisiana. Finally, the chapter ends with a close examination of recent efforts by state policy makers to enhance public participation for the development of the 2017 Coastal Master Plan and analyzes to what extent new techniques for public engagement potentially translate into more socially just selections for future coastal proposals geographically, socially, and economically.

5.2 Historical Evolution of Coastal Restoration Planning in Louisiana

To more fully understand the costs and benefits of coastal restoration and how these are distributed among coastal residents, it is important to understand the historical development of restoration polices and the restoration planning process itself. The coastal protection and restoration planning process has continuously evolved over several decades as local, state, and federal agencies developed a number of plans and policy proposals to combat the persistent loss of land that has affected Louisiana's coastline since at least the 1930s. The most expansive plan developed thus far has been the 2017 update to the state's 50-year Coastal Master Plan. Unanimously approved by the Louisiana Coastal Protection and Restoration Authority (CPRA) in April 2017, this plan significantly expanded upon the original 2007 Master Plan as well as the 2012 update. As part of the plan, state officials proposed 124 projects that would maintain or build approximately 800 square miles of land and could save as much as $150 billion in flood damages over the next 50 years. The CPRA estimates that the state would lose another 2250 square miles of land by 2067 if not able to fully implement the Master Plan in the coming decades,

resulting in over $12 billion in annual flood damages (Schleifstein 2017). The state acknowledges that, even if fully implemented, the Coastal Master Plan will be unable to protect the entire coast of Louisiana and that the combination of land loss, sea level rise, and subsidence will continue to take a toll on Louisiana's coastal communities for decades to come. Just as the impacts of the state's coastal crisis will be more pronounced in some communities than in others, the degree of protection afforded by the Coastal Master Plan will not be evenly distributed across the coast. The planning process itself will necessarily result in the establishment of winners and losers in coastal protection and restoration, raising the possibility of social and environmental injustices and outcomes.

5.2.1 Pre-Katrina: From Piecemeal Projects to Broad-Scale Ecological Planning

Though the 2017 Coastal Master Plan contains a number of grim warnings about the future of the state's coast, Louisianans are not unfamiliar with the risks posed by shoreline erosion. As early as the 1970s, scientists and researchers began warning government officials and the public about the potential impacts of losing the marshes and swamps that make up large sections of the state's coastal topography. In 1972 and 1973, the Louisiana Advisory Commission on Coastal and Marine Resources published three reports examining the loss of coastal wetlands and the potential negative consequences (Louisiana Advisory Commission on Coastal and Marine Resources 1972, 1973a, 1973b). Five years after the commission's reports, legislators passed the State and Local Coastal Resources Management Act of 1978 in an effort to manage development in 19 coastal parishes and help protect the wetlands ("Managing Our Coastal Resources" 1980). Two years later, the federal government approved a coastal management plan (CMP) that included a Coastal Use Permit system to provide additional oversight of activities in the coastal zone (Louisiana Department of Natural Resources 1980).

Although the National Environmental Policy Act of 1969 increased the ability for residents to challenge projects based on environmental and social impacts through the Environmental Impact Statement process, these early coastal policies and practices in Louisiana largely adhered to the more traditional public input process of having comments made on a report instead of public involvement in the design of projects. These initial efforts produced single-purpose project designs that restricted the vision of engineers and scientists to addressing the primary objective, whether it was flood protection, converting wasteland to productive real estate, or species perpetuation (Colten 2017). Initial efforts to manage coastal resources in Louisiana, for example, focused on species-specific habitat enhancements and often involved the manipulation of tidal regimes to maintain water levels to provide access and encourage growth of particular forage vegetation (Reed 2009).

After the CMP's acceptance in 1980, relatively few significant advances in policy implementation or administration of coastal restoration occurred for the next 9 years. However, at the end of the decade, two important policy proposals became law. First, Louisiana voters approved a constitutional amendment in 1989 that established the Wetlands Conservation and Restoration Trust Fund (WCRTF), which was intended to provide a reliable source of money for restoration projects in the state (McMahon 1989). The second notable policy development took place in summer of the following year when Senators John Breaux and J. Bennett Johnston ushered a bill through Congress that finally brought federal dollars to the state's coastal erosion crisis. Signed by President George H.W. Bush in November 1990, the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA or Breaux Act) provided dedicated funding, meaning the state would not have to request money from Congress every fiscal year. However, the amount of money CWPPRA could deliver was relatively small in relation to estimates for a fully funded restoration program reaching several billion dollars in the early 1990s (McKinney 1989).

While the limited amount of funding was a concern, CWPPRA did make some positive steps in other areas of coastal management and restoration. The legislation created a bureaucratic framework that could bring order to the piecemeal administrative regime that had troubled wetlands policy during the previous two decades. CWPPRA established a task force comprised of officials from the state of Louisiana and five federal agencies, including the US Army Corps of Engineers (USACE), Department of the Interior, Environmental Protection Agency, Department of Agriculture, and Department of Commerce. Each agency's secretary appoints a representative to serve on the task force, and every year the group selects a certain number of restoration projects to be funded under CWPPRA (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993). Furthermore, the law encouraged Louisiana to develop a conservation plan that included the goal of "no net loss" for wetlands in future developments along the coast. The two plans – conservation to prevent future losses and restoration to address ongoing losses – were intended to be complementary with regulations and allow for more comprehensive management of the coast (Coastal Wetlands Planning, Protection and Restoration Act 1990).

Unlike the majority of previous efforts, the CWPPRA process depends on project nominations from the public, state and federal agencies, coastal parishes, and other coastal entities such as ports. These project nominations are then reviewed by regional planning teams and technical teams and ultimately brought to the task force for funding decisions. This gives local communities the ability to have initial input into project selection before engineering and design even begins. During its first few years, CWPPRA tended to fund small, localized projects that primarily benefitted the immediate vicinity. Those smaller projects were successful, but they could not stop wetlands loss on a large scale over a long period of time (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1996). As the severity of coastal land loss became apparent, broad-scale ecological restoration emerged as the dominant management regime in coastal Louisiana. A primary focus of ecological

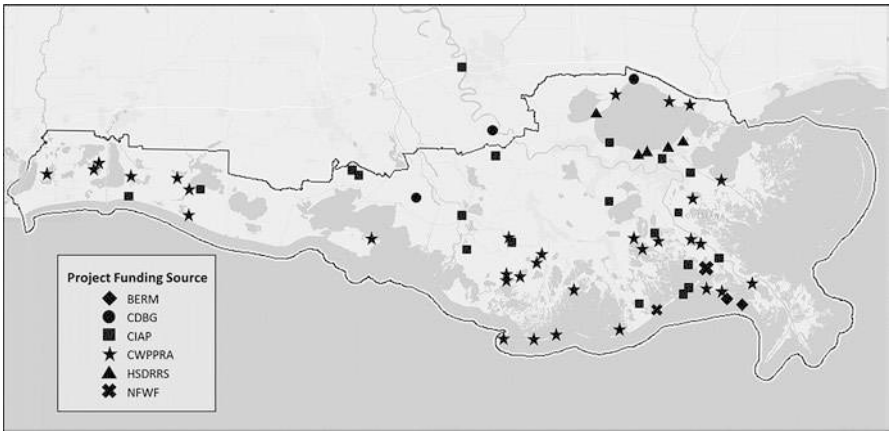

Fig. 5.2 Map showing existing restoration projects in the Louisiana coastal zone symbolized by funding source. Includes projects completed as of April 2018. (Project data retrieved from the Coastal Protection and Restoration Authority (CPRA) CIMS database)

restoration is to re-establish wetlands to a condition that will protect the region's ecology and major economic interests in the state (Colten 2017). Despite the broadening focus, however, these projects have tended to address single missions such as coastal protection or coastal restoration or were focused on geographically limited locations (Hemmerling 2017). Ultimately, these piecemeal efforts (Fig. 5.2) have had limited success and have not resulted in a net gain of wetlands (Peyronnin et al. 2013). In 1995, groups such as the Coalition to Restore Coastal Louisiana (CRCL) and members of the Louisiana Department of Natural Resources began to advocate for bigger projects that could address losses across the entire coast. In September of that year, the CWPPRA task force agreed that large-scale projects such as freshwater diversions and barrier island restoration should receive priority status on annual project lists. Going forward, the task force would dedicate two-thirds of its yearly project funding to large-scale projects and the remainder for small-scale projects (Anderson 1995a, b).

