The End Of The Line: The Nature And Politics Of Resilience In Galveston, Norfolk, And New York City

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Abstract
In the briny aftermath of Hurricanes Katrina (2005), Ike (2008), Sandy (2012), and Matthew (2016), community leaders along the East and Gulf Coasts of the United States are contemplating a radical shift in the planning, design, and management of their coastal zones. Breaking with a century-long tradition of coastal grey infrastructure planning, many of those communities--along with the U.S. Army Corps of Engineers (USACE)--are shifting their attention and their investments away from conventional forms coastal infrastructure and towards "nature-based strategies", or non-structural forms of coastal protection. But why do some communities opt for a softer, greener coast while others double-down on their investments in grey infrastructure? How do the nature-based strategies under consideration compare, performatively, to the more conventional forms of coastal protection? Using a comparative case study research design, I posit that three forces explain how and why Galveston, Norfolk, New York City and other communities along the East and Gulf Coasts develop their approach to coastal protection. The first is a product of each community’s engineering legacy, or the historical approach to flood protection that developed during the 19th and 20 centuries and the culture that organized around those forms. The second is function of resilience politics, or the value judgements about who gets to stay and who must retreat, who is worthy of protection and who is not along the American coast. The final is a product of who leads the political coalition behind each community’s resilience planning--with a particular focus on the differences between design-led and engineering or planning-led efforts. This dissertation advances the theory and practice of coastal planning and design and provides a framework for action along the Gulf and East Coasts of the U.S.

Degree Type
Dissertation

Degree Name
Doctor of Philosophy (PhD)

Graduate Group
City & Regional Planning

First Advisor
richard j. weller

Keywords
climate change, coast, disaster, ecosystem services, green infrastructure, resilience

Subject Categories
Landscape Architecture | Urban Studies and Planning

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THE END OF THE LINE: THE NATURE AND POLITICS OF RESILIENCE IN
GALVESTON, NORFOLK, AND NEW YORK CITY

William John Fleming

A DISSERTATION

in

City and Regional Planning

Presented to the Faculties of the University of Pennsylvania

in

Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

2017

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ABSTRACT

THE END OF THE LINE: THE NATURE AND POLITICS OF RESILIENCE IN GALVESTON, NORFOLK, AND NEW YORK CITY

William John Fleming
Richard Weller

In the briny aftermath of Hurricanes Katrina (2005), Ike (2008), Sandy (2012), and Matthew (2016), community leaders along the East and Gulf Coasts of the United States are contemplating a radical shift in the planning, design, and management of their coastal zones. Breaking with a century-long tradition of coastal grey infrastructure planning, many of those communities—along with the U.S. Army Corps of Engineers (USACE)—are shifting their attention and their investments away from conventional forms coastal infrastructure and towards "nature-based strategies", or non-structural forms of coastal protection. But why do some communities opt for a softer, greener coast while others double-down on their investments in grey infrastructure? How do the nature-based strategies under consideration compare, performatively, to the more conventional forms of coastal protection? Using a comparative case study research design, I posit that three forces explain how and why Galveston, Norfolk, New York City and other communities along the East and Gulf Coasts develop their approach to coastal protection. The first is a product of each community's engineering legacy, or the historical approach to flood protection that developed during the 19th and 20 centuries and the culture that organized around those forms. The second is function of resilience politics, or the value judgements about who gets to stay and who must retreat, who is worthy of protection and who is not along the American coast. The final is a product of
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CHAPTER 1 — The End: The Nature of Coasts and Coastlines in an Era of Resilience

“An arbitrary political line may divide the north...from the south...but there is no such line in nature.”¹

Frederick Law Olmsted – the progenitor of landscape architecture and American city planning – opened his first literary work, *The Cotton Kingdom*, with this poignant observation. Of course, Olmsted’s words held a different meaning then than I am implying now. Penned over the course of his journey through a roiling South – one moving rapidly towards the brink of Civil War – Olmsted’s axiom was meant to refute the premise of subjugation oft-invoked by antebellum Southerners in regard to the Union. Put another way, Olmsted wrote of the unnaturalness that such a conflict might engender. He wrote, at times defiantly, against the social, ecological, and economic cleavages that any such linear demarcation would imbue. Though his words found little favor amongst the people he met while writing *The Cotton Kingdom*, Olmsted’s views on nature and non-linearity did find an audience amongst the designers and urbanists of his day. His legacy lives on in emphasis placed on ecosystem services by contemporary landscape architects and city planners.

This dissertation represents one of the first explorations into how and why nature-based strategies are being deployed and discussed along the American coast. Premised on the idea that coastal infrastructure should provide the kinds of ecosystem services that Olmsted envisioned, these strategies include the conservation, restoration, and design of marine landscapes like dunes, wetlands, marshlands, and near-shore reefs as a means to reducing surge and flood risk. Their purported advantage over more conventional, grey coastal infrastructure is two-fold. One is that they can provide a myriad of other services that grey infrastructure cannot, including improvements in water quality, wildlife habitat, and recreational programming. The other is that they can grow and evolve over time in ways that walls and levees cannot – marshes and dunes can migrate as sea levels encroach and habitats migrate.

As this dissertation will show, the greatest challenge to making coastal communities in the US more resilient is less a product of local issues like a lack of financial capacity or political in-fighting, though those are surely barriers to the implementation of nature-based strategies. Rather, the ability of cities to build resilience-driven projects is most-hindered by institutional forces – the inability of the US Army Corps of Engineers to evaluate the ecological benefits of the projects it considers, the state land and environmental policies that are not attuned to the realities of climate change, and a design culture that reinforces misconceptions of nature as ornamentation instead of a performative piece of the coastal resilience-making project.
Were Olmsted to pen a similar missive today, it’s likely that his ire would have been directed elsewhere and in response to one of the greatest challenges embedded in our own cultural moment: planetary climate change. Its near-term effects are already being expressed in places like the Pacific Northwest, where ocean acidification, triggered by an unprecedented increase in atmospheric and oceanic CO2, is dissolving the shells and habitat of most bivalves. In doing so, it is disrupting – and, some would argue, destroying – a vital global oyster and mollusk fishery that provides significant economic wealth to the region while cleaning and filtering pollutants billions of gallons of water. But the effects of ocean acidification are not isolated to the Pacific Northwest – fisherman and ecologists across the globe are grappling with its effects across much of the Atlantic, Gulf, and Pacific basins.

Erstwhile, global temperatures are rising. Based on data from the National Oceanic and Atmospheric Administration, 2016 was the warmest year in human history. The second and third hottest? 2015 and 2014. Urban heat deaths – or the loss of life attributable to seasonal spikes in temperature – have increased

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every year in the US since 2010. The rate of heat-related mortality is expected to
double by 2100 as a result of climate change-driven temperature increases.\textsuperscript{5}

But those effects can appear abstract and somewhat removed from the
daily life of most Americans. Most scientists agree that ocean acidification and
increasing temperatures are a product of human-induced climate change, but
they differ, at times, on the magnitude of our responsibility. Also, those processes
are underway in places that are quite remote. Few people spend time in a marine
fishery along the northern latitudes. Those that do would have difficulty spotting
the slow dissolution of a shellfish population with a pair of flippers, goggles, and a
few marine scientists. Climate change is a difficult problem to solve for just this
reason – its effects are muddled and diffuse, effecting everything and, seemingly,
nothing all at once. It is difficult to construct a political constituency around such
an ethereal phenomenon, especially when the immediacy and urgency of other,
more acute crises subsumes so much political capital.

That constituency is beginning to form along the Gulf and Atlantic Coasts
of the US. There, the ocean has slowly crept towards, and is now encroaching
upon the phalanx of communities clustered along the water’s edge. Some of
those cities already find themselves periodically under water. Norfolk, Galveston,
Miami, Charleston, and Savannah each experience recurrent flooding during
their monthly high tide events. It occurs because their sewer outfalls – many of

"Avoided Heat-Related Mortality through Climate Adaptation Strategies in Three US Cities."
which were built during the late-19th and early 20th-century – now, as a result of sea level rise, find themselves below the mean high tide. So as the monthly high tide comes in, seawater is forced up, through those outfalls and drainage pipes, into the streets and lawns above their drainage system. When those tidal floods are accompanied by rainfall, the results can be jarring to an outsider.

During the course of my fieldwork for this book, I spent about six weeks in Norfolk. At the monthly high tide that coincided with my trip, a brief shower – 0.05” of precipitation – fell. That small shower, coupled with the monthly high tide, allowed as much as three feet of water to pool in parts of downtown Norfolk. Children, accompanied by parents in their galoshes, sped past me on kayaks and canoes as I watched the water bubble up through the city’s drains and into the streets. When I asked one of the parents if they were shocked to see so much water from such a small rain event, they replied “not at all…we’re out here every couple of months…in our kayak. That’s why we bought it for [our child] – he asked Santa for one to use in the streets last Christmas.”

Along the coast and within many of its communities, rising sea levels have begun to expose what Olmsted knew at the time of The Cotton Kingdom’s writing: that the very idea of a coast line is disingenuous. The ecology of coastal environments is as dynamic as any other on the planet. The tidal prism – a term describing the volume of fresh and salt water exchanged between low and high-

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tide – deposits nutrient from the tail-waters of rivers like the Mississippi, Hudson, and Delaware into estuaries and bays, creating one of those most vibrant and biodiverse ecosystem types on the planet.

The difference between those low and high-tide water levels is captured by a statistic known as mean tidal range – or the average gap in elevation between those events in a particular location. In Norfolk, that range is nearly eight feet. In Galveston, it is just a shade over five. In the outer boroughs of New York, it can be as much as twenty-five feet. Tidal range, along with a process of sediment deposition known as littoral drift, helps build the marshlands, dunes, and reefs that populate those coastal environments by scouring, depositing, and shaping landforms along the shore.

This is all a long-way around to saying that if there are no lines in nature, then surely there can be no lines between water and earth – or nature and culture – along the coast. As tides rise and fall, they shift the location of that edge each day. As sediment is deposited and scoured from our beaches and estuaries, that edge shifts dramatically over millennia. Whatever lines we choose to draw – be them in our maps or in our minds – are surely imagined. There are no coastlines. There are only coasts.

This may seem like an alien concept in many of the communities along the Gulf and Atlantic coasts. There, a century’s worth of coastal infrastructure – built in the form of bulkheads, seawalls, groins, revetments, and breakwaters – form a
hard line between the terrestrial and marine environments. All told, roughly 13,670 miles of artificial structures and grey infrastructure rim the American coast, creating a literal line where it was once only imagined.\textsuperscript{7} The coastline is an artifact of culture. The coast is one of ecology.

Still, the process of creating literal, physical manifestations of cultural natures is one that the Americans know well. Ideas about nature as a wild, chaotic force in need of control, separation, and conquest by humanity became the conceit upon which the greatest period of environmental denudation was inflicted upon the American landscape: postwar suburbanization.\textsuperscript{8} Technological innovations in earth-moving and transportation technology coalesced with shifts in federal land development and housing policy – along with racial resentment and white flight – to scatter Americans across the countryside, sprawling into farms and forests. A similar set of processes played out along the coast, where steam-power drove a growth in port capacities as new forms of concrete and coastal engineering tactics unleashed a torrent of development. Harbors and estuaries became rimmed with riprap and bulkheads – replacing the swamps and seagrass beds that once softened their boundaries. Levees and dikes protruded from the coastal and riverine edge – supplanting dunes and beach heads. All of this was done in the service of economic expansion – often through trade via ports, but also through recreational tourism and water-driven industrial


development. By the end of the twentieth century, some 90% of the land in urban coastal counties was lined with some form of grey infrastructure.\textsuperscript{9}

To the benefit of some, this process of linearizing – and then commercializing – the coast through grey infrastructure has transformed American marine environments from sites of ecological abundance to ones of substantial economic wealth. Eight of the top ten cities by gross regional product in the US are located along the coast, and more than 40% of all Americans live in a coastal county.\textsuperscript{10} The transformation of the coast has always been predicated on economic growth – and the dividend created by exploiting it is the only thing that makes sustaining the rest of the nation possible. Without such economically productive, vibrant coasts, the rest of the nation would be unable to function.

Even today, many planners\textsuperscript{11} believe that an economic imperative like that of protecting the coast will be what compels business and political leaders to join those in the scientific and advocacy communities in developing real, effective plans to mitigate climate change. It is a sentiment at the core of what has come to be known as sustainable development: the practice of building communities that balance the needs of today with those of future generations – sometimes referred to as the seventh generation principle. The desire to create a stability in the material flows, consumption, and health of urban systems has inspired

\textsuperscript{10} Ibid.
hundreds of city plans, thousands of scientific papers, and untold numbers of
design projects across the globe. It would be difficult to find a major work of
design or planning, executed over the last two decades that does not explicitly
support such an aspiration.\textsuperscript{12}

But by nearly every measure, our experiment with sustainability is proving
itself a colossal failure. Global CO2 emissions are still increasing, development
patterns are still sprawling into and consuming valuable and high-functioning
landscapes, and the ecological crisis identified by writers like Ian McHarg and
Rachel Carson continues largely unabated.\textsuperscript{13} In a chilling 2015 essay published
in \textit{Science}, Paul Ehrlich and several colleagues note that “our estimates reveal
an exceptionally rapid loss of biodiversity over the last few centuries, indicating
that a sixth mass extinction is already underway. Averting a dramatic decay of
biodiversity and the subsequent loss of ecosystem services is still possible
through intensified conservation efforts, but that window of opportunity is rapidly
closing.”\textsuperscript{14} However earnest our efforts have been thus far, humanity and the
Earth are no more sustainable today than they were a half-century ago.

\textsuperscript{12} F. Steiner. 2012. \textit{Design for a Vulnerable Planet}. Austin: University of Texas Press.
\textsuperscript{13} IPCC. 2013. “Summary for Policymakers. In: \textit{Climate Change 2013: The Physical Science
Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental
\textsuperscript{14} G. Cellabos et al. 2015, “Accelerated Modern Human-Induced Species Losses: Entering the
There are other forces rendering the potential of sustainable development moot as an instrument of climate change mitigation. One is that it is predicated on an outdated worldview that fails to recognize and plan for the interconnected systems of consumption, development, production, and neoliberalism that drive urban growth and human behavior. Instead, sustainability is premised on the idea that each can be measured and managed in discrete domains independent of one another. Most troublingly, it presumes that a balance can in fact be struck – that the inputs and outputs of consumption and growth can be managed in a way that allows people to live as they like now and for the natural resources upon which we all rely to fully regenerate. This, of course, is an absurd proposition – which stands inapposite to everything we know about the formation of fossil fuels, natural resources, and the development of cleaner, more efficient alternatives. As a number of ecological and economic scholars have begun to argue, there is simply no way to balance the desires of capitalism with those ecological and human health.\textsuperscript{15} Put another way, sustainability belongs in the same conversation as Howard’s Garden Cities and Le Corbusier’s Radiant City – utopian pipe dreams that never managed to move past their abstract diagrams and into the built environment.\textsuperscript{16}


But the inadequacy of sustainable development to meet this cultural and ecological moment has not stopped cities along the Gulf and Atlantic coasts from doubling-down on their investments in linear grey infrastructure projects. In the aftermath of Hurricane Katrina, the city of New Orleans invested $14.5 billion in a surge protection system comprised entirely of massive seawalls, flood gates, and pumps to encircle and protect what Colten referred to as “an unnatural metropolis” – a human-derived bathtub, full of people, pushing hopelessly against the Mississippi River and the Gulf of Mexico. In New Orleans – and most other coastal communities in the US – these kinds of projects have produced what is known as a moral hazard – a policy intervention intended to solve a problem (in this case flooding) that actually exacerbates it. Coastal grey infrastructure’s moral hazard is produced in three steps.

The first is that most seawalls, levees, and dikes are built to open up new areas to development – either by treating coastal swamps and marshland as a tabula rasa upon which to build new communities or by adding a layer of protection to existing low-density neighborhoods that triggers a cycle of densification. The effect is to place new residents into a flood-prone landscape – essentially creating a risk for property damage and death where it did not exist. The second is that these kinds of projects create a physical and visual barrier between the communities they encircle and the flood risks they face. The effect

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of this has been to reduce the perception of risk in those communities and thus to reduce the political capital available and necessary to maintain a reasonable level of disaster preparedness. The final step in its production of a moral hazard rests in the extraordinary expense and technical expertise required to maintain massive networks of coastal grey infrastructure. The effect of this it to create a system that is impossible to properly maintain yet is responsible for inducing new development in high-risk areas. This is the moral hazard of coastal grey infrastructure – to design a system in which new people are induced to live in an area with high flood-risk under a false promise of security. In every populous region along the Gulf and Atlantic coasts – from Brownsville, Texas across to Miami and up to Portland, Maine – similar surge protection systems are under review by the US Army Corps of Engineers (USACE or Corps).

The surge protection system in New Orleans – and, indeed, much of the coastal grey infrastructure work underway in the US – has been deeply influenced by Dutch engineers. Holland is the reference point upon which all coastal infrastructure turns. Dutch hegemony along the American coast has roots in The Netherlands’ Great Flood of 1953. That winter, a massive storm – akin to what might be called a N’oreaster in the US – swept swiftly across the low-lying

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country, killing 1,835 people and inundating an area of more than 1,300 square kilometers – roughly eight times the size of the District of Columbia. Unlike the US, Holland’s entire population and economy is located along the coast. There are no inland or upland cities to which its residents might retreat, as much of the nation is below sea level. The 1953 floods – and the precarious position of the nation’s cities – prompted a massive and sustained investment in flood control infrastructure and management protocols. It transformed The Netherlands coastal zone into a coast line – rimmed by dikes and levees, retractable flood gates and enormous pumping stations. The culmination of the Dutch approach to coastal engineering arrived in the Delta Works and Room for the River projects – both of which used massive works of grey infrastructure to resist flood-waters along with gargantuan pumping stations to displace any water that managed to overtop them. The success of the Dutch approach inspired officials in dozens of American cities to emulate their work – sometimes implicitly, by adopting a resistance strategy to flood risk management, and other times explicitly, by contracting Dutch engineers and designers to work in their cities.

Few of those city officials – or the designers with whom they work – spent much time considering how well those Dutch ideas might translate across the Atlantic, or even if they managed to perform as well as their mythology implies. If they had, a few issues might have dissuaded them from investing so many

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resources in such an approach. This is because the very nature of flood risk in Holland is so different from that of the US. In the Netherlands, coastal storms are comparatively mild events. They bring heavy precipitation and wind-driven waves to be sure. But coastal storms in Holland usually come with surge heights of ten feet or less. The 1953 great flood brought surge heights of 14.5 feet to the Netherlands, which qualifies as a one-in-ten-thousand-year storm event there. Contrast that with the US, in which a 15 foot storm surge is used to model an average hurricane event by disaster planners in the Federal Emergency Management Administration. There is simply too much variance in the magnitude of the risk facing each nation for the Dutch approach to find comparable success in the US. Even in Holland, public officials have begun to recognize that there are technological limits to their own ability to wall themselves off from the sea – the nation has been shifting its coastal investments away from large defensive structures and towards softer, green infrastructural systems. In addition, and in contrast to the U.S., The Netherlands has a deep commitment to planning and landscape design at all levels of government. A similar shift, however nascent, is beginning to emerge in a few US cities.

It also represents one of the first critical examinations of the use of resilience as a new organizing device for planning and designing cities. As a framework for contemporary urbanism, it departs from the principles of sustainability in two important ways. One is that resilience theory is premised on a worldview of dynamic equilibrium – or that human and ecological systems are
constantly shifting and that whatever stability appears is ephemeral. Put another way, resilience theory does away with the notion that a lasting balance can be struck between the interests of business and people and of growth and the environment. Instead, it flows from the idea that those systems can be resilient if and when they have the capacity to absorb and evolve from the inevitable shocks and shifts that ripple through the planet’s urban centers.