The shift to prioritizing large-scale projects was an important step toward more effective restoration projects, but officials still needed a single vision for Louisiana's coast to help officials oversee protection and development. In the mid-1990s, dozens of agencies had authority in and around the wetlands, and there was no unifying vision to guide their activities (Schleifstein 1996b). Both Louisiana and the federal government's approach remained piecemeal, even after several years of project development under CWPPRA. If the current approach were to continue, the estimates were that only 22% of future losses could be avoided (Anderson 1997; Louisiana Coastal Wetlands Conservation and Restoration Task Force and Louisiana Wetlands Conservation and Restoration Authority 1998; Schleifstein 1996a, b).

In response to such predictions, political officials in Louisiana's government and representatives from federal agencies initiated a series of meetings in 1997. The CWPPRA task force and the state's Wetlands Authority in the Governor's Office led

the process of developing a unifying strategy including inviting agencies such as the National Marine Fisheries Service and the Louisiana Department of Environmental Quality to participate in the process. The group's goals were to build a consensus about what Louisiana's coast should look like in the year 2050, ensure cooperation among the variety of agencies involved in coastal management, and determine how to administer a unified restoration plan (Horst 1997a, b; Louisiana Coastal Wetlands Conservation and Restoration Task Force and Louisiana Wetlands Conservation and Restoration Authority 1998). Over the course of 18 months, public officials met with concerned citizens 65 times to determine what coastal users wanted to see in a restoration plan (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1999).

The Coast 2050 task force built on previous plans but also made sure that the best available science guided their decision-making for future restoration policies. The Coast 2050 Plan was largely a vision document that pointed out challenges and potential solutions. However, it stopped short of listing specific projects and instead focused on strategies such as "maximize land building in Atchafalaya Bay" or "lower water levels in upper Penchant marshes." The final proposal emphasized striking a balance between wetlands protection and economic development and recognized there were multiple interests invested in using Louisiana's coast for a variety of purposes (Dunne 1998). Participating agencies agreed that there was no way to return Louisiana's coast back to the way it had been prior to the 1930s, but there was a consensus that a smaller, sustainable wetlands ecosystem was possible (Gagliano 1994).

The official response to the *Coast 2050* report was largely positive. All 20 coastal parishes formally endorsed the plan, and Governor Mike Foster voiced his support for the adoption of *Coast 2050* as a unified coastal management strategy (Schon 1998). In 2002, the state partnered with the US Army Corps of Engineers to further refine the *Coast 2050* plan and develop a coastwide comprehensive restoration plan under the existing Louisiana Coastal Area (LCA) planning authority (Day et al. 2007; Reed 2009). The resulting LCA Study produced detailed analyses of the costs and benefits of various groupings of restoration projects and included a list of critical restoration projects, many of which had already undergone planning through the CWPPRA process (Reed 2009).

Despite the scientific advances made in these early unified plans, there was still the issue of who would pay the billions of dollars necessary to implement a coastwide restoration and management plan. Some progress was made in funding Louisiana's coastal restoration efforts in summer 2005 when Congress approved the passage of a Coastal Impact Assistance Plan (CIAP). The program was designed to provide revenues to states that contributed to oil development in the Outer Continental Shelf (OCS), and nearly $1 billion in expected revenues would be split among six states. Louisiana's share was estimated to be around $540 million. The funds would be distributed starting in 2007 and could only be used for projects related to coastal erosion and mitigation of the impacts of Outer Continental Shelf (OCS) oil and gas development (Alpert 2005; Radtke Russel 2007).

However, just a few weeks after Congress approved the law containing CIAP, the devastation caused by Hurricanes Katrina and Rita changed the trajectory of coastal restoration in the state. The hurricanes led to the loss of approximately 1800 lives in Louisiana and resulted in $200 billion in damages along the Gulf Coast (Louisiana Governor's Office of Homeland Security and Emergency Preparedness 2015). New Orleans was submerged under water when the city's hurricane protection levees failed during Katrina, and removing the floodwaters took over 40 days. More than one million Louisianans were displaced from their homes in the aftermath of the hurricane (Knabb et al. 2005). This displacement was not equally distributed across the population, nor was recovery. In New Orleans, for example, it was found that black residents were less likely to return to their homes after the storm than white residents primarily because the storm did the most damage in those low-lying areas of the city disproportionately populated by black residents (Groen & Polivka 2010). This in turn reflects historical environmental inequities as black residents were relegated to the low-lying and more vulnerable areas long before the storm ever hit, highlighting that social justice for the future depends on decisions that are made in the present. Katrina thus brought issues of social vulnerability and justice to the forefront of coastal protection and restoration science and marked a dramatic shift in the state approach to coastal planning and urgency of generating more effective policies.

5.2.2 Post-Katrina: Establishing CPRA and Louisiana's Coastal Master Plan

While residents fled to other locations or struggled to rebuild in the wake of the storms, state officials took action to address some of long-standing administrative issues regarding coastal restoration. Governor Kathleen Blanco signed Act 8 into law in November 2005, which created the Louisiana Coastal Protection and Restoration Authority to replace the Wetlands Restoration and Conservation Authority. The new body was directed to coordinate "the efforts of local, state, and federal agencies to achieve long-term comprehensive coastal restoration and hurricane protection." Act 8 also charged the CPRA with creating a "Master Plan that presents a conceptual vision of a sustainable coast based on the best available science and engineering." Projects related to CWPPRA, the LCA near-term plan, and funds from the CIAP were forthwith to be organized "toward a common goal" (Louisiana Coastal Protection and Restoration Authority 2007). Legislators asserted that "the state must have a single agency with authority to articulate a clear statement of priorities," and that "without this authority, the safety of citizens, the viability of state and local economies, and the long-term recovery from disasters such as Hurricanes Katrina and Rita remain in jeopardy" (Louisiana Act No. 8 2005).

In fall 2006, voters approved a constitutional amendment that replaced the Wetlands Conservation and Restoration Trust Fund with the Coastal Protection and

Restoration Fund. They also approved a measure that directed all potential income from any OCS revenue-sharing scheme into wetlands conservation, coastal restoration, and hurricane protection (Sentell 2006). The revenue-sharing amendment was passed in anticipation of Congress authorizing the Gulf of Mexico Energy Security Act (GOMESA) in 2006. In contrast to CWPPRA or the 2005 CIAP, GOMESA was designed to provide a much larger scale of funding over a longer period of time (Walsh 2006). Though GOMESA promised another important source of funding for restoration in Louisiana, coastal advocates warned even that large amount of money was insufficient for the scope of the problem. Mark Davis, then with CRCL, praised the new revenue from GOMESA and said it was "hugely important, but it's also hugely important to know that it's only a down payment" (Shields 2006).

Another significant development happened in 2006. The state legislature had charged the CPRA with developing a Coastal Master Plan to be updated every 5 years, and the committee worked throughout the year to accomplish that goal. To maximize the benefits of coastal projects and comprehensively address both restoration and protection, the CPRA began to focus on the development of unified restoration plans that acknowledge the systematic complexity of interrelated issues in Louisiana's coastal zone and developed more coordinated, integrative frameworks. These frameworks utilize a multiple lines of defense strategy that incorporates a broad suite of structural, nonstructural, and coastal restoration features, including the Gulf of Mexico shelf, the barrier islands, the sounds, marshland bridges, natural ridges, manmade ridges, flood gates, flood levees, pump stations, home and building elevations, and evacuation routes (Lopez 2009). The unified restoration plan approach has culminated with the development of Louisiana's *Coastal Master Plan for a Sustainable Coast*, a numerical model-driven plan built on previous efforts and based upon a theoretically unbiased evaluation of hundreds of previously proposed projects, including nonstructural measures, under both current and future conditions (Fig. 5.3; Peyronnin et al. 2013). While this plan involved extensive public comment periods, public meetings, stakeholder meetings, and presentations, the science-based numerical models do not incorporate these comments. Instead, the comments are made after the plan is drafted and adjustments are made at that time. The difference between outreach, which the planning effort does well, and community engagement, which is still lacking, can make it difficult to meaningfully include social justice issues into the decision-making process.

A preliminary draft of the 2007 Master Plan was released in November 2006 and included a tentative vision for merging coastal restoration and hurricane protection. The draft also proposed some recommendations that had been previously seen as politically toxic such as closing the Mississippi River Gulf Outlet (MRGO). The state had requested that the Corps close the MRGO before the 2005 hurricane season, but the federal agency had been reluctant. A small number of shippers still used the channel; however, after Katrina, decommissioning the MRGO seemed more feasible. There were concerns that the navigation corridor had acted as a "super highway" for storm surge, and officials in St. Bernard Parish welcomed the closure (Committee on Homeland Security and Governmental Affairs 2006; Freudenburg et al. 2009; Schleifstein 2006). Other proposals in the initial draft report faced

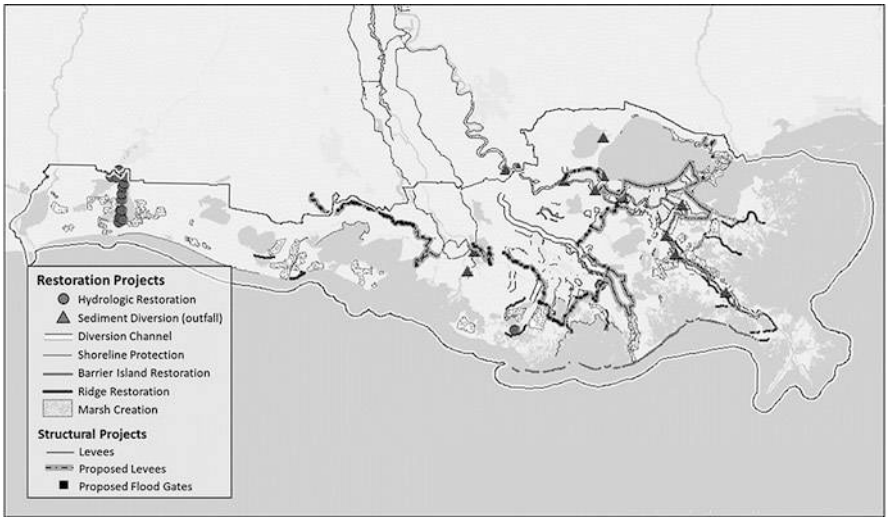

Fig. 5.3 Map showing Master Plan 2017 projects symbolized by project type. (Project data retrieved from the Coastal Protection and Restoration Authority (CPRA) CIMS database)

criticism, particularly in relation to the heavy emphasis placed on using levees for hurricane protection. Indeed, levees had contributed to coastal erosion and then failed to perform adequately during Katrina due to improper designs and maintenance and because Congress had not appropriated the necessary funds so there were incomplete portions of the system. In response to the critiques that the CPRA received in regard to its initial draft release, the committee revised the Coastal Master Plan to rely less on levees for hurricane protection and pursued something closer to the multiple lines of defense strategy which envisioned a series of speed bumps from barrier islands to interior marsh restoration and to restorations of ridges and including levees.

Much of the 2007 Master Plan was visionary rather than a list of specific projects to pursue, and in that sense, the document resembled Coast 2050. There were some specific suggestions such as closing MRGO or building the Morganza-to-the-Gulf levee system (Louisiana Coastal Protection and Restoration Authority 2007). Overall, the CPRA's first Master Plan, which was accepted by the state legislature in March 2007, was a blueprint for the future (Schleifstein 2007). To implement more specific actions, the CPRA would release annual reports with more targeted suggestions (Louisiana Coastal Protection and Restoration Authority 2007). All ongoing projects – including ones conducted under the CIAP, the CWPPRA, and the Corps – needed to be consistent with the state's Master Plan (Louisiana Coastal Protection and Restoration Authority 2008).

Overall, reception of the 2007 Master Plan was mixed. Though the plan was not a radically innovative proposal, integrating restoration with hurricane protection was a new step. Further, there seemed to be an increased commitment to funding a

plan that treated both activities as related after Hurricane Katrina. However, a review panel criticized the state over the "breakneck pace" at which the CPRA's Integrated Planning Team "attempted to craft solutions for a complex and all-important task." Other observers took issue with some of the proposals in the plan that were based on questionable scientific evidence. Technical reviews made clear that more complex modeling and scenario analyses were needed and in response the CPRA ramped up its scientific analysis and modeling efforts (Wiegman et al. 2018).

In preparation for the 2012 update to the Coastal Master Plan, the CPRA developed several new models that were linked to predict change in the Louisiana coastal system under two types of future management strategies: a future without the implementation of future protection and restoration projects and a future with implementation of individual projects (Peyronnin et al. 2013). This systems-based numerical modeling approach relied heavily on a decision support tool designed to provide an analytical and objective basis for comparing projects and developing alternative groups of projects for consideration in the final plan. Candidate projects were selected by mining earlier studies, reports, presentations, and plans to develop a final list of 397 candidate projects.

In 2012, the state released its first legislatively mandated update to the 2007 Master Plan, which included an assessment of the progress achieved in coastal restoration. Over the previous 5 years, the CPRA had administered projects related to building or improving 159 miles of levees, constructed 32 miles of barrier islands or berms, placed 150 in design or construction, and benefitted over 19,000 acres of wetlands (Louisiana Coastal Protection and Restoration Authority 2012). By 2014, 45 miles of barrier islands or berms had been built, and coastal restoration and protection programs had benefitted 26,241 acres of land. As of 2015, the state planned to monitor or maintain 230 projects, while overseeing the design and construction of 79 more (Louisiana Coastal Protection and Restoration Authority 2016). Overall, the CPRA reported that the rate of shoreline erosion was down significantly from its height in the 1970s. Despite the progress made, however, the state was still losing approximately 16 square miles of land per year, highlighting the importance of continued coastal restoration planning (Louisiana Coastal Protection and Restoration Authority 2012).

The 2017 update to the Master Plan was largely based on the same framework established in 2007 and reaffirmed in 2012. Coastal restoration projects will remain under the oversight of the CPRA, but the latest iteration of the Master Plan does contain an increased emphasis on nonstructural means of combatting storm-related flooding (Louisiana Coastal Protection and Restoration Authority 2017). Furthermore, officials appear to be less optimistic about the future of the coast in the 2017 update, citing increasing concerns about climate change. New Orleans and other low-lying areas in southern Louisiana are expected to become even more vulnerable to flooding and storm-related damages as sea levels rise in response to the warming planet (Marshall 2017). Worse, the funding problems that have undermined coastal restoration efforts since the 1970s have not been resolved. Louisiana has long been planning to use GOMESA funds to help pay for projects beginning after 2017. The state expected to get approximately $140 million in the first year but

is currently slated to get half that amount. As a result, projects scheduled to begin in the 2019 fiscal year may have to be scaled back or placed on hold while officials search for additional funding (Schleifstein 1996b).