The other point of departure between the two frameworks rest in their faith in regional and national collaborations to achieve their goals. Sustainable development is predicated on such an ideal and, as a result, places great faith in the ability of civic institutions to achieve its goals. Resilience, conversely, places little or no faith in those institutions, relying instead on local actions and design interventions to achieve its goals. If sustainability is the utopian idea of urbanism, then resilience is its fatalistic foil. Nowhere is the disparity between those two competing frameworks – and their use of grey and green infrastructure – more apparent than along that Gulf and Atlantic Coasts of the US.

This dissertation asks a number of critical questions regarding the resilience of coastal cities – and the role that nature-based strategies are and should be playing in them. How do nature-based strategies stack-up, performatively, against the more conventional methods of flood control? How do political actors and institutions view, support, and obstruct their use? How are philosophical tropes of nature reflected in design culture and, as a result, in the urbanism of coastal cities? But at its core, this dissertation attempts to answer a
singular, more complex question about the coast: what role can nature-based strategies play in building resilience? These questions form the core of this dissertation, and they are addressed through fieldwork in Galveston, Norfolk, and New York.

Mapping the Nature of Risk along the American Coast

One of the most obvious questions that reads of this book might ask is this: why study Galveston and Norfolk alongside New York City? Case selection methods vary wildly – from those chosen as a matter of convenience or proximity to the researcher to those chosen through complex models and cluster analyses that can provide researchers with a typology of cases to organize their work. For this project, I opted for something in-between.

I began by creating a filter that allowed me to winnow the universe of available cases to cities that fit three basic criteria: they must have participated in one of the major federal or philanthropic disaster resilience initiatives that began in 2013 (when the first wave of federal and philanthropic investments in disaster resilience began), they must be along either the Gulf or Atlantic coast, and they must have a population of 50,000 or more. Those initiatives include the Rebuild by Design competition led by the US Department of Housing and Urban Development (HUD), the Structures of Coastal Resilience initiative led by the Rockefeller Foundation, and the National Disaster Resilience Competition co-led by HUD and Rockefeller. Their importance to this filtering exercise was that they were the policy instruments pushing nature-based strategies out of the academy
and into the built environment. Studying the culture surrounding nature-based strategies required identifying the places where one might expect to find them under consideration. Limiting this study to the Gulf and Atlantic coasts was a product of reviewing the literature on climate change and disaster risk. Though sea level rise will surely impact cities along the West Coast of the US, the flood and disaster risks there are minimal – the oceanic and atmospheric processes regulating the Pacific simply do not produce many tropical storms that make landfall in the US.\footnote{Committee on the US Army Corps of Engineers Water Resources, Science, Engineering, and Planning: Coastal Risk Reduction. 2014. \textit{Reducing Coastal Risk on the East and Gulf Coasts}. Washington, DC: National Academies Press.} The final criteria – limiting my study to cities of 50,000 or more – came from a review of the planning literature, which indicates that this is the size at which we can expect communities to have the financial and technical capacity necessary to plan for climate change.\footnote{J. Masterson, et al. 2014. \textit{Planning for Community Resilience: A Handbook for Reducing Vulnerability to Disasters} (Washington, DC: Island Press).}

Applying these three screening criteria produced a sample of twenty-eight cities – cities in which we might reasonable expect to find nature-based strategies under serious consideration by local officials and designers. The task then became how to make sense of this group of cities – I could not study all twenty-eight, nor did I consider it wise to select two or three at random. Among the many questions I hoped to answer in this study was: how do differences in the magnitude and type of risk – surge versus tidal – effect the strategies employed in coastal resilience projects in the US?
That question compelled me to organize the cities according to their experience with disaster and by their exposure to future flood-related disasters. I measured each in two ways. For disaster experience, I used county-level data from the Federal Emergency Management Administration (FEMA) to calculate the number of Presidentially Declared Disaster events due to hurricane-related events from 1985-2014 for each city and I also summed the total value of property destroyed as a result of those storms in each city’s county over the same period. For disaster exposure, I calculated the total number of National Flood Insurance Policies (NFIP) held within each city and I also measured the total value of the properties insured through the NFIP in each. I then created a simple index of experience and exposure for each of the twenty-eight cities that I used to plot them within a two-by-two matrix containing four types of cities: high-experience and high-exposure cities, low-experience and high-exposure cities, low-experience and low-exposure cities, and high-experience and low-exposure cities. I then discarded the low-experience, low-exposure cities from consideration, as they were unlikely sites in which to expect significant investments in coastal resilience projects.24

From the remaining cities, I chose three to structure this book around: Norfolk as a high-exposure, low-experience city, New York as a high-exposure, moderate-experience city, and Galveston as a city of high-exposure and high-experience with disaster. I expected to find considerable variation in the degree

24 See Figure 1.
to which nature-based strategies were being deployed in each and in the motivations behind their implementation – or lack thereof. Norfolk, after all, is a medium-sized city and home to the largest Naval Base – including the headquarters for NATO Allied Command – in the US. It should approach coastal resilience-making in ways that are distinct from a global financial center like New York, or a petrochemical hub and barrier island community like Galveston. As this dissertation will show, the challenge of resilience-making in cities is less a product of diminished financial capacity or political in-fighting, though those factors surely delimit the implementation of coastal infrastructure projects, and more a product of institutional and cultural conflicts with building nature-based strategies.

This speaks to an unexpected set of findings in this dissertation – I expected the challenge to building nature-based strategies in coastal cities to be more idiosyncratic. Though I certainly hoped to be able to speak to the general problem of adaptation to climate change through the specifics of each city, the degree to which the challenges facing them mirrored one another proved shocking. The effect of the Corps’ recent project delivery overhaul – known as the 3x3x3 reforms and detailed in chapter 3 of this dissertation – on the prospects for coastal resilience planning appear to be ubiquitous and crippling along the American coast. There will certainly be lessons from Galveston that are of greater relevance to other barrier island communities than to other places – just as Norfolk’s may find a firmer constituency in other medium-sized port cities,
and New York’s in other global capitals. Together, they render an image of the American coast that is both hopeless and hopeful; of a territory giving way to the sea and as bold design experiments aim seek to extend humanity’s hold on its edge; and of a system for adaptation that is both designed to fail and predicated on failure to achieve progress. It is an image of the messy, decentralized process of building resilience in the US.

Case Study Research and Climate Change Adaptation

This book is structured through a comparative case study analysis of coastal resilience and nature-based strategies for climate adaptation in Galveston, Norfolk, and New York. It deviates from the more conventional, single-case research design often employed in planning and design projects for three reasons. One is that, outside of planning, the trajectory of scholarly work has been trending towards comparative case study work for some time – particularly in projects drawing from and speaking to multiple disciplines. This project was structured to place itself into conversation with comparative analyses like Crisis Cities, Acts of God, and The Social Roots of Risk as much it aims to build upon single-case projects like A River and Its City and more technical works

like *Reducing Coastal Risk*.\(^\text{30}\) Put another way, this is a book about the culture of nature, risk, and technology along the American coast.

A second reason is that I set out to answer a series of process-based questions in this dissertation. How and why are nature-based strategies being deployed in the coastal resilience plans of American cities? What are the performative qualities of nature-based strategies as instruments of flood-risk reduction? How are those qualities motivating – or not – their use in coastal US cities? Why are nature-based strategies being pursued aggressively in some US cities and not others? These are cultural questions that can only be answered through the use of ethnographic methods and a comparative case-study research design – key informant interviews, public document analysis, and participant observations. I spent considerable time in each city – eight weeks in Galveston, seven in New York, and six in Norfolk – meeting with marine scientists, public officials, community leaders, and many others involved the coastal planning process to try and answer those questions. I also pulled from extensive collections of historical maps, meeting minutes from public commissions and civic societies, and contemporary planning and scientific reports describing and projecting the effects of climate change in each city. I also attended or reviewed transcripts and videotape from a half-dozen planning commission and neighborhood planning meetings. That work provided a robust

set of data often omitted from discussions about risk and resilience along the coast: local knowledge and intelligence.

The final reason that I chose to build this dissertation around Galveston, Norfolk, and New York is that my goal in scholarly research has always been to influence public policy and design culture. That usually requires an ability to generalize from one’s research, and no other research design is as effective at doing so as the comparative case study model. Unlike model-driven studies – which are often too abstract or too complex for policy-makers to absorb – and single-case studies – which are often difficult to place in a broader cultural context – the multi-case model provided me with an instrument for creating a broader relevance and narrative than a study of only Galveston, Norfolk, or New York might have.

The import of these goals will only grow as the US enters a revivalist era of climate change denial – and, indeed, a time of profound anti-intellectualism unrivaled in my lifetime. Our coastal communities cannot face or respond to the threats of climate change alone – they need strong civic institutions and governments to do so. Denialism and censorship cannot push back against the sea, nor can they keep communities safe that remain – or will become – exposed to the effects of climate change. Truth always finds us, whether we cower from it or seek to discover it. My task in this dissertation – and our task as a community

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of scholars – is to expose it before others suffer because of the politics of obfuscation.

**Disaster, Resilience, and Design**

This book is engaged in two broad fields of scholarship. The first pertains to disaster planning, a body of literature that includes the application of public policy, urban and landscape design, and social psychology to the challenge of rebuilding and recovery. The conventional approach to post-disaster recovery can be envisioned in four simple phases: normalcy, disruption, recovery, and resilience. The normalcy phase contains the actions typically associated with disaster preparedness – developing an emergency or evacuation plan, investing in physical upgrades to a city’s infrastructure, and creating a communications network to ensure the free flow of information during a crisis.\(^\text{32}\) During this initial phase, disaster planners often endeavor to create hazard mitigation plans that can be integrated into comprehensive city plans, which carry a legal and financial force that standalone mitigation plans cannot.\(^\text{33}\)

Then, the disruption phase is the period in which these systems of infrastructure and communication are tested as the result of a hazard or other debilitating event. During this period, the conventional position of disaster

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planners is to expedite and coordinate the relief process.\textsuperscript{34} It is generally considered to be the phase of disaster planning at which the U.S. is best, though scholars argue that this is a strength borne of out necessity – that by consistently failing to invest in preventative and protective measures and infrastructure, the nation’s disaster-relief industry is well-practiced in the evacuation and relief provision processes.\textsuperscript{35}

Next, the recovery phase is where many of the activities discussed in this dissertation occur. It is when cities and governments begin to rebuild the facilities and the housing lost to storms and other destructive events. But it is also the period when the physical and social landscape of cities is most apt to change. During this phase, decisions are made about where to invest in new protective infrastructures, where and how to engage in land swaps and buyouts, and where to remove or displace pre-disaster risks – all of which have second- and third-order effects on where and how well people live.\textsuperscript{36}

The final period – the resilience phase – is characterized by a return to normalcy for a city or region, often with a more robust set of protections and expanded capacities in place. This is when investments in social capital and


community development are often prioritized by disaster planners. Though ecologists, engineers, sociologists, and planners differ on the proper scales – both in time and space – for evaluating resilience, they tend to converge around the idea that it is a property exhibited in cities and systems by an ability to learn from the past when adapting to the future. In other words, resilience should be evident in places where rebuilding – necessitated by disaster – is being explored through new, innovative means. Galveston, Norfolk, and New York City certainly fit that description.

The problem with this conceptual framework for disaster planning is that events rarely unfold in this linear, idealized fashion. Limiting planning capacity, insufficient financial resources, misaligned state and federal regulations, and a myriad of other factors all undermine the path towards resilience laid out in that body of literature. This model’s failure to produce more resilient cities is what led the U.S. Department of Housing and Urban Development (HUD) and the Rockefeller Foundation to invest in more experimental approaches like Rebuild by Design, Structures of Coastal Resilience, and the National Disaster Resilience competition – all of which inspired and are discussed in this dissertation.

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Plan for the Dissertation

This book is organized through four additional chapters. In chapter two, I develop an urban and environmental history of Galveston, Norfolk, and New York City. Its central aim is to identify the projects and processes through which each city’s coastal landscape was shaped and its geomorphology irrevocably altered. Put another way, chapter two places each city’s contemporary vulnerability in a broader, historical context of American coastal urbanism and development. I use historical documents – including maps, meeting minutes, and public documents – to develop these narratives. In Galveston, the city’s relationship with the sea was shaped by the Great Storm of 1900 – the deadliest storm event in US history\(^{39}\) – and the region’s response to it: constructing a massive seawall and raising the barrier island’s elevation by upwards of twelve feet through dredge and fill operations. The performative success of that early-20\(^{th}\) century defense system shaped attitudes on the island about the role of technological landscapes and flood risk reduction, and it inspired a suite of contemporary resilience plans that extend and expand its logic across the coastal plain of Southeast Texas. Norfolk and New York depart from Galveston’s experience and instead experienced a more conventional process of growth along their coasts: a port-driven expansion of coastal grey infrastructure along their waterfronts and a suburbanization-driven expansion of impervious surface throughout their rivers’ watersheds. They arrived at their contemporary struggle with coastal resilience through an

experience that was less defined by major, storm driven events like Galveston’s
and more by the gradual spread of seasonal, tide-driven flooding throughout
each city. Yet, each city now faces the surge risk posed by catastrophic,
hurricane-driven storms as well as the more existential risk of sea level rise – and
the possibility more regular and widespread inundation.

Chapter three focuses on the politics of resilience by tracing the norms,
functions, and influence of the USACE and its partner organizations along the
coastal zone of each city. Its central aim is to build up framework for
understanding the ways and means through which local and national politics
influence, undermine, and otherwise affect the ability of coastal cities to bolster
their resilience. I use public documents and my key informant interviews – with
technical experts, public officials, and community organization leaders – to
develop this chapter. Though each city has its own idiosyncratic politics, the force
exerting overwhelming influence on each – and, in fact, the entire American
coast – is the USACE. This chapter illustrates how a series of seemingly benign
reforms – known as the 3x3x3 reforms – rendered the Corps’ ineffective and, as
a result, severely limited the future potential of each city.

In chapter four, I examine the major proposals for new coastal
infrastructure in each city. I assess their performative qualities by pulling from
interviews with technical experts and the scientific literature – all to help
determine the extent to which each proposal will reduce risk and build resilience,
in every sense of the word, in each city. But I also explore their cultural meaning,
using the same body of evidence to assess how different views on nature and its role in coastal protection has shaped these alternative futures in Galveston, Norfolk, and New York City.

In the fifth and final chapter, I aim to accomplish two goals. One is to generalize the findings from each city – both from, say, Galveston to other barrier island communities and from the triumvirate of cities to the American coast as a whole. The aim there is to identify the ways in which political coalitions, public policy, and land development can be leveraged to build a more lasting and durable resilience along the nation’s shore. The second goal is to instrumentalize the findings from Galveston, Norfolk, and New York in the service of reshaping design and planning culture around the social, ecological, and physical science of resilience. As chapter four details, design-led resilience projects – however interesting and innovative – often succumb to the same tropes of environmental ornamentation and conquest that shaped the postwar suburbanization of the American landscape. The societal challenge along our coast is that time is a factor – adapting to sea level rise and the other effects of climate change must progress, or our cities and the people and ecosystems that inhabit them will suffer. The more discipline specific challenge to planners and landscape architects is that we may only get one shot at leading that adaptive process. We find ourselves in an exciting moment for the professions. Foundations, governments, and society writ-large are turning, more and more, to designers for answers on how to solve the wicked problem of sea level rise. But if we squander
it by chasing strategies and ideas that we know will not work, we'll only have ourselves to blame. Without a firmer grounding in the science of resilience, we risk reinforcing tropes of design as a frivolous, ornamental actor along the coast.
**Figure 1:** The Experience-Exposure Matrix (author). These matrices show where the cities outlined in chapter one fall along the experience-exposure spectrum. Galveston,
Norfolk, and New York City hold similar levels of exposure to and differing degrees of experience with disaster.


“When you make a decision about where to build a seawall or where to build a jetty…or where to expand a port, those are 100-year decisions. They aren’t the things that you can easily undo or correct…once they’re built. You live with them – whatever that means…for better or worse.”

The legacy of 19th and 20th-century coastal engineering projects in the U.S. is one unintended sociological and ecological consequences. Their primary aim often centered on expanding the commercial and industrial capacity of cities along the nation’s shore. In this, they have been successful. The American Association of Port Authorities, using data captured by the Bureau of Economic Analysis and the Bureau of Transportation Statistics, estimates that coastal ports account for roughly 26% of the nation’s economy – or nearly $17.4 trillion in 2014. The National Ocean Economics Program attributes an additional $7.6 trillion to the coastal economy during 2014 fiscal year – a figure that includes direct and indirect jobs created by the industries found along the American coast.

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Nearly 40% of the nation’s GDP is produced in coastal cities.\textsuperscript{42} Prior investments in port expansion and freight waterways made that possible.

But its effect on commercial activity came at an unexpected cost: the denudation of coastal environments along the nation’s shore. The aim of most coastal engineering projects during the 19\textsuperscript{th} and 20\textsuperscript{th}-century centered on stabilization. They sought to limit the volatility of coastal zones and to increase the ability of ship and freight logistics to operate without frequent disruptions for dredging and other maintenance procedures. Naseem Taleb and other behavioral economists have described this kind of approach as a forced smoothing – or the attempt to remove fluctuations from a system by removing or micro-managing its sources of volatility.\textsuperscript{43}

Engineers working along the American coast accomplished this primarily through the construction of massive seawall barriers along the edge of cities, jetties and breakwaters at the mouths of ship channels, and placing bulkheads and other forms of coastal grey infrastructure along the bays and harbors of most port facilities. The degree to which each of these approaches to coastal engineering were imposed upon the landscape varied considerably between the three cities explored in this dissertation. In each, the biophysical impacts to the landscape were stark. A massive, phalanx-like seawall and a pair of jetties

\textsuperscript{42} National Ocean Economic Program. 2016. “State of the U.S. Ocean and Coastal Economies.” Available at: \url{http://www.oceaneconomics.org/download/}.

characterized along the mouth of the Houston Ship Channel reshaped Galveston’s marine landscape. The seawall contributed to a pattern of scouring, which stripped away the island’s beachfront and began to alter the width and length of both Galveston and the Bolivar and San Luis Peninsulas to the east and west, respectively. The jetties altered the region’s sediment flow, creating new sand spits and land mass in some areas and stripping land – especially marshland – away in others. Galveston’s reconfiguration came swiftly and totally in the aftermath of their construction.

Bulkheads, revetments, and other less monolithic projects altered the coastal edge of Norfolk and New York. Developed more slowly and over time than those in Galveston, these projects produced similar consequences. Norfolk – already an extraordinarily low-lying city – saw its rate of land loss and subsidence increase, increasing the tidal range of the region and making it more vulnerable to tidal and precipitation-driven flooding. A similar process unfolded in New York City, though it enjoys a higher mean elevation than either Norfolk or Galveston.

Though each city blazed a slightly different engineering pathway, all three found themselves in similarly precarious positions at the start of the 21st-century. Some of that precarity is a product of planetary climate change. Sea levels are projected to rise between three and seven feet in the U.S. by 2100, inundating at
least thirteen million coastal residents and imperiling many more. At least $880 billion in home values and more than $1 trillion in commercial property is projected to be lost as result. The other immediate effects of climate change – ocean acidification and increasing volatility in weather patterns – are expected to reshape marine ecosystems as shellfish and bivalve populations wane and seasonal and tropical storm-driven flooding events become more frequent and intense. All of these effects would pose threats to Galveston, Norfolk and New York City regardless of their past investments in coastal grey infrastructure.