5.3 Shifting Costs and Benefits of Protection and Restoration: Coastal Planning as a Matter of Social Justice

The benefits of the Master Plan and other similar unified restoration plans are without a doubt broad and sweeping. These plans do, however, acknowledge that it is not possible to provide the same level of benefits to all coastal communities. Coastal management literature argues that while structural defenses can be justified in urban areas, they often fail to meet the cost-benefit test in thinly settled, rural locales (Colten et al. 2018). In coastal Louisiana, for example, much of the at-risk Native American populations reside in the small rural communities located along the land-water interface, as do many other minority communities who rely on subsistence fishing to supplement household resources. These communities, due to their proximity to the coast and their rural nature, make them especially vulnerable to natural hazards and risks (Dalbom et al. 2014). They also reside in locations where the construction of structural protection features is largely untenable. But it's not only geography that makes them vulnerable. Histories of displacement, segregation, and political disenfranchisement have made many Native communities economically under-resourced and comparatively less politically powerful than urban, white populations in south Louisiana.

When taken together, the historical and contemporary contexts that situate the negative outcomes for residents residing in small rural communities in the coastal zone are potentially magnified in areas that are highly dependent upon fisheries and other natural resources for their economic well-being. Changes in the distribution and abundance of species, for example, will likely have socioeconomic effects on fishers, hunters, and other harvesters who use the wetlands for commercial, subsistence, recreational guiding, and recreational activities. Fish and wildlife will likely adapt quickly, whereas it is harder and takes longer for resource harvesters to adapt (Peyronnin et al. 2017). This is a particular concern in coastal Louisiana, where projects focused on protecting the maximum number of residents over the long term are also projected to disrupt ecological conditions that sustain the natural resources that many coastal residents rely in the short term, creating a number of unique social justice concerns (Colten et al. 2018).

The shift from small-scale, localized projects to a science-driven, unified restoration plan has the potential to dramatically change the appearance of the coastal landscape, both natural and human (Table 5.1). Broadly speaking, numerical models are used to identify a suite of protection and restoration projects that will synergistically derive the greatest benefits for the greatest number of residents. In this

Table 5.1 Restoration planning and policy outcomes

Type of restoration planning	Louisiana examples	Policy outcomes	Advantages	Disadvantages
Small-scale projects	CIAP, CWPPRA (pre-1995)	Local areas benefit; short-term impacts	Individual communities benefit directly; multiple points of view considered	Multiple agencies involved in execution, which results in conflicting agendas; unable to stop net loss of wetlands over time
Large-scale projects	CWPPRA (post-1995), state of Louisiana, USACE	Broader areas benefit; short-term and long-term impacts	Individual communities and broader areas benefit directly; multiple points of view considered	Multiple agencies involved in execution, which results in conflicting agendas; unable to stop net loss of wetlands over time
Unified coastal restoration	Coast 2050, Coastal Master Plan for a Sustainable Coast	Mixture of area sizes benefit, but emphasis is on coastal ecosystem; short-term and long-term impacts	Streamlined administration; coastal ecosystem prioritized to slow overall losses	Viewpoints of individual communities have less influence and receive less attention; unable to stop net loss of wetlands in the near term

approach, each numerical model derived for the analysis provides input to other models, produces outputs, and estimates how the landscape.

might change and how projects might perform on the landscape over time (Peyronnin et al. 2013). The idea that the final model outputs potentially identify that suite of projects that provide the greatest level of social benefit presents a powerful justification for comprehensive master planning efforts. An analysis of the 2012 Master Plan estimated that, if fully implemented, the planned risk reduction projects would provide heightened protection to over 86% of families and nearly 85% of poor families in Southeast Louisiana (Dalbom et al. 2014). This same study reveals that, by extending protection to the majority of the population residing in the developed areas of the coastal zone, the 2012 Master Plan will simultaneously reduce the anticipated level of risk for the urban African American, Asian, and Hispanic populations of the region.

However, there are social costs associated with the shift to a purely science-based approach to project selection. While all restoration and protection plans accept that change is inevitable across the coast, more recent science-driven plans are less constrained by the impacts of these changes on local populations (Reed 2009). As a result, some of the poorest and most geographically marginal coastal groups are often outside the purview of restoration and protection. This situation raises the question of how policy makers can fairly distribute the benefits and burdens of coastal restoration (Colten et al. 2018). As a result of a purely science-driven planning process, the impacts of protection and restoration projects on individual

communities are devalued as building and maintaining land and reducing risk on a broad scale become the key decision drivers for selecting projects (Peyronnin et al. 2013). Indeed, while Louisiana's Master Plan is couched in terms of sustainability, it does not propose sustainability for all (Colten 2015). Because one of the primary goals of the Master Plan is to provide protection to the greatest number of individuals, many of the proposed projects will prioritize providing protection to urban residents and those residing in more densely populated areas. In short, as many coastal residents attest to, this approach to project selection runs the risk of sacrificing remote coastal areas home to already socio-spatially marginalized groups for the protection of environmentally viable urbanized coastal regions. This impacts a disproportionate number of small business and subsistence fisherfolks from Native American, African American, southeast Asian, and other minority groups as well as white residents with long histories of occupancy of the rural coastal areas.

Mapping onto existing geographies of racial and ethnic difference and economic inequality, the uneven distribution of risk and anticipated siting of protection projects raises the issue of social justice to the fore of contemporary coastal planning. An issue largely unexplored in Louisiana (Colten et al. 2018), social justice is comprised of three key elements, each of which can be impacted by coastal restoration programs in distinct ways: distributive justice, procedural justice, and contextual justice. The degree to which the outcomes of environmental projects address each of these elements can have a decisive impact on both the overall equity of the outcomes of the program and ultimately whether these efforts succeed or fail (Fischer et al. 2015).

5.3.1 Distributive Justice

Scholars have noted that the last several decades of research into social justice have focused largely on one key dimension: distributive justice (McDermott et al. 2013; Schlosberg 2004). This dimension focuses on the allocation of material goods, including environmental quality, and generally conceives of social justice and distribution as equivalent concepts (Dobson 1998; Foster 1998; Pulido 2000) . Distributive justice, as it relates to coastal restoration and protection, focuses on the allocation among coastal residents of costs and benefits resulting from environmental policy, resource management decisions, and environmental modifications (McDermott et al. 2013). Advances in high-end computing, numerical modeling, and geographic information systems (GIS) have allowed coastal researchers to develop innovative analytical techniques to measure and forecast the impacts of environmental change on broad spatial and temporal scales. Through these techniques, the efficient distribution of social costs and benefits can be measured and used to assess the ability of environmental programs to maximize the social welfare that can be achieved under given biogeophysical and financial constraints.

Under the distributive justice framework, the costs and benefits of environmental adaptations may be unequally distributed among individuals for the sake of net

social gain for the entire population (McDermott et al. 2013). Socioeconomically neutral coastal adaptation planning refers to the advancement of protection and restoration projects on the basis of scientific processes. This approach overlooks racial and economic inequality and the history of environmental inequity in both settlement and risk patterns. Climate change adaptation plans based upon socioeconomically neutral, physical science-driven numerical models can create winners and losers, potentially shifting the distribution of benefits or risks from one group to another (Lebel et al. 2009). The purely distributive focus of these models – greatest good for the greatest number of people – obscures the role that social structure and institutional context play in determining the patterns of distribution (Foster 1998). If such contextual issues go unrecognized, adaptation planning built upon science-driven numerical models may lead to restoration and climate change adaptation plans that benefit some populations while abandoning others (Hardy et al. 2017). Such measures may even exacerbate injustice, as when actions designed to maximize protection in urban areas or protect critical assets and infrastructure make some disadvantaged groups even more vulnerable than they were before (Lebel et al. 2009).

5.3.2 Procedural Justice

The limitations of a distributive justice framework for understanding environmental (in)justice are elaborated by scholars concerned with the ways existing and new social and economic inequalities are entrenched by practices for managing environmental hazards (Pulido 2000, 2015). By downplaying or ignoring the historical processes and causes that result in an inequitable distribution of risks and benefits across the coast, science-driven adaptation plans may inadvertently exacerbate existing inequities. The question then becomes whether promoting procedural justice by instituting inclusive, participatory processes within coastal restoration planning makes it possible to correct for any unfair distributional outcomes and potentially address causal origins (McDermott et al. 2013). The concept of procedural justice shifts the focus from the actual distribution of the costs and benefits of coastal restoration projects to the fairness of the process by which these costs and benefits are allocated and decisions are made (Clayton 2000). It involves recognition, inclusion, representation, and participation in the decision-making process by local residents and potentially impacted stakeholders (Ishiyama 2003; McDermott et al. 2013). Ultimately, reducing the risk of exposure to coastal hazards, both physical and economic, requires engagement with residents and stakeholder groups likely to be affected by policy actions and those who are especially vulnerable to risk. Engagement, in this sense, goes beyond legally mandated public comment protocols. Instead, aspirations to procedural justice would aim to give significant weight and representation to marginalized voices at all levels of the planning process and final decision-making.

5.3.3 Contextual Justice

To accurately assess the social impact or fairness of a project or program, it is necessary to identify not only the outcomes and processes of implementation but also the initial social conditions and origins of any existing environmental inequities (McDermott et al. 2013). Coastal planners need to understand current political processes and distributive outcomes within a historical context and address the fact that, in many cases, the playing field is already highly skewed against local communities due to a number of economic and social disadvantages (Larson and Ribot 2007). Such disadvantaged communities face a number of technical and bureaucratic hurdles that other communities may not face, often compounded by a lack of access to vital information and an inability to pay for needed technical expertise. For example, the lower a resident's income level, the less likely they are to be familiar with proposed restoration projects that could directly impact them and the more likely they are to think that the project will not change fisheries (Gramling et al. 2006). Without a clear understanding of the historical processes that have led to these disadvantages, coastal policy and implementation practices run the risk of exacerbating existing environmental inequities. An understanding of contextual justice, as it relates to coastal protection and restoration, takes into account those preexisting conditions that limit a community's access to decision-making procedures, resources, and benefits, effectively serving as a link between distributive and procedural justice (McDermott et al. 2013). Ultimately, to navigate these issues and effectively redress historical injustices while also promoting effective coastal planning, more and better knowledge is required about the development of those preexisting political, economic, and social conditions that limit people's capacity to engage in and benefit from the coastal planning process (Fischer et al. 2015). By incorporating aspects of contextual equity into the planning process, policy makers are more likely to identify uncover impacts that are harder to measure but are often crucial to local welfare (McDermott et al. 2013).

5.4 Public Participation in Coastal Planning

Within a procedural and contextual justice framework, those most at risk should be given opportunities to participate in reshaping and reducing risk to which they are to be exposed (Lebel et al. 2009). Echoing work in environmental justice (Checker 2011; Ishiyama 2003), such an approach must go beyond participation and token integration of marginalized voices to generate meaningful and politically efficacious modes of interaction in policy development that does eschew or co-opt the self-determination of less populated and economically marginal coastal areas.

The importance of public participation in the restoration planning process has been acknowledged by the state of Louisiana in the development of the Master Plan, which developed a set of four key outreach and engagement principles to ensure

structured and transparent interactions with the public as well as key businesses and industries, federal agencies, nonprofits, academia, and fisheries interests. Key goals outlined for the state in both the 2012 and 2017 Master Plans include:

1. Stakeholders and citizens should be given opportunities to learn about and comment on the 2017 Master Plan tools and the processes that assist in creating the plan – not just the finished plan itself.
2. Comments and ideas should be received, reviewed, and incorporated while the 2017 is being developed, not after the fact.
3. Not every stakeholder or citizen preference will be included in the 2017 Master Plan. However, the state promises that each idea will receive a fair hearing and that questions will be answered promptly and with care.
4. The state has an obligation to provide a variety of ways for stakeholder and citizens to learn about and participate in the master planning process, including small group gatherings, web offerings, direct communication with local and state government, and public meetings (Speyrer and Gaharan 2017).

These goals highlight CPRA's desire to capture a wide swath of public feedback on the Master Plan. Further, they reflect that the state understands the persistent frustrations of citizens across the coast that they are engaged too late in the planning process and that their comments make little difference to what the state decides to do.

In developing the 2012 Master Plan, the CPRA attempted to respond to these staunch and persistent critiques through the development of numerous stakeholder groups and citizen outreach tactics. Stakeholder groups engaged with in the planning process included the following: (1) a Master Plan framework development team, residents from Louisiana representing federal, state, and local governments, NGOs, business and industry, academia, and coastal communities (this group was comprised of 33 members that met on an almost quarterly basis to review ongoing research and project selection processes for the Master Plan; (2) a fisheries focus group composed of approximately 15 members in the commercial fishing industry; (3) a group of about 10 members representing the oil and gas industry; and (4) a group of approximately 15 members representing navigation interests. These groups were variously consulted over the development of the 2012 Master Plan in order to assess the impacts of potential projects upon these industries. There were a handful of coastal citizens who participated in these groups, but the majority of participants were selected because of their professional and political affiliations.

The process for public engagement entailed numerous public meetings and official hearings for the 2012 Draft Master Plan. At the outset of the planning process, the CPRA held ten regional community meetings throughout the coast. Approximately 600 citizens participated these meetings, which were designed to gather local knowledge and identify public priorities and concerns. Additionally, the CPRA conducted a statewide telephone poll to elicit information from over 1000 additional residents. The results of the initial community meetings and polling indicated that, regardless of where they live, citizens were concerned about land loss, reducing flood risk, and the future of coastal fisheries (CPRA 2012). Input from these meetings was catalogued and posted to their public site alongside suggestions

for citizens to become involved in the planning process. In total, community meetings, public forums, civic presentations, a community survey, and a telephone poll were used by state decision-makers to gather information on citizen preferences and ideas that could be incorporated into the decision-making process (Peyronnin et al. 2013).

Upon completion of the draft Master Plan in January of 2012, the CPRA hosted three additional public hearings to receive comments on the plan. The state received over 100 formal comments during these hearings and over 2200 additional comments received subsequently via email, website, and mail. After collecting comments, the CPRA had approximately 1 month to evaluate and address project-specific concerns before sending off a finalized version to the state legislature to vote on for approval. Comments related to both policy and implementation were also evaluated and catalogued to help guide the state as Master Plan projects and programs begin to be implemented in the future.