But the degree to which those global phenomena threaten each city is, in fact, a product of transforming their coastal zones into coastlines. The question that coastal cities must answer is not if they will be impacted by climate change, but the extent which that impact will be felt. Galveston, Norfolk, and New York City are more vulnerable to sea level rise because of their prior investments in grey infrastructure, not in spite of them. That is because the seawalls, jetties, bulkheads, and revetments that now characterize the physical landscape of each city induced new investments in water-dependent industry and new residential

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development in the newly drained wetlands and marshlands filled in by these projects. Though this led to a period of incredible economic expansion, it also left each with a heavy burden: nearly all of their major economic assets and many of their residents would find themselves in the FEMA-defined surge or flood zone by the end of the 20th-century.

In Galveston, the surge zone is now populated by a sprawling patchwork of cheap suburban homes, large ports, and petrochemical processing and storage facilities. Nearly all of Norfolk is exposed to sea level rise and recurrent flooding, including the NATO Allied Forces Naval Base and the Port of Virginia. New York City and its global financial center, twenty-two million residents, and massive port network are similarly exposed. When one factors in the projection that the Mid-Atlantic and Northwestern Gulf – where Galveston, Norfolk, and New York City are located – will experience an above average rise in sea level by 2100, the risks facing each city can seem overwhelming.

But understanding how those risks were produced – and the mechanisms through which design and planning might ameliorate them – requires understanding how and why each city arrived at this point, and asking three critical questions: what were the unintended geomorphological and sociological impacts of these 19th and 20th-century coastal engineering projects in each city? What motivated local leaders and federal policy-makers to invest in them? How have local attitudes towards and federal policy for building coastal infrastructure projects been shaped by the legacy of these works?
As this chapter will argue, the legacy of these investments has been the prioritization of commercial power along the American coast at all costs – a project that ultimately induced more people and businesses to settle in areas that became more vulnerable to sea level rise over time. By attempting to stabilize the ecological forces that characterize most marine environments, these projects produced a robust-yet-fragile urban system – a term Zolli and systems ecologists define as being highly productive yet highly vulnerable to collapse.48 In Galveston, Norfolk, and New York City, this resulted when the negative feedback from investing in linear, grey infrastructure projects – and the slow accrual of risk they induced – became excised from the decision-making process. Over time, all of the development incentives in such systems become oriented towards increasing economic output. The social and ecological consequences are given secondary status, if they are considered at all.

A key contribution from this chapter is that this logic can be extended beyond the decision-making process of elites and into the attitudes and values of local residents. Not only are the political institutions tasked with developing and regulating the coast affected by the misplaced incentives of robust-yet-fragile systems, but so too are the people living in each city. Many of the most revealing exchanges over the course of my fieldwork for this dissertation came in conversations with the people leading the networks of community and non-profit organizations. The clearest came in Galveston. There, a hard line is drawn

between what are known as BOIs – or people Born on the Island – and IBCs – or those who are Islanders By Choice. Amongst BOIs, there is tremendous pride and faith in the performative value of coastal grey infrastructure as a result of the perceived success of Galveston’s seawall. Most even include the moniker “BOI” on their business cards and awnings. “Why would we want to build anything else?” a BOI who runs a local non-profit asked rhetorically. “My great-grandfather helped build the seawall and it hasn’t failed us yet...we ought to extend it as long and high as we can.”

In this chapter, I develop a history of the major works of coastal engineering in Galveston, Norfolk, and New York City. I rely on a blend of archival documents – including maps, engineering studies, newspaper coverage, and other public materials – and key informant interviews to identify how and why each city’s coast was transformed into a coastline. The impact and the legacy of these projects – both on the social and ecological systems of each city, and in the attitudes towards green infrastructure and nature-based strategies of their residents – remain powerful, durable forces along the American coast. Their obdurateness must not be overlooked.

The Legacy of Coastal Engineering in Galveston

Fifty miles southeast of Houston, Galveston Island serves as a barricade between the nation’s fourth-largest city and the sea. It spans twenty-seven miles

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in length and nearly three in width, stretching westward towards the edge of West Bay and eastward towards Bolivar Peninsula – both of which are low-lying protrusions of sand from mainland Texas. To the island’s north is Galveston Bay, the nation’s seventh-largest estuary and home to both a robust marine fishery and a bustling port and petrochemical economy.\textsuperscript{50} Oyster reefs line the rim of the Bay and the Gulf Intracoastal Waterway – the nation’s second-busiest shipping route – bisects it. Along the shore, at least a dozen refineries process, store, and distribute up to four million-billion barrels of oil each day – a legacy of the deep-water channels and protected harbors carved out over millennia throughout the region.\textsuperscript{51} It is the petrochemical capital of America, if not the planet.

With more than fifty-thousand permanent residents, Galveston is the most densely populated barrier island along the Gulf Coast. Many of the island’s residents work in the refineries, ports, and fisheries rimming the Bay.\textsuperscript{52} Others work in the tourism industry that anchors the island’s economy – a legacy of Galveston’s place in southern culture as a paradisiacal retreat along the Gulf.\textsuperscript{53} This industry clusters along the seaside of the island, pressing up against the golden beaches of Galveston and along the top of Seawall Boulevard. Behind


\textsuperscript{53} See image appendix.
that phalanx of hotels, restaurants, and tourist traps are the homes of Galveston Island’s permanent residents. The dense cluster of petrochemical processing facilities, port and shipping logistics, and low-lying housing render Galveston highly exposed to the surge risk posed by tropical storms. Given the necessity of proximity to water by those industries, these vulnerabilities are likely to persist and increase over the next century.

Though a variety of forces drove Galveston down this path towards vulnerability, none contributed more to its precarious contemporary position than the three major works of coastal engineering imposed on the region during the nineteenth and twentieth centuries. The first project involved the construction of the North and South Jetties at the mouth of the Houston Ship Channel. At the time of their construction, they were the largest jetties on the planet. Their principal purpose was to reduce the need for the ship channel to be dredged – a goal they accomplished by diverting large volumes of sediment away from it and towards other parts of the Galveston Bay region. The second project came in two parts, both in response to the Great Storm of 1900 – the deadliest hurricane in U.S. history. Those parts were an island-wide, 17’ high seawall and, incredibly, the nation’s single largest grade-raising project ever that increased Galveston Island’s elevation by as much as 12’. Their goal was defensive – to wall Galveston off from the risk of future storm surge damage. They proved largely

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successful, though as this chapter will discuss, that success came at a steep ecological cost. The third project centered on the construction of a jetty field – an island-wide array of relatively short jetties built to stabilize its rapidly eroding beachfront. It too reshaped Galveston in unexpected ways – and helped create the conditions of vulnerability that now pervade the region.

But before one can understand how these projects altered the ecology and geomorphology of the Galveston Bay region, there must be some understanding of how those forces evolved prior to the three works of coastal engineering outlined above. This section begins by describing those forces and then moves on to the projects, their impact on the evolution of Galveston, and, ultimately, their influence on the landscape of risk and vulnerability across the region.

The Ecological and Cultural Context of Galveston

Along a geologic time scale, barrier islands like Galveston often begin as small spits of sand. They are formed when the littoral drift – the sediment transport pattern – and the prevailing or dominant drift of near-shore currents are not aligned. This is due to the disruption that occurs when those two drifts intersect, which causes sediment to settle out of the water column and begin accreting on the seafloor. In Galveston, the prevailing drift created by the Trinity and San Jacinto Rivers, which empty into Galveston Bay and create a sediment-rich outflow that is perpendicular to the coast. This outflow is then disrupted by the east-to-west littoral drift that is endemic to the region. When this process
happens at a large enough scale and over a long period of time, a sand spit – or glorified sandbar – begins to form. The effect is then compounded, as the spit of land created by sediment being stripped from the water column and deposited onto the seafloor attracts more sand, detritus, and other land-building materials into its territory. As the spit grows in height and area, pioneer vegetative species begin to colonize it, stabilizing portions of the landform and allowing dunes, marshes, and other coastal habitat types to form. On Galveston Island, the east-to-west direction of littoral drift would have created a shearing effect, stripping sand and sediment from the east end of the island and transporting it westward down the coast – some of which would settle along the opposite the island’s west end. The long, narrow profile of Galveston is a product of this process.

The gradual process of accumulation, dissolution, and migration that built Galveston Island would have been accelerated at times by tropical storm activity in the Gulf of Mexico. As storms traversed the Texas Coast, their surge and wind energy would literally push, pull, and drag the barrier island. Storms moving over the island would reshape dunes and depress its overall topographic profile. Occasionally, these events would break the island apart, dividing it into a complex of several smaller landforms and introducing another layer of complexity to the regional geomorphology. Nineteenth century maps indicate that as many as five distinct landforms – separated by channels scoured during one such storm over-wash cycle – were considered part of Galveston Island.55 Storms

55 See image appendix.
creating a backwash effect would deposit organic material along the bayside of
the island, seeding the marshes and wetlands that later colonized it. Much of the
Texas coast formed in this manner. From Brownsville to Port Arthur, a barrier
island complex parallels the state’s coast, with sediment generally flowing
towards Corpus Christi from all directions.

Prior to European colonization, this megaregional landscape was of
dynamic, evolving, and low-lying barrier islands. They performed important
ecological services – buffering the mainland from wave energy and contributing
to robust estuarial fisheries like Galveston Bay. They also existed in a state of
flux. There was a coast to be sure, but the idea of a coastline had not yet
permeated the environment. On a daily time scale, the ebb and flow of the tides
ensured that the boundary between Galveston Island the Gulf of Mexico
remained fluid. Geologically, the physical space occupied by Galveston was
constantly shifting. The transformation of the region’s coast into a coastline would
come later, at the hands of European colonists and, eventually, engineers with
the U.S. Army.

Though encountered for the first time by sailors in 1528, Galveston’s
colonization began in 1817 under the direction of Jean Lafitte.\(^{56}\) A French pirate
who led smuggling and privateering operations along the Gulf Coast for much of
the early nineteenth century, Lafitte transformed Galveston from a non-descript

sand spit into an icon connoted with tropes of paradise and wealth. With permission from the Spanish colonists in New Orleans, he quickly established a trading outpost on the island. As many as two-hundred craven, swashbuckling privateers and pirates joined Lafitte there and their operation was wildly successful. By 1818, Galveston had become one of the Gulf Coast’s principal hubs for trade. This included agricultural and textile products, treasure captured from wayward ships, and slaves being sold to colonists throughout the region.\textsuperscript{57}

But Lafitte and his privateering comrades quickly ran afoul of the island’s Karankawa tribe. They skirmished repeatedly – often at Lafitte’s instigation – over the next year.\textsuperscript{58} One battle during the summer of 2018 ended with Lafitte turning his ships corsairs on the tribe, an act that killed dozens of their members and sent the rest fleeing from the island. The pirates’ savage peace would prove fleeting. That fall, a hurricane ravaged Galveston. It leveled the island, destroying all but six of the men’s homes and their entire shipping fleet.\textsuperscript{59} Though they attempted to rebuild and reestablish their privateering operation in Galveston, Lafitte and his men never fully recovered. Three years later, a U.S. Naval fleet arrived at the island to expel the pirates. Lafitte and his men went quietly, though he managed to abscond with much of their entire stockpile of treasure. The

material wealth they accumulated on the island helped to form one of Galveston’s first national advertising campaigns: the “Treasure Island” branding strategy carried out during the postwar period by the island’s visitor bureau.\(^6^0\)

Lafitte’s expulsion marked the beginning of Galveston’s ascension in the economic hierarchy of Texas and the nation. The crude port developed by the pirates soon became the state’s largest.\(^6^1\) The deep-water channels scoured into the marine landscape by the outflow from the Trinity and San Jacinto Rivers – and the well-protected estuary enclosed by the island – gave the region a natural advantage over others along the Gulf Coast. By the start of the Civil War, the Port of Galveston became the planet’s largest cotton-shipping depot and the nation’s second-busiest immigration portal.\(^6^2\) In the antebellum period, what would later become the U.S. Army Corps of Engineers (USACE) initiated a period of massive infrastructural investment in and around Galveston. Their work ranged from small, bulkhead and groin development along the shore to massive feats of engineering aimed at beating back and controlling the sea. Three of their projects conspired to entirely and irrevocably reorganize the geomorphology of Galveston: the North and South Jetties along the mouth of the Houston Ship Channel, the great grade-raising and seawall construction, and the jetty field


development along the seaside of the island. Their construction marked the physical and metaphorical onset of the Anthropocene in Galveston. The changes they wrought – and the landscapes they destroyed – would spark a century of redevelopment aimed at conserving what remained and recovering what was lost.

The North and South Jetties

In 1874, the USACE proposed building the North and South Jetties at the mouth of the Houston Ship Channel. Their purpose was instrumental: to preserve and enhance the navigability of the channel in order to bring reliability and opportunities for growth to the burgeoning freight industry in Galveston.63

Protruding thirty-four thousand feet into the Gulf of Mexico, the North and South Jetties were the largest such structures on the planet when completed in 1892.64

The jetties functioned by disrupting the coast's littoral drift and diverting sediment away from the channel and towards other areas of the Galveston region. Sediment being pushed through the channel by the prevailing drift of the Trinity and San Jacinto Rivers would be accelerated through the pass and deposited farther out to sea. The same material that once moved and spread

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evenly along the island’s coast was also altered – creating areas of accretion and erosion that were novel and unexpected.

They were envisioned by the Army as instruments of economic development – a mechanism for limiting the frequency and intensity of dredging operations in the Houston Ship Channel. Without them, the USACE feared that frequent disruptions to the flow of freight ships in and out of the port would limit the growth potential of the region and, potentially, drive some of that traffic to other locations along the Gulf.\textsuperscript{65}

By that measure, the North and South Jetties were a success. Dredging operations moved from a quarterly endeavor to an annual exercise. This allowed the Galveston region to industrialize and urbanize at a rapid pace as its ports and industrial facilities expanded with the Houston Ship Channel. But the sediment that those jetties displaced had to settle somewhere. It turned out that the East End neighborhood of Galveston would be that somewhere.

Behind the South Jetty, sediment that was once distributed evenly along the island began to accumulate in large volumes on what became East Beach.\textsuperscript{66} This began to alter the shape and stability of the region. The eastern third of Galveston Island grew – rapidly in places – as the western third became sand-


\textsuperscript{66} K. Benson. “Implications of Gulf Coast dynamics for coastline building strategies.” \textit{Galveston Historical Foundation and University of Texas Medical Branch Resilience Conference}, Galveston, TX: October 9, 2014.
starved and began to shrink. This is because this part of the Texas coast is continuously scoured by near shore effects like littoral drift and by the global currents that help transport sediment across the planet. Once the jetties were built and the steady supply of sand and gravel to western Galveston became disrupted, there was nothing left to counteract that scouring. “Any project that gets built in the catchment zone like that…which is probably two or three miles in Galveston…there are winners and losers in terms of where the sediment goes. The East End [neighborhood] won as a result of the jetties and the West End [neighborhood] lost. Big time.”

This effect might have proved minor if not for a subsequent series of municipal development decisions that induced new housing developing in the island’s West End. But for much of the twentieth century, Galveston’s city council invested in infrastructure extensions that helped guide development into its eroding extents and away from the stable and growing portions of the island. Eager to establish a lucrative, vacation home presence on the island, the city’s political class helped create a luxury enclave in Galveston – and they did so in an area rendered highly vulnerable to flooding and storm surge by the North and South Jetties.

The impact of the jetties may have also been less pronounced had Galveston’s experimentation with coastal engineering ended with their

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construction. The problems it created were serious but manageable for the region. But when they were compounded with a massive barrier system developed during the early twentieth century, the jetties – and other works of coastal engineering – ensured Galveston’s vulnerability.

_The Seawall, Grade-Raising, and the Great Storm of 1900_

On August 20, 1900, a massive hurricane swept across the region. The storm ravaged the island and bay communities around Galveston, killing at least eight-thousand residents en route to becoming the deadliest tropical storm in American history. It razed the ramshackle houses and bungalows scattered across the Galveston coast, and it severely damaged the port and industrial facilities rimming the bay. Galveston’s economy was premised upon a proximity to the water. Ports and industrial facilities could not operate without physical access to the water, beaches could not attract vacation-goers without an oceanfront, and residents working in the region’s industrial and tourism sectors could not live outside of the surge zone. The 1900 Storm laid bare these vulnerabilities.

Though other storms in other places occupy much of the literature and nearly all of the public’s imagination on the topic, the sheer scale and scope of Galveston’s destruction remains unmatched in the American experience. Much
of the storm’s destructive capacity is derived from the era in which it struck. Homes built before the storm were not designed to withstand hurricane force winds nor twenty feet of surge. There were no early warning systems and no official evacuation plans. Most importantly, there were no flood-gates or barriers. All that lay between the homes of Galveston Island the surge were a low-lying dune and a row of salt cedar trees. A century into the island’s development, little had been done to adapt the coast to its growing population of residents and businesses. Galveston remained a fluid component of the Texas Barrier Island Complex – designed to be reshaped by the tides and to be over-washed and relocated by tropical storms. The natural defenses of the island were not built to protect a community of fifty-thousand residents. In the aftermath of the 1900 storm, Galvestonians dedicated themselves to redesigning their coastal defenses for that singular purpose.

Their work was hastened by the need to project stability and calm to the industrial and touristic economic pillars driving the city’s growth. Prior to the storm, port operators had begun to slowly drift northward, establishing new facilities near what would become Texas City, League City, Kemah, and Houston. Their purpose at the time was to support the freight operators’ primary terminal in Galveston, but they also served as a hedge against over-crowding and disruption at the hub.

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After the storm, those operators began to shift more of their volume northward, abandoning the Galveston Port en masse to seek shelter in the more protected ports of Galveston’s West Bay.\footnote{Anonymous. “Galveston one of pioneer manufacturing centers of state before 1900.” \textit{Galveston Daily News}, April 11, 1942. ; Anonymous. “Natural advantages, man-made improvements make great port.” \textit{Galveston Daily News}, April 11, 1942.} City officials also had to contend with public concern over the vulnerability of the region to future storms. In order to quell a growing public fear about the viability of the island, Galveston’s civic leaders framed the 1900 storm as an act of god – a brutal and rare event, rather than the natural outcome of life on a barrier island in the Gulf of Mexico.\footnote{T. Steinberg. 2006. \textit{Acts of God: The Unnatural History of Natural Disasters in America}. Oxford: Oxford University Press.}

To project a calmness and to frame the disaster as a one-off episode, city officials did two things. First, the island’s public officials embarked on a propaganda campaign aimed at projecting an image of rapid recovery and resilience in Galveston. The local Chamber of Commerce and the island’s Visitors Bureau produced pamphlets, newspaper advertisements, and other marketing materials to this end.\footnote{See image appendix.} This proved to be a relatively simple task.

Then, they lobbied the federal government for investments in new protective infrastructure along the coast. The key components of their plan involved building a seawall along the southern edge of Galveston Island and then...
raising all of the homes, infrastructure, and other structures behind it to a safer elevation. This proved to be a more complex endeavor.

The process for raising the island required engineers to construct a patchwork of dikes and canals. Engineers began by enclosing a quarter-mile square section of land with temporary dikes. Next, they would dredge a canal from that section to the primary depot for fill material along the east end of the island – which was often up to two-and-a-half miles away. Then, the physical infrastructure and buildings would be hydraulically lifted and remain suspended in the air for months at a time. Finally, the fill material would flood into the diked-off section of land. When it settled and dried out, new building foundations were constructed on top of it.

The work was excruciatingly slow – this process would repeat until mid-1911, when the last homes were lowered back to the newly-raised ground. In all, more than sixteen million cubic yards of sand were piled atop Galveston. In places, the dredge-and-fill operation doubled the island’s existing elevation, leading some to exclaim that “a new Galveston had been constructed upon the old one.”

As laborers raised the inland elevation of Galveston, those working along the beach were constructing its primary defensive mechanism: a 17’ foot concrete seawall. Where salt cedars and undulating dunes once stood, a stark, imposing wall began to take shape. The initial section of the wall – completed 1911 – stretched from Stewart Beach to 14th Street, armoring the East End neighborhood where most of the islanders resided.