Accounting for how public comments become incorporated into and/or influenced the Master Plan was addressed in 2012 through specific tactics the CPRA used to test particular projects. As the Master Plan notes, projects were adjusted "based on local knowledge and stakeholder input where appropriate. The changes were principled responses to the feedback we received, grounded in science, and responsive to the needs of our coastal communities" (CPRA 2012, 112). The state noted that they considered all public comments, categorized them by major theme, and provided responses to each theme, specifically identifying the policy- and project-level adjustments to the final plan (CPRA 2012). Changes were reflected explicitly in several structural protection and flood risk reduction projects that were either added or adjusted in the final plan, based upon a combination of policy constraints, public input, and scientific models. For example, the CPRA used public comments to test preferences for and against large-scale river sediment diversions. Using data generated by seven integrated predictive models, nine decision criteria, and various project implementation constraints, the CPRA evaluated the presence and removal of several sizes of river diversions and evaluated what different public preferences for diversion sizes and locations would be.

Goals and approaches to the 2017 Master Plan were similar to 2012, but with several key changes. First, the state introduced a community focus group as one of the handful of advisory groups they met with regularly during the plan development. Community groups included leadership from local Native American tribes, community organizations serving Vietnamese fishermen, and organizations serving predominately African American communities in rural coastal areas. They met four times between April 2013 and October 2016, having anywhere from 4 to 15 members in attendance. Beyond CPRA presentations, participants in the focus group primarily discussed interest in attaining small grants for local community organizations to help with CPRA education and outreach, explicit concern for projected land loss in certain Native American communities along the coast, and how projections of future flood risk might impact low to moderate income populations on the coast (Speyrer and Gaharan 2017). Concern for expanding the geographic scope of community engagement was also a frequent topic of discussion between community

focus group members and CPRA officials as was defining the scope and content of what nonstructural projects – such as home elevation, flood proofing, and relocation – would be. This latter point is particularly important among the community focus groups as most participants are residents of small coastal communities located outside the extensive levee and flood wall protection.

While the community focus group was not framed explicitly by the CPRA as an attempt to engage minority communities, in practice it was the most consistent and strategic engagement the state made with representatives from minority communities. In the context of coastal planning in Louisiana, there is no explicit representation or study of minority or economically marginalized communities within research that informs the Coastal Master Plan. Meetings with the community focus group reflect the ethos of socioeconomically neutral planning techniques that utilize a non-specified, generic notion of "community" as a stand-in for representing the experiences of marginalized communities without naming racial, ethnic, economic, or other forms of difference – let alone social justice – as a key motivation for the generation of the community focus group. For example, the needs and challenges inside bay subsistence and small-scale commercial fisherfolk face with impending coastal restoration projects and their changes to regional ecologies are distinct from those that local homeowners face: For one group, environmental changes for restoration mean potentially going out of business or taking on the financial burden of developing new fishing practices. For the other, those same environmental changes point to the possibilities of high flood risks for private property, a financial burden many might not be able to shoulder. Beyond these basic examples of difference within the generic category of "coastal communities," review of CPRA documents shows that it is unclear how and if this particular focus group, or any of the advisory councils CPRA engages, actively shapes the projects and decision-making frameworks that the state utilizes to develop coastal policy.

The CPRA also established several other focus groups, including landowners and parish floodplain managers. Inclusion of these groups reflects the state's gradual expansion of the stakeholder and resident types who they believe need to have a sustained engagement in the master planning process beyond limited public hearings. The state also began to publish materials in Vietnamese, Spanish, and French and developed a series of online flood risk and other informative tools in order to reach more diverse audiences around the coast. While communication techniques are crucial, they do not necessarily equate a more robust engagement with the coastal public or incorporation of social justice concerns into planning. They might, however, increase the likelihood that state representatives will develop a more consistent relationship to different groups and perhaps incorporate changes to Master Plan projects derived from coastal communities in concert with numerical models and scientific expertise.

As with master planning initiatives in 2012, the CPRA partnered with NGO groups to organize public meetings and series of open houses prior to the official public comment period that commenced in January 2017. In October and November 2016, the CPRA held community meetings in several coastal communities to solicit early feedback on draft lists of potential projects for the 2017 Master Plan in

response to increasing public pressure to give individual citizens who are not members of select advisory or focus groups more opportunities to vet Master Plan ideas prior to the production of the draft Master Plan. According to CPRA, approximately 500 people attended 7 meetings held across the coast (Speyrer and Gaharan 2017). There is no information on the demographic or geographic composition of the crowds, and it is difficult to assess how, exactly, more meetings correlate to a plan that more effectively represents the diversity of values and interests associated with protection and planning projects.

Establishing new focus groups that include community organizations, landowners, parish floodplain managers, and commercial fishing interests and doubling engagement efforts (including expanding the range of linguistic outreach to access southeast Asian and Latino residents) reflects a recognition that the impacts of the Master Plan are geographically and economically diverse. Reluctance to name social, racial, or economic justice as a matter of concern for coastal planning, however, reflects that the state envisions coastal restoration as something that operates outside of explicitly racial, economic, geographic, and social disparities and histories. Recent efforts by the CPRA strive to achieve social justice through a scientific model-based distributive justice framework but often do little to address historical and ongoing power inequalities that circumscribe small coastal communities to disproportionately bear the burdens of environment risks. While public participation has been ramped up from 2012 to 2017, the extent of addressing social, economic, and spatial inequity in coastal planning remains vague.

5.5 More Meetings and Public Participation, More Justice?

Despite ongoing efforts by the state of Louisiana to actively engage with local residents and incorporate aspects of procedural justice into the restoration planning process, many community groups have condemned the process as exclusionary and undemocratic (Gotham 2016a). Additionally, many residents feel disenfranchised by what they perceive to be a repetitive and ambiguous public engagement process that often leaves them feeling fatigued, frustrated, and ignored by state policy makers and coastal planners (Carruthers et al. 2017). The stark contrast between the goals of the state's outreach and engagement plan and the experience of some coastal residents highlights an essential dilemma faced by CPRA and other coastal policy makers. Debates over coastal protection and restoration are not just about risk but represent struggles over access to resources and the power of residents to define and defend cultural forms (Gotham 2016b). The current focus on developing world-class, science-driven numerical models is perceived as coming at the expense of taking residents' concerns seriously. These same residents feel ignored or left to fend for themselves against the forces of nature and the economy because they are often the inherent "losers" of land loss *and* coastal planning. When used as a tool to substantiate the integrity and power of the state to make "decisions in the best interests of Louisiana's citizens," the coastal restoration planning process runs the risk of

reinforcing a longer history of state and federal governments justifying their power over environmental management practices in the United States that frequently results in the political, economic, and geographic displacement of politically and economically disenfranchised groups (Kosek 2006; Spence 1999; Hardy et al. 2017). The question of whether or not the government intends to have disproportionate impacts on socially, politically, and geographically marginalized groups is difficult to answer and obscures the fact that supposedly objective decisions about where and how to protect the coast often struggle to move beyond limited notions of distributive justice to address broader social justice and equity issues.

To be sure, coastal restoration has not historically been designed to remediate or define ways to cultivate social justice and equitability when it comes to addressing Louisiana's coastal land loss crisis. Instead, planners and scientists have used numerical models to justify and legitimize the selection of specific risk reduction techniques to protect broad swaths of the coast, while residents often use perceptions of increased threat and a fundamental distrust of government at all levels as a justification for locally rejecting many of these techniques (Colten 2015; Gotham 2016b). While Louisiana's most recent iterations of the Coastal Master Plan boost extensive public engagement efforts operating in parallel with the systems-based scientific analysis of coastal projects that forms the backbone of the protection and restoration plan, the capacity to effectively integrate these streams is not readily apparent to many frontline coastal communities nor is it apparent to external scientific working groups (Wells et al. 2015). Coastal residents continue to struggle with bureaucratic processes related to how restoration projects are nominated, prioritized, and selected and understanding where restoration efforts and funds are spent (Carruthers et al. 2017). This highlights the fact that simply increasing the number of people touched by public engagement may reduce levels of procedural injustice inherent in the restoration planning process, but it is not a guarantee that social justice can be achieved for socially or economically marginalized groups. Instead, increasing levels of outreach and engagement often appears to recapitulate notions of distributive justice which, by and large, does not resolve the fact that there will be, as state officials are partial to saying, "winners and losers" in coastal restoration and protection planning. The decision-making process is still largely top-down and guided by scientific models that do not reflect or have the capacity to change the power dynamics inherent in the restoration planning process itself. While the state has significantly increased and documented the number of public meetings that have been held as part of the restoration planning process, a mechanism of accounting for input derived from these meetings has yet to be generated. It is therefore difficult to assess the extent to which holding more public meetings, or creating different interactive formats for public meetings, will result in any change in outcomes for groups who disproportionately bear the greatest risks from coastal hazards and land loss. In short, increased engagement is not a guarantee of risk reduction.

At a minimum, outreach and engagement attempts can build trust with citizens, trust on the part of citizens that state officials have their best interests in mind. As the introduction to the 2017 Master Plan succinctly captures, "our goal is to develop public confidence that CPRA is the primary technical authority on coastal protection

and restoration for Louisiana and is making decisions in the best interests of Louisiana's citizens" (CPRA 2017, p.1). More outreach and engagement efforts aspire toward increased procedural justice and accountability to diverse coastal population and a genuine concern for coastal Louisiana's well-being. However, merely increasing levels of procedural justice does not necessarily result in increased social justice. If public participation drives the selection of certain specific projects that protect a small number of residents at the expense of a greater number of residents elsewhere on the coast, then it will have reduced the level of distributive justice, which is focused on maximizing net social gain for all residents of coastal Louisiana.

5.6 Mapping a Path Forward

Despite the power of incorporating local knowledge into the coastal planning process, to date it has been challenging to broadly implement due to difficulties in achieving scientifically rigorous, replicable, and widely accessible methods of data collection. In large part, projects that have taken such an approach have been wholly qualitative in nature, which, though valid, are still not as easily accepted across the sciences. However, with advances in geospatial technologies, a growing acceptance of mixed methods research, and awareness of the validity and importance of local knowledge, this situation is changing (Curtis et al. 2018). There is a growing literature on the potential of combining local knowledge systems with technical scientific knowledge to manage both ecosystems and resources, including the evaluation of climate change impacts and the management of fisheries, biodiversity, and landscape dynamics (Folke et al. 2005). The people who live and work in coastal communities are becoming recognized as repositories of valuable local knowledge of concentrated community risks that reduce capacity in preparedness, such as issues of safety, health, and education, as well as on the critical social infrastructure network that they would access in response and recovery. Community members also hold perceptions of risk that shape their preparedness and mitigation activities, such as which places in their community are dangerous and which are thought to be safe. Such local knowledge and environmental perceptions are often geographically explicit and are powerful influences on behavior (Curtis et al. 2018). It is essential that coastal planners account for these data to form a more complete evidence base in guiding the development of resilient coastal communities.

Several recent methodological advances that allow for the input of qualitative local knowledge into mathematical models have provided tangible ways to evaluate potential outcomes and shortcomings of ongoing and planned restoration and protection projects against projected results which can allow coastal planners to make adjustments that respond to the real-time needs of impacted communities. Methods such as local knowledge mapping, social return on investment, and competency groups have all been used in coastal Louisiana to collect, analyze, and map qualitative data with the goal of characterizing local community members' understanding

of what ecological restoration has historically achieved, as well as a suite of potential short- and long-term outcomes of emerging ecological restoration projects identified by residents. Results from these approaches provide a new, geographically targeted, evidence base for planning strategies, especially those focused on coastal protection and restoration. These approaches are not designed to directly address issues of social injustice or change public policy. Rather, they present examples for state agencies and policy makers to follow as a means of anticipating, understanding, and attempting to alleviate unequal impacts before they occur, an important first step in addressing many of the social justice issues faced by coastal residents.

5.6.1 Local Knowledge Mapping

Many science-driven planning processes, including Louisiana's Coastal Master Plan, rely upon quantitative, geospatial datasets as model inputs and to derive metrics as criteria for evaluating the effectiveness of protection and restoration projects. While these datasets are effective at locating any number of nonresidential, residential, and infrastructure assets at risk within an area, they are not able to specifically identify places that have social or cultural value to residents and communities. State planners recognize that protecting such places of value is vital to preserving the culture and identity of Louisiana's various coastal communities (Louisiana Coastal Protection and Restoration Authority 2012), yet modeling efforts have focused largely on the more tangible aspects of cultural heritage that can easily be captured by existing geospatial datasets, such as the presence of ethnic minority groups or historic properties. The overreliance on such datasets in the planning process, particularly when presented with no additional context, may result in any number of social justice outcomes. Local knowledge mapping is an approach that aims to encourage community member participation in sharing knowledge and perceptions of a given area and has been shown to provide an effective means of incorporating community and traditional ecological knowledge into a coastal protection and restoration framework. The incorporation of these data into the planning process would represent an important first step in ameliorating the impacts of past environmental inequities while reducing the risk of future disproportionate impacts on particular social or cultural groups. While local knowledge mapping typically involves having local stakeholders mark locations on paper maps, recent advances in mapping and in GPS-enabled technology that are low in cost, widely available, and accessible to the public have allowed researchers to directly gather geospatial data from local knowledge experts, which is particularly important when the pace and geographic scale of change is dynamic (Curtis et al. 2018). Qualitative data collected during local knowledge mapping exercises have been used to create a geospatially explicit baseline dataset allowing researchers to incorporate local knowledge into an assessment of ecological restoration projects. When incorporated into a GIS environment and assessed in combination with biophysical data, the resultant "Sci-TEK" data can potentially be used to refine the large conceptual footprints of restoration

projects and aid in the identification of future restoration projects and identify associated areas of consensus and potential conflict between local stakeholders and policy makers (Bethel et al. 2011, 2014, 2015). The information gained in this way has also been used to determine the geographic specificity of local perceptions and develop community-informed prioritization tools that can be used to plan future ecological restoration projects (Barra 2017; Carruthers et al. 2017).

5.6.2 Social Return on Investment

Ecological restoration and other activities that interact with environmental systems have typically relied on scientific analysis to predict the impacts of these projects and have operated on the assumption that good science could reveal and remedy potential problems (Colten and Hemmerling 2014). Because coastal planning is fundamentally a human activity, however, effective predictions of human impacts demand equal attention to the social, political, cultural, and economic systems in which environmental management takes place (Ludwig et al. 1993). Protection and restoration projects deliver variable costs and benefits to Louisiana coastal communities and the economies they depend upon, such as navigation and fisheries (Caffey et al. 2014). Residents impacted by these projects have recognized these variabilities, valuing some projects as vitally important and highly desirable, while questioning or opposing others (Colten 2014). Qualitative data analysis can successfully classify differences in the ways stakeholder groups potentially impacted by ecological restoration projects engage with the project sites and identify a suite of outcomes unique to each stakeholder group. Identifying these outcomes is integral to defining both the specific objectives and variables needed to develop a comprehensive assessment and monitoring framework.