The seawall’s first test came in 1915 when a category three hurricane roared through the region. Though much of Galveston Bay experienced significant damage from the storm, the island’s residents emerged relatively unscathed. The seawall had worked as advertised and, in doing so, it began to establish a cultish following. The *Galveston Daily News, Texas Monthly* magazine, and a number of other local and state publications became filled with stories, op-eds, and letters to the editor extolling the virtues of the wall – and calling on Galveston’s civic leaders to extend it across the rest of the island. Many of those who helped build the wall had also lived through the 1900 and 1915 storms – and they became quick converts to the religion of coastal grey infrastructure.

As a result of the seawall’s performance, city officials called for a westward extension of the wall to 45th Street. Construction began in 1916.\(^\text{78}\) By 1922, city officials managed to extend the wall even further, stretching the barrier

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all the way to 61st Street – which protected nearly all of the island's permanent residents at the time.

Plans were made to extend the seawall all the way to 103rd Street, where it terminates today.79 Between 1925 and 165, five major hurricanes made landfall in Galveston. A dozen minor storms struck too. None breached the seawall. None flooded the neighborhoods directly behind it. Over time, the seawall became a symbol on the island – a symbol of strength and progress, a symbol of stability, and a symbol of conquest. Nature could not override the ingenuity of the islanders. Nor could it thwart Galveston's booming tourism and industrial economies.

Soon, the island’s promotional materials began to feature the seawall – framing it as both a protective mechanism and a spectacle to be experienced by beach-goers along the Gulf.80 The seawall adorned brochures and postcards, and it inspired new public works that were carried out in other locations across the country by the USACE.81 By the start of the postwar period’s suburbanization, Galveston had begun branding as “The Atlantic City of the South, “Treasure

Island”, and “Nature’s Resort” – a tranquil, paradisiacal environment in harmony with the sea.\textsuperscript{82}

But quietly and without much public attention, the seawall began to reshape the ecology and geomorphology of Galveston. The wide, low-lying beaches that once characterized its coast were replaced by much narrower ones along the east end of the seawall. They disappeared entirely from the western end of the seawall. The wall created a scouring effect which, when combined with the shift in sediment deposition introduced by the North and South Jetties, slowly dissolved most of Galveston’s idyllic beachfront.

The only area to benefit – in terms of accruing new land area as a result of the projects’ ecological disruption – was the East Beach public park near the mouth of the ship channel. Remote and uninhabited, it grew wide and established dunes as the rest of the island’s beaches disappeared.

This did not stop the city’s civic leaders from investing heavily in new infrastructure and commercial development along the seawall. New hotels, souvenir shops, restaurants, and tourist traps colonized the area – a welcome sight at the time as Galveston sought to revitalize its tourism industry and shed its reputation as a storm-ravaged, island outpost. The island simply could not survive without such patronage – not at a time when its port facilities were migrating northward and its role in the global shipping industry diminishing.

\textsuperscript{82} See image appendix.
Like many other tourism-driven cities, Galveston’s permanent residents grew poorer as its industrial facilities relocated and were replaced by low-paying retail and service-oriented businesses. In addition to this physical exposure to flood risk that the seawall, grade-raising, and jetty projects produced, they also contributed to the social vulnerability of islanders – a product of rising poverty rates during Galveston’s deindustrialization period, but also of a spatial reorganization that shuffled many of the its poorest residents into areas unprotected by the seawall. In fact, many of those newly low-income neighborhoods were actually harmed by the seawall – coastal engineers now know that many of the flooding issues on the bayside of Galveston Island are a result of the seawall deflecting wave energy away from the beachfront and towards those homes.

The island’s wealthy vacation homeowners in the West End had a different experience. Though their flood risk did increase, the homeowners there were able to successfully lobby the city for a subsidy to help raise their homes using pilings by as much as 18’. By the end of the 20th century, the West End had become the center of political power in Galveston. As its property owners association, West Galveston Island POA, is fond of saying, the neighborhood’s property taxes makeup 40% of the municipal budget. The West End gets what the West End wants.

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With the performative value of the seawall firmly entrenched in the minds of Galveston’s residents, the city’s civic leaders began to look for ways to counteract the slow dissolution of their beachfront. Rather than recognizing the role that the jetties and seawall played in creating that problem, they decided to double-down on their investment in coastal grey infrastructure. They decided to build a jetty field across the length of Galveston Island.

The Jetty Field and Reverse Engineering the Coast

The Galveston jetty field – an array of sixteen groins and jetties, each around 1,500’ in length – was conceived during the 1960s by the USACE as an instrument of shoreline stabilization. Though the Corp’s documents did not frame it this way, the jetty field was developed to counteract the effects of the other major coastal engineering projects in Galveston. They were built to restore the beachfront the North and South Jetties and the seawall dissolved.85

There are parallels in the biological world to this approach – and the unexpected consequences that often ensue. The mongoose – a carnivorous mammal endemic to the Indian subcontinent – was often brought into Western nations during the 19th century as a way to control local snake and rat populations. Though it occasionally did this, the mongoose ate many other species too. In Hawaii, the mongoose feasted on rare birds and lizards – pushing dozens to the brink of extinction. The voracious mammal is often seen as a

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marker of globalization – an invasive species distributed throughout the world by colonists which has, in the decades since, completely changed local ecosystems.\textsuperscript{86}

Though the effects of the jetty field were not this dramatic, they too wrought unintended consequences on Galveston. The island’s shoreline erosion slowed, but did not stop as a result of their construction.\textsuperscript{87} Because the Corps could not build a jetty field across the entirety of the Texas coast, the project also created downstream sediment depositions like the North and South Jetty. By halting their construction at 61\textsuperscript{st} street, the Corps ensured that the West End’s erosion issues would not be addressed by this project – in fact, they were exacerbated.\textsuperscript{88}

But the ecological debt of these projects would go unnoticed – and unpaid – for the rest of the 20\textsuperscript{th} century. In building the North and South Jetties, the seawall and grade-raising, and the jetty field, the USACE and Galveston’s civic leaders reshaped and fortified the island’s coast in ways that projected a performative value for grey infrastructure and a frivolity to its nature-based and green infrastructural analogs. The seawall become a symbol of the island itself – diminishing its importance or breaking from its precedence would be to diminish

or break from what it meant to be a Galvestonian. The obdurateness of its legacy on the island cannot be overlooked.

**Fortifying the Norfolk Coast**

Nearly two hundred miles southeast of the nation’s capital, Norfolk sprawls across the alluvial plain endemic to coastal Virginia. Unlike the relatively linear coast of Texas, Virginia’s coast is crenulated and complex, carved up by the myriad rivers slicing through the landscape. Norfolk sits at the center of the state’s Hampton Roads region – a constellation of small-to-medium coastal communities strewn along the waterfront of its many inlets, bays, and sounds. This includes the communities of Hampton and Newport News to the North, Virginia Beach to the East, Chesapeake to the South, and Suffolk to the West. Norfolk is also rimmed by water. Chesapeake Bay, the nation’s largest estuary and home to a global marine fishery, lines the northern shore of Norfolk. The James and Elizabeth Rivers help to define its western edge. Though it is low-lying and prone to flooding, Norfolk is relatively unexposed to the surge risk facing Galveston and New York. This is due to the protected position of the city – the Atlantic Ocean is buffered by Virginia Beach before reaching Norfolk. As a result of that favorable position, Norfolk is home to the largest ship-building port

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in the world and the fourteenth-largest overall port by volume in the US.\footnote{Bureau of Transportation Statistics. “Tonnage of Top 50 US Water Ports, Ranked by Total Tons.” Available at: \url{http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_o1_5_7.html}.} It is one of the planet’s most important hubs for shipping – freight, military, or otherwise.

With nearly a quarter-million residents, Norfolk city is one of coastal Virginia’s largest cities. Most of those residents work in one of the city’s two major employment centers: the Port of Virginia and the Norfolk Naval Station. Unlike Galveston – which saw its industrial and tourism sectors rise in equal measure – or New York – whose FIRE industries quickly surpassed its manufacturing base – Norfolk never grew another pillar in its local economy. Both port facilities are clustered along the western edge of the city, where deep-water channels scoured by the James and Elizabeth Rivers link to Chesapeake Bay.\footnote{C. Hein, G. Fitzsimons, D. Fitzgerald, and A. Fallon. 2016. “Records of migration and ebb-delta breaching at historic and ancient tidal inlets along a river-fed paraglacial barrier island.” \textit{Journal of Coastal Research}, SI 75: 228-232.; M. Fincham. 2011. “Channeling the Chesapeake: In search of ancient estuaries.” \textit{Chesapeake Quarterly}, 10(1).} This is also the least-exposed area of Norfolk – it is both protected from open water by the mainland and atop a small topographical protrusion. Beyond the dense, militarized cluster of the ports, the rest of the city sprawls rather evenly across a low-lying coastal plain. There, the average elevation is about seven feet above sea level. Most of Norfolk’s residents work in the shipping and logistics industry, or in the retail sector that services them.\footnote{V. Agarwal. 2015. “State of the region report.” \textit{Old Dominion University Economic Forecasting Project}. Available at: \url{https://www.odu.edu/content/dam/odu/offices/economic-forecasting-project/docs/2015/2015-state-of-the-region.pdf}.} The combination of low-lying
housing and high-levels of employment in low-wage jobs leaves Norfolk highly vulnerable to sea level rise and climate change. Ameliorating that condition would require not only a physical transformation of Norfolk’s landscape, it would require a socio-economic transformation as well. But as in Galveston, the shipping industry and naval operations require proximity to the sea. The social and biophysical vulnerability of Norfolk is likely to persist as the conditions of the Anthropocene worsen.

Norfolk’s evolution from a flood-prone, non-descript settlement along the coastal plain of Virginia to a global center for ship-building, military operations, and freight movement differs from the experience of Galveston. There were no shock events like the Great Storm of 1900 to catalyze Norfolk’s planners and engineers. Rather, the city – like many others along the Mid-Atlantic – grew up around its port. As it expanded, so did Norfolk. Along with that growth in port capacity came a halting, inexorable growth in coastal grey infrastructure. Bulkheads and breakwaters pervaded the city’s landscape in lieu of seawalls and levees, but the end result was the same: a city left highly exposed to sea level rise and with few, if any, good options for adapting to a wetter future.

The Ecological and Cultural Context of Norfolk

Across a geologic time scale, coastal plains like the Hampton Roads region are the product of three geomorphological events. The first requires receding sea levels. Over the last two million years, oscillations in glacial mass have triggered eustatic or global shifts in sea level. As glacial mass shrinks, sea levels rise. As
glacial mass grows, sea levels shrink. During periods of glacial mass growth and sea level recession, the Virginia coast extended into the Atlantic Ocean. This helped to trigger the second geomorphological event that shaped Norfolk: shifts in the channels of the James and Elizabeth Rivers. As the tail-waters of these rivers were forced to migrate eastward towards Virginia’s new shoreline, their flow rates would slow and their channels would fill with sediment. When that deposition reached a critical threshold, the rivers would shift towards a path of least resistance, carve new channels in the landscape, and begin depositing sediment elsewhere. This process repeated for millennia, increasing the complexity of the region’s coast while smoothing over its topographical profile. This set the stage for the third geomorphological event to take place: a gradual rise in sea levels as global glacial mass began to shrink. As the Virginia coast slowly submerged, the channels cut over prior eras of land-building became the tail-waters for the James and Elizabeth Rivers and, as a result, the edge between Norfolk and the sea. This resulted in a low-lying coastal plain with little topographical variation. Put another way, this process of shifting sea levels and oscillation rivers created a rather start, featureless plain rising ever so slightly out of the sea. Though it shares characteristics with Galveston in terms of exposure, it differs from the barrier island in an important way. The complexity of Virginia’s

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coast means that a large, linear system of protection is not possible there – at least not without creating a massive dead zone akin to Holland’s. 96 Such a plan is a non-starter in the nation’s largest estuary and most robust fishery. But the region’s landmass would be – and still is – slowly consumed by rising seas over the last twenty-thousand years. Norfolk was created to be submerged.

The scouring effect of the James and Elizabeth Rivers also created a network of deep channels in and around Norfolk. This created a tremendous natural advantage for the city. Already buffered by the more exposed regions of the Virginia coast, the deepwater channels connecting Norfolk to the Atlantic Ocean made it an early and critical hub in the global trade network. British colonial settlers discovered this ecological asset during an expedition in the early seventeenth century. Led by Christopher Newport and Sir George Yeardly, the colonists began establishing the port network in Hampton Roads as early as 1607. 97 Like Laffite and his privateers in Galveston, Newport and Yeardly’s men quickly clashed with members of the indigenous Chesapeake tribe. Unlike their swashbuckling counterparts, the British colonists forced the tribe to sell their land rather than aiming corsairs at them. 98 Though this freed the colonists of conflict, it did not initiate the sort of rapid growth in Norfolk that one might expect. The

colony of Virginia’s bankruptcy in 1624 and the Revolutionary War suppressed
the port city’s potential for much of the seventeenth and eighteenth century. But
the region’s natural advantage would not be squandered under American control.

By the late-nineteenth century, the economic potential deep-water
channels and protected harbors of Norfolk and Hampton Roads were finally
being exploited. Innovations in shipping technology – including the advent of
steam-power – enabled merchants to use larger ships carrying heavier freight
loads across the globe. This required deeper channels and ports, rendering
many of the smaller, shallower, and more exposed locations along the east coast
obsolete as the shipping industry modernized. What had been a relatively small
and un-profitable hub during colonial rule was now growing into a major logistical
node. As the shipping industry revolutionized, the city’s port network
consolidated, with the larger, heavier ships shifting towards deep-water ports like
Norfolk.99 This, in turn, created a population expansion in Hampton Roads as
people poured into the region to work in the booming freight industry.100 This led
to a massive investment in grey infrastructure – to harden the port, to facilitate
inter-modal freight transfers through new rail lines and roadways, and to develop
the city’s landscape in order to house its new workforce. Slower than the
processes that reconfigured Galveston, the gradual spread of coastal grey

Portsmouth-Newport News shipbuilding district.” Washington, DC: US Department of Labor, Bureau of
100 Norfolk Southern Corporation. “A Line in Time: The NS Story.” Available at:
infrastructure proved similarly transformative in Norfolk. The region’s soft, featureless coast became a hardened, urbanized landscape. Norfolk was always going to succumb to rising seas. Only now, that submersion would place hundreds of thousands of people and trillions of dollars at risk.

*The Port of Virginia and the US Navy*

The economic potential of Norfolk's port induced local, state, and federal lawmakers to direct massive investments in grey coastal infrastructure to the region. Later named the Port of Virginia, Norfolk’s deep-water harbor became the foundation on which the Hampton Roads region would be built. Its depth and well-protected position provided Norfolk with a natural advantage over most other east coast cities.

But the ports of New York, Philadelphia, Savannah, and others along the East Coast were similarly endowed. What set Norfolk apart – and allows it to remain globally competitive to this day – was the migration of the nation's capital from Philadelphia to Washington, DC in 1790. The Hampton Roads Region – and Norfolk's port in particular – represented the lone waterborne passage to DC and thus became a critical national security outpost during the 19th and 20th centuries. Unlike Galveston, where commercial interests were the sole driver of urban development, the growth of Norfolk centered on both its port’s economic values and the region’s military significance.
As the nation’s center of political gravity shifted to DC, civic leaders in Norfolk capitalized on their strategic position investing in its first wave of major port upgrades and expansion They built bulkheads, logistics and storage facilities, and began developing one of the first multi-modal freight hubs in the U.S. Though Norfolk’s coastal position came with a set of major economic advantages, engineers working on the city’s port plans came to view its complex, crenulated shore as a liability. Nearly all of their infrastructural proposals for the port involved hardening and stabilizing the shore – removing the dynamism and volatility that once characterized it so that, like Galveston, the region’s commercial interests could grow uninterrupted.

Beyond the shoreline, Norfolk’s deep-water channels traversing the Chesapeake were also dredged wider and deeper. Much of this was driven by the revolution in steam ship-engine technology during the Industrial Revolution. It led to larger, heavier ships carrying higher volumes of goods – all of which required upgrades in port facilities to accommodate. Most American ports grew in response to the steam engine – few grew as quickly as Norfolk’s.

By the end of the 19th century, the city’s port was a key hub in the nation’s global trade network. The growth of its port brought tens of thousands of blue collar jobs to Norfolk which, in turn, instigated the slow, outward sprawl of low-

density housing across the regional landscape. Until the start of World War II, the
growth of the port and the sprawl of the city happened slowly and through
relatively minor projects. Until then there were no major works of engineering to
spur Norfolk on. That all changed in 1914 as World War I erupted in Europe.

The city’s industrialized waterfront, high-volume and modern port facilities,
and proximity to both the nation’s capital and the European theater made it an
ideal location for Naval shipbuilding. Federal officials directed billions of dollars to
the city in the run-up to – and throughout – the Great War. Though Norfolk is
now synonymous with shipbuilding, the industry – like many other mass
manufacturing processes developed during World Wars I and II – essentially
grew from scratch and for the sole purpose of defeating the Central, and then
Axis, Powers.

Norfolk’s Naval operations grew slowly during the 1920s and 30s. But it
received another massive federal investment during the ramp up to World War II.
By the time the U.S. emerged victorious from the conflict, the city’s port had
become the global hub for shipbuilding. That strength – coupled with its close
proximity to D.C. – played a key role in the establishment of Norfolk’s Naval

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Baltimore: Johns Hopkins University Press.
Station and its 1952 designation as the center for NATO’s Allied Command Atlantic – a provision of the North Atlantic Treaty Organization’s charter.\textsuperscript{103}

The designation of Norfolk as a military outpost of international significance marked the start of what would become a decades-long conflict between the federal and naval planners, port operators, and the city’s public officials. As the port and the city’s military significance grew, tens of thousands of new residents moved to Norfolk during the postwar suburban boom. This placed incredible pressure on the city, which had to keep land development regulations relatively lax to compete for growth in the Hampton Roads region.

The resulting sprawl created a myriad of issues for Norfolk, but the most vexing proved to be the strain it placed on the city’s stormwater management system. With its shoreline hardened and its rivers channelized, those pipes became the only vehicle for moving water through the city’s low-density landscape and out to sea. Because Norfolk’s mean elevation is less than ten feet and its average gradient or slope is around two percent, it became very difficult to capture and convey all of the new runoff created by sprawl.

During the 1970s, the city commissioned Wallace, McHarg, Robers, and Todd (WMRT) to develop a new comprehensive plan – and part of their charge involved addressing the increasingly frequent flooding that came when the

drainage system backed-up. Though little came of that plan, some of WMRT’s maps proved particularly prescient. They identified areas that could expect to experience a higher frequency of flooding in the future. Nearly all of those neighborhoods flood regularly today. Some, including Ghent and The Hague, are historic districts considered vital to the city’s architectural character.

But like the slow creep of sea level rise, the fortification of Norfolk’s coast took place so slowly and subtly that, by the time the public noticed, it was too late to reverse its effects. The legacy of Norfolk’s port and militarization is akin to that of Galveston’s: the commercially driven tenets of stability and predictability supplanted the ecological values of dynamism and evolution along the coast. Though they followed different paths, the coasts of Norfolk and Galveston both become coastlines during the 20th century. Each has been trying to figure out how to live with that burden ever since.