In order to quantify locally specific social impacts and develop a framework amenable to measuring social change resulting from ecological restoration, qualitative data derived from focus groups, surveys, and one-on-one interviews with a selection of key stakeholders have been used to develop empirically grounded forecast and retrospective assessments of protection and restoration projects (Hemmerling and Barra 2017). Recent restoration work conducted in coastal Louisiana by the Restore the Earth Foundation used qualitative research to inform the calculation of economic, recreational, cultural, educational, and ecological values of ecological restoration projects on numerous stakeholder groups (Hemmerling et al. 2017a, b). Interviews, survey methods, and focus groups were centered around these discrete topics to develop a consistent analysis across groups and a framework for future research and monitoring. Conversations with participants were analyzed to determine which qualities or concerns were important to participants as well as how they weighted different social and environmental values derived from the restoration projects. The qualitative data derived through this process can provide new insight into the social impacts of restoration that cannot be gained through traditional scientific approaches and identify potential inequities in the distribution of

costs and benefits. This knowledge can help to bound the uncertainty of a purely quantitative analysis and therefore makes it more useful in setting public policy and making cost-benefit decisions between different environmental interventions. The suite of methodologies used in this research can be translated into a longer-term monitoring program, tracking where and how different economically and geographically situated communities are unequally impacted by the changing material conditions that accompany restoration projects over time. Empirically derived information on residents' perceptions of the values – positive, negative, or otherwise – of restoration projects grounds anticipated social impacts in the material experiences of the residents themselves.

5.6.3 Competency Groups

Despite recent efforts by public officials and scientists to actively engage with coastal residents and stakeholders, many of these residents still feel that their local knowledge is not ultimately accounted for in the coastal restoration planning process within their own communities (Carruthers et al. 2017). This is due in large part to the fact that science-based knowledge, including such expert devices as predictive models, risk indicators, monitoring instrumentation, environmental services calculations, and cost-benefit analyses, is still a priori granted priority over experience-based knowledge (Landström et al. 2011; Whatmore 2009). When this prevailing scientific expertise contradicts the direct experience and knowledge of coastal residents, knowledge controversies may develop, generating conflict and eroding public trust in both scientists and public officials. In coastal Louisiana, one such knowledge controversy has developed around the planned reintroduction of Mississippi River water and sediment into the Breton Sound Estuary in an attempt to mimic the natural functioning of the river delta (Barra 2016). Public opposition to this and other large-scale sediment diversion projects has developed around a number of perceived threats, including the over-freshening of coastal estuaries, displacement of fisheries, and assertion that nutrients in the river water will lead to wetland deterioration (Day et al. 2018). This location recently served as a pilot to investigate the utility of an innovative competency group approach to predictive modeling that utilizes a collaborative process to redistribute expertise between local residents and resource users, hydrological modelers, experts in numerical modeling, and members of an interdisciplinary project team. The scientists participating in the competency group were experts in numerical modeling who played key roles in the initial modeling of the sediment diversions, while many of the local residents were fishers, shrimpers, and oystermen who utilize the estuary on a daily basis. The competency group met on a regular basis over a 6-month period to define the scope and priorities for the creation of a new nature-based defense model (Fig. 5.4). The effort culminated with the co-development of a Delft3D flexible mesh model that incorporates local knowledge and input from the local community on preferred nature-based defenses and criteria for evaluating the effectiveness of the tool for cultivating

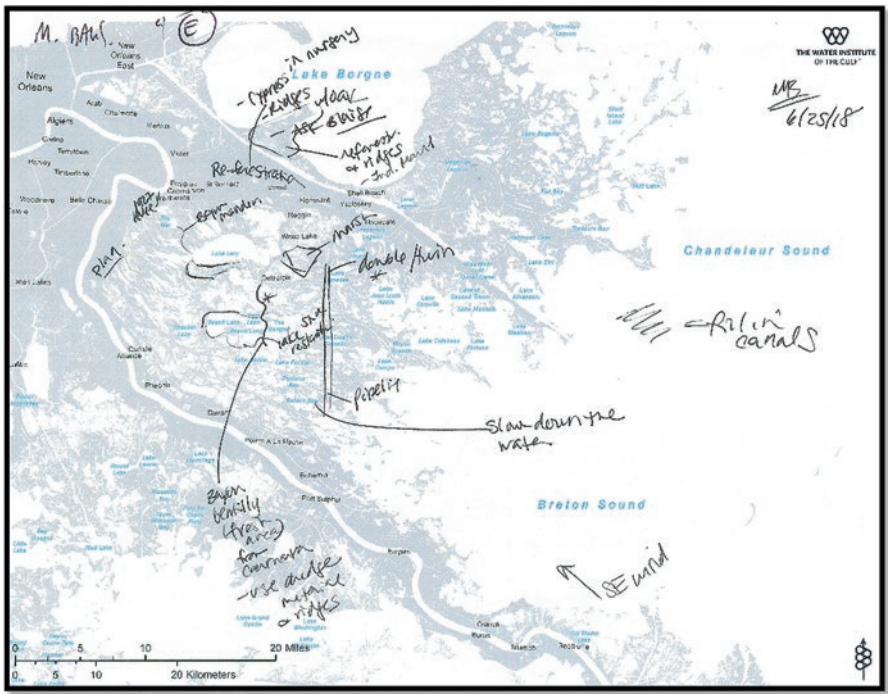

Fig. 5.4 Coastal protection and restoration projects designed and modeled by a competency group consisting of coastal residents and scientists. (Used with permission of The Water Institute of the Gulf)

coastal resilience in different geographic regions (Hemmerling et al. 2019). While the resultant model may bear a superficial resemblance to other scientifically derived models used in efforts like Louisiana's Coastal Master Plan, it is qualitatively different in that the model was co-designed to specifically address current and historical inequities identified by local resource users and residents. By bridging the information gap between local and technical knowledge experts, the competency group process provides a mechanism to bring issues of social justice to the foreground of the planning process.

5.7 Conclusion

Ultimately, for coastal protection and restoration to proceed in a socially just manner, the coastal planning process will need to strike an effective balance between science-driven processes and engagement with residents and stakeholder groups who are especially vulnerable to risk as well as those who are likely to be affected by policy actions. A central goal of restoration and protection planning should

therefore be to create and sustain a process that is just, transparent, and accountable to those affected by its actions (Olsen et al. 2006). Many coastal residents feel that their local knowledge is not ultimately accounted for in the coastal restoration planning process, even within their own communities, and that new, meaningful, and actionable ways of accounting for and integrating community input into the management, planning, and decision-making process were seen as necessary to increase local support of restoration projects (Carruthers et al. 2017). It is not enough to simply introduce participation into a system that has historically been considered unfair or biased (Larson and Ribot 2007). To be both effective and sustainable, coastal management programs must be supported by the generation and incorporation of reliable knowledge that allows affected stakeholders and the project management teams to better understand and anticipate the consequences of different courses of action. This knowledge should be drawn from both the scientific community and from the observations and local knowledge of community members who reside and work in the systems of which they are a part. The participation of local knowledge experts in the planning process can provide insight into social, ethical, and political values that cannot be gained through scientific approaches alone and allows coastal planners to generate more alternatives, resulting in flexible actions and mutual benefits (Stringer et al. 2006; Zedler 2017). Such a participatory process should create opportunities for coastal planners and project managers, residents, and key stakeholders to assess project outcomes through every step of the process. To begin to ameliorate social justice issues, engagement needs to involve residents as full partners in the process. If their voices are heard but do not impact the process, then the process will fail to even begin to address deep-seated justice issues. By incorporating data derived from two-way dialogue with local knowledge experts into the coastal planning process, coastal managers will be able to more effectively adapt to local needs and changing circumstances, particularly when knowledge is transferred horizontally between stakeholder groups and vertically to higher institutional levels (Zedler 2017). It may be this institutional acceptance of the validity of local knowledge as an important data source, one on par with technical scientific knowledge, determines the ability of local residents to effectively influence the protection and restoration process. Ultimately, if the results of the engagement process are not used by coastal planners, then the engagement effort will be to no avail because it will fail to contribute to a better and more just coastal restoration.

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