**Holland in New York**

New York is a territory of confluence. It is where the Hudson and East Rivers meet the brackish waters of Long Island Sound, Newark Bay, Jamaica Bay, and the Atlantic Ocean. There, a massive, tidally driven estuarial system cuts through the coastal landscape, encircling Manhattan, the outer boroughs, and the myriad small islands characterizing the region. Unlike Norfolk – which has a mean city elevation of seven feet – or Galveston – which is directly exposed to the Gulf of

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104 See image appendix.
Mexico – New York is in a relatively protected position. Prior to colonization, Manhattan and its surroundings were a vibrant, verdant landscape of oyster beds, marshlands, and soft coastal edges. Though that ecology vanished more than a century ago, city officials and designers continue to long for its restoration.

Buffered by Long Island, Staten Island, and the deep-water harbor behind them, the city experiences neither the tidally driven flooding of Norfolk nor the frequent tropical storm events of Galveston. Yet, New York remains at the center of the climate change conversation in popular and design culture.\(^{105}\) Part of its centrality to the discourse around climate change is a function of New York’s primacy in other sectors: namely the finance, insurance, and real estate (FIRE) industries that made it into a global financial capital.\(^{106}\) The wealth generated by these sectors contributes to an exceptionally sophisticated planning culture in New York, where the resource constraints that often undermine the profession in other cities are far less restrictive.

It is also due, in part, to New York’s role as the cultural capital of the nation. It has been – and remains – a hub for immigrants and young professionals alike, each of whom continually refresh the city in ways not found in


other post-industrial regions. More recently, the city’s experience with Superstorm Sandy triggered a renewed focus on the coastal vulnerability of New York.

Since 2009, New York has been the focus of at least three sea level rise-related design competitions or exhibitions: On the Water, Rising Currents, and Rebuild by Design. Though their products varied in mission and method, they each sought to restore a nostalgic vision of New York to the present day. But ecologically, the city no longer resembles the robust, verdant territory described in *Manhatta*.

It shares traits with Norfolk, Savannah, and other port cities that hardened and grew as freight interests drove urbanization. The city’s wealth – spurred on by an agglomeration economy drive by the FIRE industries – induced a cluster of highly valuable development in southern Manhattan. There, Wall Street’s firms form the economic center of New York.

But outside of Manhattan, the boroughs of Queens, Staten Island, Brooklyn, and The Bronx remain have been largely overlooked. The Financial District received the majority of the city’s 9/11 and Superstorm Sandy disaster

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appropriations. This is, at least in part, a result of Manhattan’s perception as quintessential New York City and the outer boroughs’ perception as other, less important places. As walls went up around lower Manhattan, dunes and wetlands were conserved and restored in Queens and Brooklyn – a literal manifestation of the nature-culture dialectic at the core of Western environmental thought. Like Norfolk, New York City arrived at that point through a gradual – though far greater – expansion of its port and development pattern.

The Ecological and Cultural Context of New York

New York is composed of Manhattan Island, Staten Island, Long Island, and more than thirty other small islands – some occupied, some not – along the shore. Its metropolitan footprint extends into New Jersey and Connecticut. Those islands provide a buffering service to Manhattan, attenuating wave action and, in the event of a coastal storm, suppressing surge risk for the region’s financial center.

As in Galveston and Norfolk, New York is part of a dynamic marine ecosystem. The Hudson and East Rivers carry sediment and runoffs from the Adirondack Mountains into the estuarial harbor that surrounds the city. There, a network of deep-water channels, inlets, and sounds are refreshed by one of the
largest tidal prisms in the nation – the volume of fresh and saltwater exchanged during high and low tide events.111

Unlike Galveston and Norfolk, New York sits upon a hardened bedrock of Schist, Marble, and Gneiss formations. Without the magnitude of erosion found in those cities, New York’s shore remains relatively stable, even across a geological timescale. But they do share some geologic commonalities.

During periods of high glacial mass and sea level retreat, the Hudson and East Rivers extended hundreds of miles east. Sediment accumulating in their tailwaters forced the rivers to shift course, carving a complex network of deep channels in the process. As sea levels rebounded during the latest period of glacial mass shrinkage, the New York coast – and Manhattan in particular – became the beneficiary of that riverine scouring. In this, Norfolk and New York City share similar geomorphologies.

But it was the combination of those marine assets with New York’s firm bedrock that distinguished it from other locations along the Atlantic Coast. The region’s relatively stable coast provided Dutch colonists with a tremendous natural advantage – the ability to construct and intensify their port in ways that

would never be possible on a sand spit like Galveston or loamy coastal plain like Norfolk.

When Henry Hudson and his crew of Dutch and English sailors stumbled upon Manhattan during voyage to China in 1609, they recognized the tremendous advantage New York’s stability and assets could provide. The robust marine ecology, deep and well-protected harbor, and, of all things, the robust beaver population convinced Hudson to settle in and fortify the region.

For much of the 17th century, the colonists organized Manhattan around the fur trade. The mammals’ pelts were incredibly popular in Europe and provided Hollands’ colonists with all the incentive they would need to settle Manhattan. But the also trafficked in slavery, bringing African captives to the island to build the homes and infrastructure necessary to house the settlers. The colony also became an important node in Holland’s slave trade network and physical conflicts between the slaves and their owners became a frequent occurrence. Crude fortifications along the coast enabled Hudson’s men to trade pelts with the French and English. Their small settlement – known as New Amsterdam – remains preserved through sporadic quirks in the gridded

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streetscape of the Financial District, especially Beaver and Pearl Street.\textsuperscript{116} Hudson’s accidental discovery of Manhattan in 1609 marked the beginning of New York’s rise to the pole position of global trade and commerce.

By the middle of the 17\textsuperscript{th} century, New Amsterdam had become a critical part of the Dutch West India Company – though it proved to be one of Holland’s worst investments. The fur trade simply was not enough to sustain the high cost of developing and fortifying Manhattan. This left it exposed to capture by the British military, who were also in search of a trading outpost along the Northern Atlantic to enrich their empire – a feat their army accomplished rather easily in 1664.\textsuperscript{117}

Renamed for the Duke of York, the British colony of New York received significant upgrades throughout the 18\textsuperscript{th} century. Walls, bulkheads, and other port and militaristic infrastructure fortified the city, leading New York to become the continental headquarters for Britain’s military. In 1763, the military invoked the Navigation Acts in New York regional tensions mounted between the British, French, and colonists – a colonial decree forcing Manhattan to funnel all of its trade through England and to invest all of its revenue from the port in a massive new coastal defense system.. By the time the French-Indian War and the


Revolutionary war conspired to wrest New York City from their empire and give it to the Americans, the island was a literal fortress.¹¹⁸

New York’s hardened coastline made it an ideal location for the new nation to invest in a port. Like Norfolk, the benefits of that investment would be immediate and immense – New York became a global capital for trade and wealth during the 19th and 20th centuries. But it came at a high, delayed cost in the form of ecosystem denudation and the slow but total erasure of the region’s natural floodplain functions.

The Port of New York and the Wild Outer Boroughs

As the nation’s military conflicts with Europe subsided over the course of the nineteenth century, Manhattan’s port benefitted from the massive British and American investments in coastal upgrades and fortification that military action induced. The steam revolution in shipping created faster, heavier ships that required deeper, better-protected ports. Few were as well positioned as New York to capitalize on that revolution.

As in Norfolk, this triggered a slow, inexorable spread of grey infrastructure along the coast and new urban development behind it. Both World Wars also contributed to the growth of its port, though its exports included tanks and arms rather than naval fleets. The incredible manufacturing and shipping capacity that wartime created in New York’s ports helped to ensure its

importance throughout the rest of 20th century. Indeed, the port of New York and New Jersey remains the third-largest such facility by tonnage in the nation.\footnote{Bureau of Transportation Statistics. “Tonnage of Top 50 US Water Ports, Ranked by Total Tons.” Available at: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_o1_5_7.html.}

The regional scope of the port grew as New York’s population spread into the hinterland. But the walls, bulkheads, and revetments deployed around Manhattan’s major economic assets were mostly absent in the outer boroughs. There – in Queens and Brooklyn, on Staten Island and in The Bronx – the city’s bedroom communities received little attention or investment from civic leaders. But their marine ecology – including the fisheries and beachfronts upon which many of those outer borough communities relied – suffered all the same. The benefits of port expansion and urban development tended to accumulate in Manhattan. The costs were borne elsewhere, in the outer boroughs.

This all left the majority of New York City highly exposed to storm events like Sandy. Hurricanes Carole (1954), Agnes (1972), Bob (1991) and Irene (2011) all dealt significant damage to the outer boroughs of New York – and left Manhattan relatively unscathed. Unlike Galveston, no great seawalls or island-wide grade-raising projects followed on from those storms. A few portions of Staten Island, Brooklyn, and Queens received small floodwalls, levees, and bulkheads, but no major surge barrier plans were ever seriously considered in New York City. As long as the damage and the risk was relegated to the outer
boroughs, the city’s leaders felt no imperative to invest in coastal resilience projects. Their only concern along the coast involved finding ways to preserve and enhance the port’s capacity and to turn its waterfront into a site for luxury condos and boutiques.

For much of the 20th century, New York’s greatest flood events came from two different sources: winter N’oreasters and spring thunderstorms. The former certainly involved the coast, with much of its damage coming as a result of wind and tide-driven flooding issues. But the city never developed a design response to the flood risk those storms posed. It would take a direct hit from Superstorm Sandy to turn their focus towards the city’s coast.

Living with an Engineered Coast

This chapter lays bare the legacies – and burdens – borne by coastal cities transformed over the last two centuries by investments in grey infrastructure. From the experiences of Galveston, Norfolk, and New York, three particular legacies stand out. The first is that, despite that multitude of pathways or options available for developing the coast, in the U.S. nearly all of them lead to approximately the same place: cities that are poorly prepared for the challenges posed by sea level rise and climate change. Galveston’s 20th century civic leaders built a massive seawall and raised the grade of the entire island by nearly a dozen feet. Though better positioned to deal with flood risk than some communities along the Gulf Coast, it is still not well positioned to do so. Norfolk’s and New York’s
founders made more modest and sustained investments in bulkheads, levees, and other forms of coastal grey infrastructure, often to help fortify and militarize their cities. Yet they too are ill-prepared for a future of rising seas and more powerful storms.

As one of the marine scientists I interviewed over the course of my fieldwork said at the opening of this chapter, these decisions – the walls, bulkheads, and levees – are 100-year decisions. In Galveston, Norfolk, and New York City – and indeed across much of the American coast – those decisions radically transformed those territories, creating coastlines where once there were only coasts. The next generation of infrastructural investment in the coast will be similarly transformative. The only question now is whether it will reinforce or dismantle the 20\(^{th}\) century’s attempts at stabilizing the coast.

The second legacy is that experience disaster and exposure to flood risk are crucial elements in understanding how and why the leaders of coastal cities plan and develop the ways that they do. As I posited in chapter one of this dissertation, we should expect to see significant yet varied investments in coastal resilience in cities according to their place in the exposure-experience matrix.

A high-exposure, high-experience city like Galveston is precisely the sort of place where we should expect to find massive investments in
large, structural protections. New York City, which measured out as high-exposure, moderate-experience, and Norfolk, which came in as high-exposure, low-experience, are precisely the kinds of places where we should expect to see less extensive investments in protective infrastructure. This chapter discussed that phenomenon from an historical perspective. Chapters three and four engage in it through political and contemporary design lenses.

The final legacy of considerable durability discussed in this chapter is a product of longing – or, more precisely, the long-held desire of local leaders and coastal designers to restore and recover landscapes lost to the urbanization and fortification of the 19th and 20th centuries. Memory and nostalgia are powerful forces in American landscape planning. They contribute to a system of planning and design in which a desire for the verdant outweighs the need for the functional – one in which adorning the coast with golden beaches, thriving oyster beds, and dynamic marshland becomes the focus of designed resilience projects in lieu of a more evidence-based approach to the designing the coast.

In the next chapter, I explore the ways in which those preferences have become institutionalized in the USACE and why that creates such a massive barrier to resilience for coastal cities.
Figure 2: The Galveston Entrance to the Houston Ship Channel (1867). This map, drawn by surveyors from the U.S. Army, shows the bathymetry and geography of Galveston Island and its environs before the North and South Jetties were constructed. Note the cigar-like shape of Galveston Island, the small land mass of Pelican Spit, and the shortened western extent of Bolivar Peninsula – all of these would be considerably altered by the jetties.
Figure 3: A Study for the Improvement of Galveston Harbor by Douglas (1870). This map, drawn by a local surveyor (last name Douglas) shows one of the first plans for constructing jetties at the Galveston Entrance to the Houston Ship Channel. Because the drawing conventions are unclear, it's difficult to discern how closely this resembles the final, constructed project.
Figure 4: A Plan for the Improvement of Galveston Channel (1900). This map, drawn by Captain Riche, U.S. Army Engineers, shows the completed South Jetty and indicates where in the bay that significant dredge operations and wetland fill-and-draining work will take place.
Figure 5: The Port of Galveston (1884). This map, published in the *Galveston Daily News* on December 1, 1884, portrays Galveston’s port as the economic center of the nation. Though this was never actually true, the city’s port was a major international hub during the 19th century. Most of its facilities and operators migrated northward, towards Houston, after the 1900 storm.
Figure 6: The City of Galveston (1871). This rendering, produced by the Galveston Visitor's Bureau, shows the city's landscape before civic leaders invested in the seawall and grade-raising projects that reshaped the island. The foreground is the bayside and the background the seaside – not the low topographic profile of the island indication of wet or tidally influenced zones (blue/gray) throughout the area.
Figure 7: The Galveston Storm (1900). This map, produced by Joseph Love on commission from the Galveston Daily News, shows the extent of the damage caused by the 1900 storm.
Figure 8: Post Announcing the Preliminary Construction Plans for the Seawall (1902). This document was posted throughout the island to solicit public input – and buy-in – for investing in the seawall. It was produced by the Grade-raising Commission in partnership with the U.S. Army Engineers.
Figure 9: Storm Damage Photos via the Galveston & Texas History Center (1900). These images are part of a special collection held at the Rosenberg Library in Galveston. They show the totality of the damage and death wrought by the storm.
Figure 10: Grade-raising Photos via the Galveston & Texas History Center (1904-1909). These images are part of a special collection held at the Rosenberg Library in Galveston. They show the totality of the process of re-engineering and raising Galveston Island.
Figure 11: Seawall Construction Photos via the Galveston & Texas History Center (1902-1910). These images are part of a special collection held at the Rosenberg Library in Galveston. They show the totality of the process of re-engineering the coastline of Galveston Island.
Figure 12: Postcards of the Galveston Seawall via the Galveston & Texas History Center (1915-1932). These images are part of a special collection held at the Rosenberg Library in Galveston. They show the rise of the seawall as a cultural icon on the island. It appeared on a myriad of promotional materials – including these postcards.
Figure 13: Promotional Brochures and Stamps from the Galveston Visitor’s Bureau, Chamber of Commerce, and Other Agencies via the Galveston & Texas History Center (1936-1960). These images are part of a special collection held at the Rosenberg Library.
in Galveston. They show the projective framing of Galveston as a utopian resort town along the Gulf.
Figure 14: Promotional Brochures and Stamps from Norfolk from the Norfolk Chamber of Commerce (1951). These images are part of a special collection held at the Old...
Dominion University Library. They show the projective framing of Galveston as a utopian resort town along the Gulf.

**Figure 15:** Coastal Survey of Norfolk (1958). This document was commissioned by the City of Norfolk to identify areas in need of fortification along its historic neighborhoods and civic core.
Figure 16: The Port of Norfolk Expansion Study (1961). This is part of a report produced by the Hampton Roads Economic Development Commission – a regional planning organization that helped fund the planning of Norfolk’s Port Expansion.
Figure 17: The Cover of the Norfolk Regional Development Plan Produced by WMRT (1973). This is part of a set of reports and plans produced for Norfolk during the 1970s for the City of Norfolk by McHarg’s former firm, WMRT.
Figure 18: The Cover of the USACE’s Regional Infrastructure Promotional Manual for the Hampton Roads Region (1977). The manual was used to promote the region and to disseminate best practices amongst other districts of the Corps.
Figure 19: A Promotional Mailer Produced by the Hampton Roads Chamber of Commerce (1977).
Figure 20: A Redraft of the Castello Plan for New Amsterdam (1660). This image shows the ambition of the Dutch Colonists in Manhattan and indicates where and how the port upgrading and fortifications along the island began.
Figure 21: An Engraved Map of New York Harbor by Emanuel Bowen (1750). This image provides a rough overview of the landmarks and verdant character of New York and its environs during the period of British Colonial Rule. It is an image that persists in the minds of New Yorkers today.
Figure 22: A Military Survey of New York (1776). This image, commissioned by the British military, aimed to callout strategic points of high ground and critical assets to fortify and protect.
Figure 23: A Survey of Manhattan (1854). This image shows the scale of Manhattan's urbanization and port expansion by the middle of the 19th century.
Figure 24: A Pocket Map for Manhattan (1879). The red shading indicates new infrastructural investments – some of which are transportation related and some of which are along the waterfront.

Figure 25: An Aerial of New York (1911). This image, published by the New York Times, shows the relatively compact footprint of the City during the early 20th Century. It also shows the extent to which the port and waterfront development expansion had stretched.
Figure 19: The Manufacturing Economy of New York (1922). This image shows the footprint of the city’s then-booming manufacturing sector.
CHAPTER 3 — Resilience Politics: How the Institutional Norms, Inter-Governmental Tensions, and Provincialism of Coastal Infrastructure Planning Undermines the Viability of Nature-Based Strategies

This chapter traces and analyzes the forces delimiting the ability of the USACE to promote resilience and nature-based strategies in coastal cities. It builds on chapter two by examining how – and why – the legacy of 19th and 20th century coastal engineering continues to impact the design of coastal cities. In it, I use primary sources, key informant interviews, and public documents to interrogate a question at the heart of this dissertation: how do political actors and civic institutions view, support, and obstruct the construction of nature-based strategies along the American coast? Drawing from the experiences of residents, planners, scientists, policy-makers, and others in Galveston, Norfolk, and New York, I posit that the resilience politics of coastal design are what shape the physical features and social processes of those communities.

Like Vale’s design politics, the resilience politics of the American coast can describe both the *products* of landscape design and the *process* of designing the landscape. They are an expression of cultural and social values, an aesthetic judgement about how to value coastal landscapes and the people who occupy
them. These are inherently political acts – ones with which planners, designers, and engineers routinely engage.\textsuperscript{120}

If the design politics of public housing involves “the dual act of clearing sites and displacing communities”\textsuperscript{121}, then the resilience politics of coastal cities requires the dual act of removing sites of apparent disorder and ornamentation and replacing them with more serious, technological works of engineering. But it moves beyond the aesthetics or poetics of risk reduction along the coast. Resilience politics also imbues a set of value judgments about who gets to stay and who must retreat, who is worthy of protection and who is not, and which risks are acceptable parts of coastal life and which are not. Landscape planning and design decisions are, inexorably, expressions of policy and politics along the coast.

This means that the resilience of a community is as much a product of its social and political landscape as its physical one. Along the coast, physical risk is an endemic condition. Wetness and the specter of flooding are always present there. But it is not risk borne through ignorance or hubris. Rather, the risks posed by living along the American coast are borne of necessity – the necessity of ports, of manufacturing and heavy industry, and of military operations to be proximate to the sea. They are the primary drivers of local economic


\textsuperscript{121} Ibid.
development along much of the East and Gulf Coast, and their existence is inseparable from risk. In a sense, the natural condition of coastal cities like Galveston, Norfolk, and New York City involves living in a perpetual state of high risk. The resilience politics of each city are what govern whose risk is mitigated, whose is increased, and how the instruments of design are deployed in the service of each.

But it would be a mistake to view that process as a purely, or even mostly, technical one. There are a limited number of methods for reducing coastal risk, most of which fall into two categories. The first are often referred to as resistance strategies. Whether in the form of grey infrastructural walls and barriers or green infrastructural dunes and breakwaters, the design intent of resistance-based resilience strategies is to draw a literal line around the areas to protect and those that can be sacrificed. The criteria used for drawing those lines – property values and commercial activity – are purely economic. They determine where resistance-based forms of resilience infrastructure will be built and the level of protection that they will provide.

The second set of methods are known as avoidance strategies. Whether in the guise of managed retreats, rolling setbacks, or building code upgrades, the design intent is generally to completely remove structures and people from flood-risk. The criteria used for this approach are also economic in nature – land

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values and other property-driven cost estimates are used to determine which areas should be depopulated and which should not. It is often prohibitively expensive – and politically toxic – to embark on an avoidance strategy. Buying out homeowners can add up quickly for small communities. So too can the political cost of displacing entire neighborhoods. But that does not always deter public officials from pursuing it. In fact, buyouts became a key component of resilience politics in Galveston during the post-Ike disaster recovery process, which I discuss at great length later in this chapter.

Most communities pursue a resistance-only approach to coastal resilience. The example of New Orleans is instructive in this regard. In the aftermath of Hurricane Katrina, a variety of approaches were put forth for the city to consider. Some, like the infamous Green Dot Plan, proposed a managed retreat from the city’s lowest-lying and most-impoverished neighborhoods. Others, like the Louisiana Recovery Authority’s coastal wetland restoration plan, proposed massive investments in green infrastructure around the city. Ultimately, the city’s civic leaders opted to invest in the nation’s largest and most expensive surge barrier system – a sprawling, towering system of walls, pumping stations, flood gates, and other fortifications.123 Less than a year after the system’s

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construction, local officials began sounding a public alarm about their inability to fund its maintenance.\textsuperscript{124}

Given all of the options available to New Orleans after Katrina, why did its leaders elect to build such an expensive and difficult to maintain system of flood protection? The answer is, at least in part, because the resilience politics of coastal design tend to reinforce and reproduce pre-existing vulnerabilities. Resilience thinking requires an approach to design that eschews the conventional problem-solving approach that most American institutions are designed to pursue. Instead, it requires planners and designers to think incrementally – over time and space – about how to manage and reduce risk through projects that are phased in over time, hybridized with grey and green infrastructure, and adaptable to unforeseen shifts in coastal ecology.\textsuperscript{125} The challenge in the U.S. is that the principal agency tasked with designing, planning, and managing the coastal zone – the USACE – is incongruous with resilience-thinking.

That is because, as an institution, the USACE is primarily equipped to build one type of project in and around cities: vertical works of grey infrastructure. Though it has a stated interest in building alternative, nature-based strategies


along the coast, the Corps’ norms and internal policy framework largely preclude it from pursuing their construction.

The resilience politics of coastal planning are channeled through the USACE in three important ways. One is that the Corps evaluates and selects projects using a narrowly tailored cost-benefit method. Property values, commercial activity, and public infrastructure are the primary considerations within their system. This creates a framework in which areas of property and commercial value become sites of intervention and areas of lower value are ignored. The result is that the Corps’ projects tend to protect those with the most resources and leave poorer, more vulnerable communities to fend for themselves.¹²⁶

A second delimiting factor is that the USACE treats ecosystem services as an ancillary consideration in its evaluative process. More precisely, the Corps does not consider the various services and benefits that nature-based strategies can provide. Rather, its primary measure of environmental impact comes by estimating the number of habitat units created or destroyed by a project – a metric used by wildlife ecologists to determine the suitability of certain landscapes in specific areas (e.g. wetlands and seagrass beds). But even then, the Corps does not make a one-to-one comparison between the impacts on

property values and commercial activity with those on the environment. The USACE’s environmental impacts are generally delivered qualitatively and are treated as secondary to the impacts on local economies.\textsuperscript{127} The result of being unable to properly assess the ecological impacts of their work means that the USACE’s project evaluation method is skewed towards grey infrastructure.

A third sources of constraint for the Corps is that they, as an institution, possess very little agency or self-determination. The USACE is, by definition, a political body. It is governed by the U.S. Congress and its funding is subject to the same appropriation process that stifles many other federal agencies. Through the course of my interviews with civilian staff and engineers in the Corps, it became clear to me that they recognized the importance of reforming the way they evaluate projects. But it also became clear that they were unable to do so, either because it might require Congressional action to do so, or because there may be political retribution for the agency if it instituted internal reforms that proved unpopular in either legislative chamber.

It is important to note that there are few technological limits to the height, scale, or scope of the projects that the Corps builds along the coast. Most seawalls, surge barriers, and levees could be built to a height and at such length so as to suppress the probability of flood damage to nearly zero in most coastal

cities. In The Netherlands, these goals are often achieved because it uses a risk-standard approach to project evaluation, rather than a cost-benefit method. Within their system, risk reduction is the primary concern while capital costs are considered ancillary.128 This creates a uniformity of protection along the Dutch coast that does not exist in the U.S. Gotham and Greenberg were correct in asserting that there is an “uneven landscape of risk and resilience” within American cities. Yet, there is also a high degree of variability from one city another – not just within the individual neighborhoods of a particular city. Just as some neighborhoods are considered worthy of protection over others, the resilience politics of the coast also dictate that the perception of worthiness and unworthiness extends to entire cities.

The USACE’s institutional limits are exacerbated by the decentralized system of governance that characterizes American Federalism. Though the USACE plans and builds coastal infrastructure, local communities are often tasked with managing it. The Corps only funds capital construction – not maintenance and operations. This creates serious challenges, as few, if any, municipalities have the financial resources necessary to do so. Worse, most of these systems traverse multiple jurisdictions, leaving the broader system vulnerable to failure if and when only one municipality fails to maintain their

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portion.\textsuperscript{129} This is precisely what happened in New Orleans during Katrina – the city proved unable, or unwilling, to maintain the Corps-built levee system. When a stretch of the network breached, it led to a cascade of failures throughout the region’s entire flood-control system.\textsuperscript{130}

The resulting system of American flood-protection is thus, predictably, one of extreme fragility. The USACE builds protective infrastructure that provides total protection up to the point at which its marginal economic benefits decline. For instance, the height of a community’s floodwall might be twelve feet instead of thirteen simply because that’s the height at which the benefits of protection began to decline – and not because it provides some standard or ideal level of protection.

Once that threshold of protection is breached, the Corps’ system no longer provides any protection – and it can even exacerbate the underlying flood risks facing the area. It does this by inducing new development behind the Corps’ structures by flooding the real estate market with cheap marshland that was once undevelopable. Because the Corp uses a fail-safe approach to coastal risk reduction, some form of catastrophic, system failure is inevitable. By placing new people and structures behind these failure-prone systems, the probability of a


breach does not change – but its consequences do. Understanding how and why resilience politics shape this system is key to devising an approach that can reimagine the USACE’s role operations in coastal cities.

The rest of this chapter examines the ways in which resilience politics shape the Corps, the way the Corps shapes the American coast, and the way those forces affect the viability of nature-based strategies in coastal cities. In Galveston, those forces are manifest in the anti-science, anti-government sentiment of public officials throughout the region. Their antagonism towards climate science and the Obama Administration left Galveston bereft of the resources and attention it needed to rebuild after Hurricane Ike. In Norfolk and New York, those forces are more coded, but they – and their underlying problems – remain.

**Institutionalizing Risk, Undermining Resilience**

This section traces and analyzes the forces delimiting the ability of the USACE to promote resilience and nature-based strategies in coastal cities. As the introduction to this chapter noted, the USACE lacks the internal agency necessary to respond to the growing body of knowledge regarding ecosystem services, the ability of nature-based strategies to provide them, and their role in the broader notion of resilience. This section explores those limits through the experiences of residents and planners in Galveston, Norfolk, and New York.

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The USACE is a singular, near-omnipotent force along the American coast. No project that deals with flood risk, navigation, or storm defense can proceed without input from – and approval by – the Corps. Historically, their operations centered delivering “vital public and military engineering services” by way of designing and constructing military fortifications. That changed throughout the early 19th century, as Congressional legislation – including the General Survey Act of 1824 – shifted the USACE’s mission away from militaristic operations and towards the planning and design of public works projects. By the start of the 20th century, the Corps began to focus on two types of projects along the coast: the channelization of rivers and hardening of coasts, and the dredging of shipping lanes, ports, and harbors.\(^{132}\) Their purpose became centered on providing stability and predictability to the large commercial waterways and ports of the American coast. Put another way, the 20th century saw the Corps focus its efforts on controlling nature.

As a result of the passage of the National Environmental Policy Act of 1969 (NEPA), the commercial mission of the Corps eventually grew to include ecological stewardship. Its influence on the environment expanded again through the Clean Water Act of 1972 (CWA), which gave the Corps broad new authorities over the regulation of wetlands, coastal zones, and water supplies.\(^{133}\) But that


expansion in power did not always lead to better stewardship practices by the Corps. The USACE’s commercial origins often proved difficult to shed.

Indeed, many of the Corps signature environmental projects along the coast – ones enabled by the NEPA and CWA – remain economic in nature. The most obvious example of that commercial durability within the Corps can be found in its dredge and beach nourishment operations. The USACE dredges an incredible volume of sediment from the nation’s waterways and ports each year – more than 200 million cubic yards per annum. The spoils of all that dredging are often repurposed and used as fill or foundational material in many of the Corps’ restoration projects.

When deciding if and where to use that dredged sediment along the coast, however, the USACE uses an economic calculation known as incremental cost: they will use the material along the coast, to replenish beaches or to build dunes and wetlands, only if the cost of doing so is less than the cost of dumping it out at sea. If the cost of restoration work is higher, the Corps requires a local partner to pay the incremental cost difference. What this means, ultimately, is that, until very recently, the Corps has been dredging massive volumes of sediment from

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the nation’s waterways and dumping it in the middle of the ocean – all while the beachfronts and edge conditions of coastal cities erode and deteriorate.

The Corps’ 404 wetland permitting program follows a similar logic. In it, the USACE relies on a form of internal credits to decide if and when wetlands and marshlands can be filled or should be conserved. As a planner in Galveston remarked, “the 404 permits allow the Corps to tell everyone else what counts as a wetland and what doesn’t – they decide which ones stay and which ones go.”

Though the Corps often tries to ensure that the wetlands it allows to be filled are replaced by new, constructed ones nearby, which is not always possible. In a sense, the 404 permitting program treats environmental restoration as a zero-sum proposition. Only what is lost can be replaced – a sentiment that is both antithetical to the idea of stewardship and entangled in a misplaced sense of saving or conserving nature.

Though the Corps possesses an incredible transformative potential, its vast power is rarely used to bolster ecosystems. Indeed, their power is often wielded in the service of ecological denudation. This is, in part, a result of the USACE’s focus on technological solutions to the issues of navigability and flood risk reduction. Walls, levees, and other defensive structures provide real, tangible, and easily calculable economic benefits. But they also disrupt and damage ecological processes in ways that are difficult to see and measure.

Isolating the effect of a flood-wall on a Bay’s ecological health is far more complex than simply adding up the value of the property and economic activity that sits behind the structure.

The Limits of a Cost-Benefit approach to Coastal Resilience in Galveston, Norfolk, and New York

The Corps wastes a lot of money. They have to look at every alternative. All the crap they have to do is nonsense…It costs a lot more money than should.¹³⁷

One of the greatest barriers to building resilience in coastal cities is the use of a contrived, cost-benefit method by the USACE. Cost-benefit analyses are not a problem in and of themselves. In fact, one might expect a public agency like the Corps to use it or other methods to ensure that public funds are used judiciously. But the resilience politics of coastal design ensure that only a select set of costs and benefits are included in their analysis. The issue in this case is that the inputs to the USACE’s cost-benefit analyses – the things they have chosen to measure – are driven entirely by its commercial mission. Property value, commercial activity, and industrial and infrastructural assets are the only benefits quantified by the Corps. Environmental features – measured through the creation or destruction of habitat units, an opaque environmental metric – are considered qualitatively and are often framed as ancillary to the decision-making process within the USACE.¹³⁸ Ecosystem services, or the ability of natural features and

systems to provide tangible benefits to human health and economic growth, are not a core element of their analyses.\textsuperscript{139}

This places nature-based strategies at a significant disadvantage in coastal cities. Their ability to provide ecosystem services – whether by improving water quality, providing new recreational benefits, or developing new wildlife habitat in addition to reducing flood risk – is simply not considered in the Corps’ method. The result is that the USACE is perpetually biased towards the construction of conventional, grey infrastructure projects. They are easier to model and measure than their green, nature-based counterparts. Most importantly, grey infrastructure often requires less land area to develop. A wall providing flood-protection for a 100-year storm event has a relatively narrow foundational footprint. A dune or breakwater system providing commensurate protection generally requires much more land area. This is because nature-based strategies tend to rely friction, rather than resistance, to suppress surge and flood risks – and the physics behind that approach simply requires more land area to absorb all of that wave energy.

In cities, where the performative stakes of flood protection are highest, the Corps' bias towards these vertical interventions reinforces the nature-culture dialectic. It does so by treating nature as frivolity – an intervention best left to the hinterlands, where fewer people live and work. Technological projects like the newly built surge defense network around New Orleans are the only approach that can pass muster with the Corps. This means that the USACE will tend towards the construction of monolithic grey infrastructure in and around cities while relegating nature-based strategies to their exurbs. This is because outside of cities, there is more room to build nature-based strategies and the economic stakes are often much lower.

As a result, the USACE’s cost-benefit method of project evaluation tends to undermine resilience more than it enhances it. It does this by privileging and thus creating a near-ubiquity of vertical centralized systems of grey infrastructure along the American coast. One of the marine scientists that I interviewed over the course of my fieldwork has extensive experience with coastal planning through the Corps. When asked about the prospects for building nature-based strategies along the Galveston coast, they remarked that “[The USACE] is never going to spend federal money for surge protection unless it’s for a wall. They also aren’t going to just protect rooftops – if the barrier doesn’t help the refineries in the Bay...
or if they build their own, that will kill the project here. They’ve told the folks in Galveston as much.”

The Corps’ bias towards these systems is instrumental. To calculate the benefits of a given project, the USACE relies on three models: the Advanced Circulation (ADCIRC), Sea, Lake, Overland, and Surges from Hurricane (SLOSH), and Coastal Storm (CSTORM) simulation models. Each provides the Corps with a way to estimate property damage and economic loss as a result of storm events. Each also allows the Corps to run millions of scenarios in which the size and intensity of the storm, its surge, its wind, and its movement vary. This creates a probabilistic distribution of impacts – a series of odds that tell the Corps what the expected economic impact of a storm will be and how the various projects it is considering reduces them. The projects are then ranked according to which generates the highest marginal benefit, not which provides the most overall protection.

This means that the key performative feature of projects favored by the Corps is an ability to deflect storm surge as cheaply as possible. In cities, simply reducing wave energy is not enough. There, some nature-based strategies can be competitive. Dunes, where there is ample land to construct or restore them, can absorb and mitigate surge energy. But most others – marshes, beaches, and near-shore reefs – simply provide a frictional surface against which wave energy

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is attenuated. Inundation often still occurs, but without the force of an unfettered storm surge. These kinds of strategies do not fare well in the USACE’s analysis. I spent nearly twenty hours in conversation with employees on the civilian side of the USACE. When discussing the Corps’ cost-benefit analysis methods with a group of its own district managers, one remarked that “[The Corps does] the incremental analysis on how the protection should be and whichever has the best cost-benefit ratio is the one we’ll build. Then we can say how much protection it provides – we can’t start with a level of protection and go from there. It’s hard to justify most of those [nature-based] strategies that way – they just don’t perform the way structures do in our models.”

The USACE’s cost-benefit method of project delivery also undermines resilience by attempting to balance economic and security concerns. A planner who worked on post-disaster recovery planning in Galveston noted that “Even though [FEMA] is in Homeland Security – and has to deal with the consequences of inadequate storm protection – and, at least in Galveston, we’re talking about protecting billions of dollars in military fuel processing capacity, flood risk management is treated as an ancillary concern…You could never get away with that in the other areas overseen by Homeland Security and FEMA…like counter-

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terrorism.”142 Put another way, the security of coastal cities is not always a priority of the Corps.

In some countries, their USACE-equivalent agencies use a risk standard approach in lieu of a cost-benefit approach to floodplain management. Under that system, the governing agency sets a minimum standard of protection – in Holland this standard is a ten-thousand year storm event – and all of the projects under its purview are required to meet or exceed. Of course, the vulnerability of The Netherlands differs greatly from that of the U.S. – there are no major inland cities in Holland. A Katrina-like event in Amsterdam or Rotterdam would cripple its national economy in ways that are impossible in the U.S. This partly explains why the degree of protection required in The Netherlands is so high, and why the Corps has no such standard for coastal cities in the U.S. While discussing this disparity with a team of engineers from the Corps, one remarked that “Ultimately, the engineers can tell you the parameters [of the wall], but it’s a political decision as to how much protection you want. We could tell you the sweet spot where it’s most cost-effective, but that’s all…That’s what determines the height of a wall for the Corps.”143

For the regions of Galveston, Norfolk, and New York, the lack of a risk-standard approach to flood risk reduction leads to a number of issues. The most

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serious one is that broader system of protective infrastructure is uneven, affording certain places more protection than others. Almost invariably, the best-protected neighborhoods are also the most affluent. This creates an uneven landscape or risk and resilience in cities that can be found in the divides between the Bay side and West End in Galveston, the Ghent and Chesterfield Heights in Norfolk, and the Financial District and Far Rockaway in New York.

Another issue presented by the Corps’ cost-benefit-driven operation is that, in addition to building infrastructural systems that may already be incongruous with the risk, the cost of management are precluded from its calculations. One of the central challenges to grey infrastructure-driven risk reduction is that it is extraordinarily expensive to maintain – especially in the loamy soils that often characterize the low-lying landscapes they traverse. Yet, the Corps does not include those costs in its calculations because it is not responsible for them. The cost of management falls on local government and, unsurprisingly, most lack the resources to carry it out effectively. The result is that levees and walls sink – sometimes rapidly, always inexorably – as their footings settle. Thus, the uneven landscape of risk and resilience created by the Corps provides less protection over time. In most cities, the lack of any real monitoring or management strategy means that no one is sure what level of protection is actually being provided. A group of engineers from the USACE

noted that “All we have are the design specifications – which are often amended as the projects are built – to tell us what standard of protection [the levees] are providing. Most of those projects are a decade old or more and we just don’t know…how much the walls of slumped or settled…but we do know that, if the drawings say you have one-hundred year storm-level protection, it’s probably significantly less than that.”

This is not to say that grey infrastructure has no place in coastal cities. Indeed, it has vital role to play in promoting urban resilience. But the notions of resilience drawn from ecological science argue that no single system – grey, green, or otherwise – should have near-ubiquity in the landscape. Rather, coastal resilience emerges when there are blended approaches to protection, restoration, and design. At their best, these interventions provide redundancy, modularity, and multi-functionality within a region’s flood-control system. These characteristics are endemic to nature-based resilience strategies and they feed into the broader idea that infrastructure should help create cities that are safe-to-fail.

### The Preclusion of Nature-Based Strategies from Cities

Well I’ll tell you what is really frustrating: the emphasis on structural flood hazard mitigation that some people would like to see is distracting from the non-structural options which, at least [in Galveston], are most cost-effective and easier to implement…People holding out for this grand scheme of the Ike

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Dike or whatever you want to call it just diverts people’s attention and effort away from doing what we can right now to mitigate our risk.\(^{147}\)

The resilience politics of coastal design often preclude the USACE from given full consideration to nature-based strategies. Even hybridized, grey-green infrastructures struggle to find approval within the Corps. New York’s largest post-Sandy project – the BIG U or Dryline around lower Manhattan – proposes braiding public space, flood walls, and ecosystem services into a massive barrier system. But the USACE is designed to strip away the recreational and ecological components of projects like it. “It seems unlikely that anything resembling [the BIG U] will be built. Sure, there will be a wall and probably some kind of earthen levee or berm, but not much else. The Corps wants to build big, dumb walls – and that’s what New York is going to get.”\(^{148}\)

A similar stripping process is being contemplated in Galveston. There, the primary design response to Hurricane Ike came in the form of the Ike Dike – a massive, island-wide coastal spine blending sea walls, fortified dunes, and parkland aimed at absorbing surge energy. “If you want to protect this region, a coastal spine is the only solution. Every analysis will converge on that. But I just can’t imagine the Corps approving any of this…nature-based stuff. It will get cost-engineered off the Ike Dike by the time it’s built.”\(^{149}\)

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Norfolk has already moved past this phase. Though its district office for the Corps is actively pursing nature-based projects along the coast, most are being treated as ornamentation, not protection. “Unless you can afford to build a monster dune, nature-based strategies are not going to work here. We’re doing some reefs, but those don’t address storm surge. Tidal erosion, maybe, but if you get a surge of two feet or more they won’t attenuate any wave energy. We’ll have to build walls in areas where there are serious assets to protect.”

There, as in New York and Galveston, nature-based strategies are viewed as ancillary components of the coastal landscape – interventions to be introduced when the stakes are low and where the desire for ornamentation outweighs the need for protection. As long as the ecosystem services they provide are precluded from the USACE’s cost-benefit calculations, grey infrastructure will predominate.

The resilience politics of coastal design – and their impact on the viability of nature-based strategies – are also reflected in the ways that the USACE’s storm surge models measure success. In each of the SLOSH and ADCIRC simulation tools used to estimate property damage by the USACE, success is measured by the presence or absence of water – whether a property or element of infrastructure was inundated, or not, and to what depth. Borne of the resistance-oriented approach to resilience so prevalent in engineering, this approach elides past a crucial variable: wave energy. Though inundation causes property damage which often requires substantial work to remediate, it is the

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energy from a storm surge that knocks buildings off their foundations, breaks them apart, and demolishes infrastructure. Building a fortification aimed at resisting that energy is one way to ensure that wave energy is attenuated – but not the only one.\textsuperscript{151} Some nature-based strategies can provide similar services. But because they work by slowing water down and allowing a very small volume of low-energy water into the areas they protect, they do not perform as well in the models used by the Corps – models which typically use wetness and dryness as proxies for damage and non-damage.

This all contributes to a system of project development within the USACE that privileges grey infrastructure over green, structural protections over landscape-based ones. Not only does this fail to remove the risk of catastrophic failure and flooding in those cities, but it also contributes to the widespread denudation of ecosystems and their services in coastal zones. Resilience politics dictate what areas receive protection – and whether it comes in the form of grey infrastructural walls or green infrastructural landscapes. Either way, the result is often the same: large, one-off works of grey infrastructure are typically built around areas with high property and commercial value while others languish with little or no investment from the USACE. The Corps largely recognizes this failure. I spoke to a former engineer at the Corps and local public official in Norfolk, who noted that “We have to frame [all of our coastal work] as part of a national

economic benefit…and a lot of that is driven by our navigation mission. In the end, what we build will come down to that. I don’t know if natural or nature-based strategies can be a part of that in cities. I would love to…but we just aren’t equipped to build them."

The Lack of Agency in the USACE

My assessment is that we might have a lot of things that are authorized and not built until an event happens – then coffers open up and we can build projects. That’s what happened with Sandy…I hope and pray that we don’t have a Sandy event here in my lifetime – if we’re able to formulate some things and get them authorized then I would hope and pray that we can actually implement them before one of those happens, but the reality is that it will take an event like that to get us the money we need to build it. Then localities have little or no cost-share – that’s the big hang-up. You have a $500 million program and a local sponsor is on the hook for 35% of it – that’s not chump change for a small or medium city – that’s not even chump change for some states.

Though it would be easy to fault the USACE for these shortcomings, laying the burden at their feet would be a mistake. Indeed, most of the program officers and civilian staff with whom I met over the course of this research openly acknowledged that their mode of operations appeared to be at odds with the reality of rising seas along the coast. The issue at the center of the Corps’ inability to promote resilience is that it is an institution with little real agency – its operations are subject to the whims of Congress. Despite widespread recognition within the career staff of the Corps that its method of cost-benefit analysis was broken, that its bias towards grey infrastructure creates serious problems, and

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that its approach to risk reduction often exacerbates the very issues it is attempting to solve, the USACE is incapable of feeding that knowledge into a process of internal, institutional reform. That is because the conventional process institutions follow for developing cultural and behavioral norms is largely irrelevant to the Corps – its culture does not evolve in the same way that the culture of more autonomous institutions can.\footnote{K. Tierney. 2014. The Social Roots of Risk: Producing Disasters, Promoting Resilience. Paolo Alto: Stanford University Press.} An engineering consultant with significant experience working with the USACE described this by saying that “It’s not the Corps’ fault. It’s the legislature’s fault – they’ve tied the Corps’ hands because they don’t understand anything about coastal engineering.”\footnote{Anonymous interview with technical expert by author. Digital Recording. Galveston, February 22, 2016.}

This is best exemplified in the recent “three-by-three-by-three” reforms carried out by the Corps since 2009. Under this new regime, the Corps is required to complete all of its individual projects and studies within three years, at a cost of three million dollars or less, and, depending on their format, come in file sizes of three megabytes of less or bindings of three inches or less.\footnote{US Congress. 2014. “HR 3080: Water Resources Reform and Development Act.” 113th Congress, Second Session, available at: \url{https://www.congress.gov/113/bills/hr3080/BILLS-113hr3080enr.pdf}.} Prior to 2006, Congressional appropriations were subject to the process of earmarking – or the designation of specific, and often non-germane, capital and programmatic projects in all spending authorizations. They were often used to incent members of Congress in moderate districts or states to break with their political party and convey an imprimatur of bipartisanship. Under this system, the USACE became
one of the primary vehicles for channeling earmarks to the elected officials willing
to cross party lines in exchange for earmarks. Their dissolution after the 109th
Congress is often blamed, at least in part, for the rise of hyper-partisanship in
both chambers.\textsuperscript{157}

The effect of this new mandate upon the Corps has been to both slow the
pace with which it operates and to diminish its ability to take on large, complex
projects. This runs counter to the intent of the three-by-three-by-three mandate,
which sought to expedite their work and free up the resources necessary to scale
up the ambition of their work. Each of the “threes” helps to explain why. By
limiting the expenditure on individual projects overseen by the Corps to three
million dollars, Congress essentially severed their ability to plan at a scale large
enough to meet the challenges of sea level rise. “The baseline expenditure for
any project that comes [to the Corps] is about $1.5 million – that’s the minimum
we can spend for staff time. Most are well over that, so to limit costs on
projects…we now have to break them up into smaller parts that can fit this
mandate. That eats up more time…and slows us down considerably.”\textsuperscript{158} By
limiting the timeline of their work to three years, Congress also forced the Corps
to take on far less ambitious projects. “After Ike, we all got together…and
decided that the best way to think about strategic, structural protection [in our
region] would be to study the whole coast – Brownsville to the Louisiana

\textsuperscript{158} Anonymous interview with two technical experts by author. Digital Recording. Norfolk, April 21, 2016.
The constraints of the three-by-three-by-three mandate are such that the vital, complex work of resilience-building is nearly impossible to carry out for the Corps.

The Corps is now forced to rely on two project delivery pathways, neither of which lends itself to the construction of progressive, ecological infrastructure. The first requires them to compartmentalize their work into small, discrete projects that can easily circumnavigate the three-by-three-by-three process. In coastal territories where complex, geomorphological processes are involved, this often means that the only projects considered by the Corps are simple walls, levees, and berms. It also means that the USACE must process and consider a greater volume of projects than ever before. In Galveston, this meant abandoning the idea of a hybridized approach to the coastal spine in favor of large, resistance-driven structures. A local engineer described it by saying that “there’s no way to do this [project] for $3 million. We’re talking about huge megastructures and crazy geo-technologies for the foundation. If it gets built – and who knows if it will – we’ll have to do it in sections or hope for a waiver from the three-by-three-by-three.”

In Norfolk, the pace of work has been nearly ground to halt as a result. “The most obvious shift [of the mandate] is that it’s cut
down on our already dwindling resources – so it’s slowed down projects we already had in the queue and kept us from getting others lined up.” Breaking the projects – including studies and actual physical projects – into discrete elements that can negotiate the three-by-three-by-three system has produced a steady stream of work, but dramatically limited the scale of intervention available to the Corps. An engineer in Norfolk described it as “when we begin a study, that’s a new start decision that’s made. When we go to build it, that’s another new start. So we might complete a study, but then we have to go back in the queue to try and compete for the money we need to build whatever came out of the study. That’s a challenge, because it creates a big backlog of projects – even bigger now that everyone has to break them up into such tiny pieces.”

Scientists and policy-makers in Galveston and Norfolk both cited New York as an example they wished they could follow – the unleashing of a project backlog, funded in large part through Disaster Recovery appropriations.

The second pathway for USACE projects to be realized is through a Sandy-like event – one that triggers a large, congressional appropriation of disaster recovery funds. A form of crisis-driven urbanization, this approach to coastal resilience borrows from notion of “bounce-back” found in sociological and ecological research. “Since the USACE budget was frozen and they banned earmarks, the way you get more money is through disaster bills. That’s how the

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Corps builds its big projects now – it’s all storm related…I don’t think the Corps will ever have any significant money again unless there’s an event. They’ll try to get these couple million dollars per year, but that just won’t build anything…It’s frustrating, that they’re as broken as they are. You want it to work. But I think it will take us pushing and pushing on them until a storm hits and then BAM – we’d have our surge barrier under construction immediately.”

For projects like the BIG U in Manhattan, the Ike Dike in Galveston, and the Chesterfield Heights redevelopment in Norfolk, this pathways seems to be the only one capable of producing large, complex, and experimental strategies for coastal resilience.

This shift, then, marks a foreboding time for coastal communities in the US. Cities that follow the first pathway that resilience politics offers will see their protective systems built in excruciatingly slow increments. As a result, the costs of construction will surge, the political coalitions supporting them will lose energy, and their resilience will be undermined. The poorest neighborhoods will be forced to bear the greatest burden of this incremental approach – the surge barriers built by the Corps in places like Galveston, Norfolk, and New York will protect the most valuable assets first. That means the second homes on the West End of Galveston, the Ghent and other historic neighborhoods in Norfolk, and the Financial District in Manhattan. These are the types of neighborhoods often considered worth protecting by Corps-led planning processes. Not only will this leave the poorest communities exposed to the effects of sea level rise, but it may

also exacerbate their issues by displacing flood-water away from wealthy enclaves and into poorer ones. Those projects following the path of crisis-driven urbanization – while likely to be realized more quickly and completely – will come at a tremendous cost: the displacement of the region’s poorest, most vulnerable residents from its newly protected neighborhoods. Whichever path a Corps-led project takes, there is little hope for near-term investments in nature-based strategies as long as their method of evaluation privileges grey infrastructure over green and they remain hamstrung by Congress.

The Tension between Federalism and Resilience

Though the conversation amongst planning and design scholars as to which elements of a city or landscape contribute the most to its resilience remains lively, the discussion around how that resilience can be made is mostly settled. Resilience is, at its core, the ability of someone or something to learn from the past, and to incorporate that learning into a process of adaptation in preparation for a less certain future.¹⁶⁴ There are no prescribed forms, only evidence of adaptive learning. This section explores the ways in which the resilience politics of each city form, how they shape their potential futures, and why they are important for designers operating along the broader American coast.

For coastal cities, this means being to translate information about flood risk, geomorphological change, and socio-political power into physical and policy-

based interventions. It means building cities that fail safely, intelligently, and justly. If “the illusion that we understand the past fosters an overconfidence in our ability to predict the future”\textsuperscript{165}, then the evidence of urban resilience should be found in the humility of the interventions. In lieu of the massive, one-off structural engineering projects that often traverse robust-yet-fragile coastal territories, one would expect to find a tapestry of interventions in more resilient ones. Healthy dunes systems, thriving wetland ecologies, and all manner of coastal green infrastructure would be layered within smaller, more strategic works of grey infrastructure. But this, as is now clear, is inapposite to the baseline operations of the USACE.

As an institution, the Corps is best-equipped – and some would argue, only equipped – to build large, monolithic, single-purpose works of grey infrastructure in coastal cities. The redundancy, modularity, and multi-functionality that characterizes both nature-based strategies and notions of resilience is mostly absent from that work. Instead, coastal cities are often forced to rely on a single, flawed system of protection. It is rarely a question of \textit{if} those systems will fail, only of \textit{when}.

Yet, for the fatalism this near-certain failure ought to engender, optimistic and progressive proposals for alternative forms of coastal protection abound in Galveston, Norfolk, and New York. There is no paucity of ideas for how to make

these cities more resilient through nature-based strategies. The limiting factor in each is a product of the politics of resilience. Indeed, I spend considerable time in the two final chapters of this dissertation parsing the differences between – and the viability of – those different ideas. It is manifest in the inherent tensions between the overlapping layers of government that intersect in coastal zones, and it is evident in the harsh, antagonistic posture of anti-government and anti-science coalitions in Galveston, anti-climate change advocates in Norfolk, and anti-reform officials in New York.

The anti-science, anti-government sentiment in Galveston undermine resilience in two important ways. One is that it strips local officials of the ability to act on the threats posed by sea level rise. The Texas coast is managed by the General Land Office (GLO) and its commissioner, Jeb P. Bush. Under his leadership, the GLO has literally banned the phrase “climate change” from its vocabulary and, in doing so, effectively blocked the state’s ability to act on the phenomenon. A public official in Galveston remarked that “Jeb and the GLO are just grandstanding – they’ve never done anything decent in their lives…The problem is that he sees this as a stepping stone to becoming Governor, so he started all this anti-climate change stuff to strengthen his credentials…in Texas.”

This feeds into the other way in which resilience is undermined in Galveston: the state’s elected officials are openly hostile towards federal officials as well as climate science. A federal employee who worked on the post-Ike

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recovery process noted that “It’s hard for [the Federal Government] to justify investing in a place that won’t do the work or acknowledge the problem. We have plenty of communities who are willing partners in this…we can’t be the ones to make them face their own reality.”

Though the tone is less hostile in Norfolk, the sentiments are largely the same. Rather than referring to sea level rise or climate change, city and state officials describe Norfolk’s issues with inundation as a product of “recurrent flooding” – a phenomenon that, for reasons unknown, is increasing in scale, scope, and frequency throughout the region. But the lack of hostility has served the city well. It is the recipient of significant, non-disaster-related investments in long-range resilience planning from HUD, the Rockefeller Foundation, and the USACE. With one exception, however, these funds have all been directed towards research and planning – not implementation and construction.

New Yorkers have no such issue acknowledging and planning for climate change. In the aftermath of Superstorm Sandy, then-Mayor Michael Bloomberg mobilized the vast technical resources he and others cultivated during the PlaNYC process to focus the city’s attention on its coast. Their work resulted in the SIRR (Special Initiative for Recovery and Resilience) Report, which called for several hundred resilience-oriented projects along the waterfront. But as that

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report’s proposals were fed into the ensuing Rebuild by Design (RBD) competition, a rift emerged between the city’s design politics and the federal officials tasked with administering it. That inter-governmental tension began to undo the work of the SIRR Report and RBD.

That tension – between communities and states, states and federal agencies – underpins all of the work underway in Galveston, Norfolk, and New York. Several interviewees remarked that “Texas isn’t a coastal state – it’s a state with a coast”\(^\text{169}\) and that dismissive shorthand rings true in Virginia and New York too. The resilience politics of coastal design intercede here too – within states and between them. Coastal cities are convenient scapegoats in state and federal politics – enclaves of progressivism and territories of risk perceived by some undeserving recipients of federal and state insurance subsidies and infrastructure investment.

**Anti-Science and Anti-Government Sentiment in Galveston**

Galveston – like most other major cities in Texas – is something like a pariah in state politics. Its position along the coast only furthers its negative connotations amongst legislators. But there is one aspect of Galveston which endows it with a unique ire amongst public officials in Texas: the city benefits greatly from the Texas Wind Insurance Association (TWIA), a public insurance market for coastal

cities. The TWIA exists because, like the market for flood insurance, the pool of property owners in need of wind insurance is relatively small and homogenous.

Well-functioning insurance markets are structured and governed by Mossin’s Theorem – an economic principle describing the relationship between full and partial insurance and real and perceived risk. TWIA, and most public insurance markets, exist because few people are able to accurately assess their own risk – and because private insurance carries a significant premium that actuarially fair insurance would not. Because no one outside of the Texas Coast purchases wind insurance and because there is no real risk of wind damage inland, there is no real market for the product in the state. The state runs the insurance program because no one else can.

Galveston benefits disproportionately from the TWIA market and, on at least three occasions since 2000, state legislators have sought to reform or abolish it in retaliation to the city’s perceived progressivism. Wrapped in the rhetoric of rugged, resilient individualism, the TWIA fight is at the center of the coastal-inland divide in Texas. This is, increasingly, a common fight in urbanizing American states.

But what differentiates the relationship between Galveston and the state from most other places are the stakes of that antagonism and the methods

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through which it is employed. The stakes should be abundantly clear. Galveston is highly exposed and vulnerable to sea level rise and storm-driven flooding events. Without a strategy for adapting the region to climate change, large swaths of economically and ecologically valuable land will be lost and thousands of lives will be disrupted. Yet, the state is, at best, agnostic towards the threat of sea level rise along its coast. At its worst, the state is often antagonistic towards the idea of climate change broadly and the Galveston region specifically.

That antagonism is manifest in three important ways. One is in the state’s consistent denial of climate science. The Governor, the GLO, and an overwhelming majority of state assemblymen are on record disputing the validity of the phenomenon. The effect on Galveston is that it lacks the institutional and financial support necessary to engage with the issues presented by sea level rise in a serious and pragmatic way. A second is a product of the state’s antipathy towards the Obama Administration, evidenced in public statements and actions taken to undermine the credibility and authority of the federal government in Texas. The most glaring example of this relationship can be found in the book authored by former Governor Rick Perry during his first campaign for the presidency, *Fed Up! Our Fight to Save America from Washington*. The effect on Galveston is to deprive it of the federal resources necessary to construct any meaningful form of flood protection.

The third is a result of the strong, private property rights sentiment in Texas. It is a rite of passage in Texas politics for candidates to proudly proclaim that ninety-five percent of the state’s land is owned privately. One of the only bastions of public land is along the Texas coast, where nearly the entire shore is protected by the Open Beaches Act of 1959 – a remarkable piece of legislation guaranteeing public access to the entire coast of the state. It came under attack in 2010, when a Texas Supreme Court decision – which originated in Galveston – stripped away the Act’s authority. The effect on Galveston has been one of paralysis, as questions about which property is public and which is private complicate their ability to use state and federal funds for coastal management and resilience projects. It created considerable uncertainty as to how and where CDBG-DR money could be used for property buyouts, new infrastructure investments, and other post-disaster recovery efforts.

The anti-climate science posture of Texas legislators is unique in both its hostility and obdurateness. It is also one of the principal barriers to resilience in Galveston. A public official in Galveston described this by saying that “One of the problems…in [Galveston] is that our political machinery is not focused on our coast at all…they will all tell you, Texas isn’t a coastal state – it’s a state with a

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coast. They can afford to ignore sea level rise because none of them care what happens out here anyway.”

Not only are legislators disinterested in the coast, but – at the direction of Governor Greg Abbott and Land Commissioner Jeb P. Bush – the GLO and other state agencies have institutionalized climate change denial by banning language that acknowledges it from public documents. A former planner with the GLO described it by saying “all the draft reports – at one time or another – from TCEQ and GLO had references to sea level rise or climate change. But that language was always redacted by the Governor’s office or [Land Commissioner] Bush in the final, public documents. So they are flat out denying the expert advice of state employees and using their offices to politicize science.”

Of course, Texas is a state built upon the wealth of oil and natural gas and, as a result, many of its legislators’ campaigns are funded through the oil and gas industry – including the engineering firms that help build and maintain their operations. “This is typical Texas – Danaenbaum [Engineering] just wants to make money and to give their friends money. They took around six million dollars in Ike recovery money – it just burns me as a researcher. They’re doing the work we’ve already done over again and they’re doing it worse – and I’m sure that whatever gets built here, the contract will go to Danenbaum.”

The combination

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of anti-Galveston and anti-climate science sentiment in Texas politics makes it unlikely that any meaningful attempt will be made to address the surge risk along the coast.

The state’s antipathy towards the federal government presents another significant barrier to resilience in Galveston. “Texas is a very anti-Obama Administration state. Our rapport with the federal government - it’s just awful. I’m not surprised we don’t get much financial support for surge protection [in Galveston].”

Though Galveston received nearly one billion dollars to support the Hurricane Ike recovery, much of that money went into rebuilding homes and businesses – little, if any, was available for new investments in a coastal defense system. Part of that is a product of the state’s lack of institutional capacity to plan for and manage climate change along the coast. An elected official in Galveston remarked that “Texas doesn’t see itself as a coastal state, so all of our institutions – the GLO especially – treat this region as ancillary. After Ike, we didn’t even have a state organization that could manage the federal recovery dollars…it’s why that process took so long. The Feds see that and that lack of state commitment to the coast and to climate adaptation is going to hinder the federal investment in Galveston. We can’t build an Ike Dike or surge barrier on our own – and the Feds won’t help us if our legislature can’t even bring themselves to utter the phrase climate change.”

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Many of the public officials that I interviewed for this dissertation looked at New Orleans and New York with envy. Both cities received massive federal investments in surge protection. Both also have highly sophisticated coastal planning institutions. Without commensurate institutions, Galveston will never be able to compete for commensurate resources. But for most of the political class in Texas, scoring points – and winning an election – by denigrating the federal government is always preferable, even if it costs the state much-needed investments in protective infrastructure. A marine scientist in Galveston bemoaned this reality by saying that “we have some real dumbass politicians in Texas. Don’t misunderstand that. They’re in it for the short term. They don’t want us to build anything – but you can bet your ass they’d be here for the ribbon-cutting if we did.”\textsuperscript{179}

There is some validity to the frustrations of local officials trying to work with federal partners in coastal zones. FEMA rules and regulations mandate that critical facilities – like the wastewater treatment plant destroyed by Hurricane Ike in Galveston – be rebuilt in place.\textsuperscript{180} The same is often true for homes insured through the National Flood Insurance Program and those eligible for Community Development Block Grant Disaster Recovery (CDBG-DR) funding and financing programs. One local official said “FEMA says, like manner, like design, like

\textsuperscript{180} FEMA. “Unit 8: Substantial Improvement and Substantial Damage.” Available at: https://www.fema.gov/pdf/floodplain/nfip_sg_unit_8.pdf. Covers the FEMA 50% rule on facility replacement found in 44 CFR § 206.226(f).
location. It’s cheaper to rebuild things where they were…It’s crazy. Nobody wanted to take them on because FEMA isn’t there to learn new ways of enforcing or interpreting regulations after an event. We literally had to rebuild that plant and most of our homes – to a higher standard, sure – right where they were before Ike. If we didn’t, FEMA – and then HUD – threatened to pull all of our recovery money.”

Finally, the durability and prevalence of attitudes towards private property continue to complicate resilience-making in Texas. The Open Beaches Act of 1959 – authored by then State Senator Babe Schwartz – passed sweeping reforms to the state’s coastal zone. In essence, it created a buffer zone that provided Texans with unfettered access to every inch of the state’s coastline. Unlike Malibu – where the beachfront is completely privatized – or even Norfolk and New York – where industrial facilities and commercial activity have colonized the waterfront – Galveston and its environs were wholly and unequivocally part of the public realm. This meant that as coastlines eroded, whether due to the slow onset of sea level rise or the more episodic impact of hurricanes – private property owners were often forced to sell their land as the water encroached upon them. That all changed in 2010 when, in response to a suit filed by a wealthy woman named Carol Severance – who owned a vacation home in the tony West End of Galveston Island – the Texas Supreme Court ruled “evulsions” or the sudden erosion of a beach due to storm activity was not covered by the

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Open Beaches Act. This meant that portions of the Texas Coast – including and especially the West End of Galveston – were no longer public lands. That ruling triggered a cascade of issues for the region.

The two most damaging aspects of the ruling were that it prevented the city from spending public resources on surge protection in and around the West End. Because this once-public land was now private – and because the strings attached to it prevented it from being used to upgrade private land – discussions about how to best-protect the island quickly broke down. “When the GLO lost to Severance, it put into question any ability of the state to lay money down on the West End. What that means now is that if you say you own the property, that’s fine – then you have to care for it. We’re not going to do that for you. Not a lot of people can care for a beach – beach nourishment and surge protection aren’t things you can do at the parcel-level.” The ruling effectively quashed any post-Ike momentum towards a comprehensive surge barrier for the island. But it also led city officials – many of whom were swept into office during the 2010 Republican electoral wave – in Galveston to funnel tens of millions of dollars towards the wealthy second-homers on the West End.

The CDBG-DR funding in Galveston came with few restrictions on its use. CDBG money is typically reserved for place-based, anti-poverty projects like

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mixed-income housing and improvements to the social service infrastructure of a city. Though that was its intent after Ike, Galveston’s city council managed to appropriate more than ten million dollars from that fund into purchasing vacation homes from residents of the West End who did not want to return to the island. “That council bought out a lot of beach houses with that [CDBG-DR] money. It was just a naked admission that, as a city, we’re going to spend federal money that’s meant for the poor on political purposes. There was no public benefit to it. It was just deplorable – to spend money like that…people here always knew that if you bought a house out on the West End, you should only do so if you’re wealthy and can afford to lose it. Now all that’s been undone.”

Recurrent Flooding in Norfolk
Norfolk receives little attention from legislators in Virginia. Larger communities in the Washington, DC metropolitan area – Arlington, Alexandria, and Fairfax – are viewed as the engines of economic growth and demographic change in the state – and they are where the resources are often sent. This is true, though to a lesser extent, for the capital city of Richmond. Like Texas, Virginia is also home to a vast rural and agricultural landscape which, due to its sprawling geography, dominates the state’s politics. Like Galveston, Norfolk is often viewed derisively by the state’s legislators as a result of its coastal, urban status.

That derision is manifest in Norfolk’s approach to and engagement with sea level rise – or, as it’s referred to in Virginia, “recurrent” or “nuisance

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flooding”\textsuperscript{185} – in at least two important ways. One is the manner in which climate science is denied through legislative language and action. The Virginia General Assembly pressured Norfolk and its neighboring communities to redact language about sea level rise and climate change from its public documents and to use the phrase recurrent flooding in its place.\textsuperscript{186} “It was such a joke – there’s this thing called recurrent flooding. Like, we don’t know what it is or why it’s happening.”\textsuperscript{187} The term is used to describe the increasing frequency of precipitation-driven flood events in and around Norfolk.

But their proliferation over the last decade is not the result of some unknown phenomenon. It is the result of the city’s sewer outfalls sitting below Norfolk’s mean high tide – a relatively recent development and the result of sea level rise. A city official described it by saying that “we don’t really have the surge issues [other cities have]. We have nuisance flooding, because we’re getting heavier rains, we’re extremely flat, and our stormwater system’s outfalls are now underwater at least once a month. So often times, if it isn’t raining at high tide, you can walk downtown and see water bubbling up, through the stormwater system and into the street.”\textsuperscript{188} Norfolk found ways to work around this barrier, but without a willingness to name and address the issue of sea level rise, the state

\textsuperscript{188} Anonymous interview with technical expert by author. Digital Recording. Norfolk, April 21, 2016.
legislature effectively blocked any large-scale attempt at adaptation in the city. "We had to get real about it, even though most of our state elected officials have been saying there's no such thing as climate change or there's no such thing as sea level rise. We had to, because we have so many more days now each year in which parts of Norfolk are underwater." Indeed, much of Norfolk's ongoing resilience planning is focused on ameliorating social vulnerability. There are no major public works projects or defensive structures under discussion there.

The denial of climate change – through the coded language of recurrent and nuisance flooding – prevents Norfolk from thinking more strategically about how to defend and manage its coast going forward. "It's hard to justify building any big defensive structures here anyway – the coast isn't linear in Norfolk. It's very complex, so a wall or other structure would be a hard sell. But it's impossible to really broach the topic of defensive measures – whatever they might be – when we can't even acknowledge that sea level rise is occurring." This is driving the city to consider resilience at the individual rather than community level. While important, this approach to coastal planning is, essentially, an acknowledgement that nothing can or will be done to forestall or limit rising seas. Norfolk is simply trying to provide its residents with the safety net and services it needs to navigate a wetter future – it lacks the will and ability to envision a drier one.

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A second manifestation of Norfolk’s disjointed relationship with sea level rise lies in its fatalistic approach to resilience. By that I mean that Norfolk – unlike Galveston, New York, and nearly every other coastal city in the US – has largely abandoned any ambitions for armoring the coastline, whether through grey or green infrastructure. Instead, the city is focused on two things: bolstering the social resilience and safety net of its residents, and providing incentives to property-owners to initiate a parcel-level approach to stormwater management.

Some of that focus is evidence-based, a result of the city’s tidally-influenced flooding issues. A marine scientist whose work is focused on the Hampton Roads Region remarked that “Our landform just is not designed for massive defense structures. The shoreline is too complex and everything else is too low – it would take a truly massive network to defend it all. Plus, building something like that here – which would have a measurable impact on surge reduction – would inflict major and irreversible ecological damage. It also just doesn’t work for N’oreasters, which are a much more serious issue in Norfolk than tropical storms.” But much of it is a result of the political constraints placed on the city by state officials unwilling to acknowledge and to grapple with the reality of rising seas. The same marine scientists went on to say that “There just aren’t any simple solutions here. If you’re willing to invest in things that might provide a century’s worth of protection, but are ultimately doomed then there are a couple of areas you could defend with a dyke or barrier. But between the wind

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and rain here, it’s really hard to move water out of the city and it’s only going to get worse – especially because the state isn’t interested in sounding any alarm bells about the future. They don’t want to spook businesses or other industrial actors in the region.” Though there is an argument to be made that such an approach is, perhaps, more intellectually honest than strategies aimed at fortifying and preserving coastal cities, it is unique amongst the more aspirational visions for the future under development in Galveston and New York.

The lone force pushing back against Norfolk’s fatalistic vision is, ironically, the US Navy. Already heavily invested in the region for national security purposes, Naval planners and officials with the USACE and city of Norfolk have begun looking for ways to braid their planning efforts together. “The Navy is saying that there are some things that make mission-readiness easier for us that happen outside of our gates – and sea level rise might impede that going forward…As a result, Norfolk is the first pilot for the Navy and the Feds to try and coordinate their planning with a municipality’s.” Whether that collaboration bears fruit remains an open question.

The bottom line is that for Norfolk, the high point is about ten feet above sea level. The SLR curves take you to about seven feet by the end of the century, so the city is effectively doomed. But it will be interesting because the naval base and the port will have to stay – DoD won’t give up the strategic position of their NATO Allied Command Center sitting at the only waterway entrance to DC. And

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more water may not be such a problem for them – ship captains will never complain about more water beneath their keel.¹⁹⁴

The Navy will always be in Norfolk. The fate of the city’s residents is far less certain.

_Provincialism in New York_

Before Superstorm Sandy struck New York in 2012, planners and designers in the city had already begun thinking about the impact of sea level rise. Design competitions – like *On the Water*¹⁹⁵ – and art exhibitions – like *Rising Currents*¹⁹⁶ – instigated thoughtful, albeit outlandish, approaches to resilience in New York as early as 2008. The former, a design competition led by the Van Allen Institute, fell victim to the forces that typically undermine such exercises: the lack of a political constituency for the work. Disconnected from the people and the institutions governing New York’s neighborhoods, *On the Water* failed to produce any real movement in the city’s approach to its waterfront. The latter, an art exhibition commissioned by the Museum of Modern Art, fell victim to its own insularity. The designers and artists involved produced a series of provocative visions for the future of New York’s coast, but they did so without any real basis in the science of climate change or its effects on the city. One participant went so far as to say that “it should have just been called Artists against Climate Change. We didn’t really understand what we were doing – and we probably weren’t supposed to.

The work may not have been as beautiful if we did." However, the divide between the city’s design culture and its vast reservoir of political and scientific expertise began to narrow after Sandy.

But RBD was not destined to fail as an instrument of disaster recovery. Instead, two forces undermined the competition. One was a concerted effort within the state and federal bureaucracy to delegitimize the Dutch-led effort as naïve and ill-suited to the New York region. As the competition drew to a close and the winning teams began planning to pursue their proposals, one designer involved in RBD said that “there are a lot of people who do not like [Henk] in the agencies and the governor’s office because he’s saying they all need to change. They were all bad-mouthing him. When we’d bring something to them that had been discussed with Henk, they’d say ‘who in HUD are you talking to? Real people who can do something or other people?’ That was pretty alarming to us.”

One of the most consistent topics raised by participants in the competition was the divide between career staff in the state and federal agencies and their political leaders. By all accounts, RBD did little to bridge that divide. This is why many of the proposals that were selected for implementation are moving forward in forms that might appear alien to competition participants. Those entrenched in

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state and federal agencies simply waited for RBD’s political constituency to fade and are now working to scale down the ambition and creativity of its projects.

Part of that also came from the structure of the competition, which emphasized community engagement in its marketing materials but forced design teams to operate independent of it for significant periods of time. “The weird part about their process is that they didn’t want to piss anyone off – so they asked us to do all this design work without talking to any communities because they didn’t want us to work with them on proposals that weren’t selected to go forward. So we were put in this terrible position of trying to figure out what the right design opportunities were without talking to anyone who lived in these neighborhoods.”199 The efforts by the institutional partners to delegitimize the Dutch-led competition and to drive a wedge between the designers and their communities ensured that a durable political coalition could not be sustained for RBD.

The second force that undermined the competition came in the ways in which funding and resources were apportioned across New York’s neighborhoods. More specifically, the competition’s viability suffered from its clear bias towards investments in the already-wealthy and fairly well-protected Financial District – a decision that, in a zero-sum effort like RBD, drained resources from places of higher need like the Hunts Point, Far Rockaway, and

Staten Island. “The frustrating thing for us – and especially for our partners in [the neighborhood] – was that we really needed the time and the money Rebuild and later the National competition provided. We couldn’t do much of this work without it. We all knew that [the Financial District] would get something but when it was announced that so much of the competition’s money was going there and almost nothing would come to us – we were all pretty distraught. Our partners felt played.”

This is not to say that RBD was inconsequential. But the degree to which it altered where and how the city chose to invest in coastal infrastructure is unclear. Lower Manhattan was always going to get a large surge suppression system and Staten Island was always going to invest in some shoreline stabilization projects. The argument in favor of using competitions like RBD as a post-disaster recovery vehicle is that they allow for CDBG-DR appropriations to be spent differently than conventional methods might allow. As the next chapter discusses in greater detail, the ability of RBD to do so in New York City remains an open question.

Political Resilience and Ecological Fragility

The challenges to building resilience in coastal US cities are a result of both top-down, structural impediments and more localized, inter-governmental tensions. As an institution, the USACE is the primary structural force shaping the physical environment of the American coast. It is largely incompatible with the

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characteristics of resilient systems described by Ahern and others: redundancy, modularity, and multi-functionality. As this chapter has made clear, the Corps is organized around the goal of building large, one-off works of grey infrastructure that serve a single purpose. Its methods of project evaluation and its lack of agency render it an insufficient force in creating more resilient cities. Put another way, the USACE is not equipped for the task of building resilience along the coast on its own. Yet it remains the most powerful broker in that territory and thus possesses an untapped reservoir of power in the broader project of climate change adaptation. Locally, the politics of resilience are a comprised of anti-science, anti-government, and anti-reform sentiments that threaten to halt whatever progress might be made through the Corps. Only recently has there been hope that a new model for climate change adaptation might be found. But even there, the results of RBD are being whittled away by the shearing force of those sentiments.

This chapter has focused on underscoring those forces and their influence on coastal resilience across three fronts. One is to make clear that the characteristics of our coast are a reflection of the institutions that govern them. No amount of design intelligence can alter a system that is designed to exclude it. In Galveston, Norfolk, and New York, the coast is a reflection of the Corps: rigid and robust-yet-fragile. A second is that politics of resilience are ordered in such a way as to counteract any bottom-up effort to counteract the institutional inertia of the Corps is inevitably stripped away. The solidarity one might expect to
find in regions universally imperiled by the threat of sea level rise is mostly absent along the American coast. There simply is not enough money or protection to go around and all of those at risk know it. If the market-oriented process of crisis-driven urbanization is left to govern who gets protection and when, the results will be devastating: the wealthiest enclaves of New York, Norfolk, and Galveston will receive considerable public investments in new infrastructure while the rest are left to face the threat of rising seas on their own.

But the third argument made in this chapter is that there are real limits to all of these impediments and some cities are pushing up against them. By that I mean more than just the technological limits of a grey infrastructure-only approach to coastal engineering – I mean a limit to the politics of obstruction that have defined prior eras of coastal urbanism. A point will come when the inertia of the USACE and the obdurateness of local politics break down and an opening for new ideas about building resilience in coastal cities through nature-based design strategies will appear. In Galveston, Norfolk, and New York, that breakdown is coming – and will continue to come – through the disruption of tropical storm events. Hurricane Ike (2008) and Superstorm Sandy (2012) unleashed a torrent of ambitious, progressive planning efforts in each city. They are the focus of the next chapter.
Figure 26: The Galveston Greenprint Plan (2007). This map, drawn by planners with the Texas chapter of the Trust for Public Land, shows where shoreline erosion is an issue along the east and west end neighborhoods of the island.
Figure 27: The WMRT Plan for Norfolk (1974). This illustration, produced as part of the firm’s comprehensive plan for the city, shows the downtown waterfront of Norfolk and several of its neighborhoods.
Figure 28: The WMRT Plan for Norfolk (1974). This series of maps shows the growth – both in development and in land mass via fill – of Norfolk's downtown core.
Figure 29: The Division of Surveys Map of High Tide in Norfolk (1933). This map, used in the WMRT analysis section of the city’s plan, shows the historic flooding issues in Norfolk.
Figure 30: The Hurricane Evacuation Zones of New York (2006). This image was used within the On the Water competition to illustrate the flood risk posed to the city pre-Sandy.
Figure 31: The New Urban Ground Proposal for New York’s Waterfront (2011). These images, produced for the Rising Currents Exhibition by dlandstudio, show the growth of Manhattan’s waterfront via fill (pp 53) and a proposal for softening the area’s edge via nature-based strategies (pp 54).
Figure 32: The Oytser-tecture Proposal for New York’s Waterfront (2011). This image, produced by SCAPE/Landscape Architecture, shows a plan for oyster bed restoration in the New York Harbor. It grew into the Living Breakwaters plan for Staten Island, discussed in chapter four.
CHAPTER 4 — Unnatural Futures: How the Relationship between Resilience Politics and Nature-Based Strategies is Reshaping the Coast in Galveston, Norfolk, and New York

In this chapter, I examine the ways in which attitudes about nature, resilience politics, and engineering legacies are influencing the post-disaster recovery projects under consideration in Galveston, Norfolk, and New York. It builds on chapters two and three by contextualizing and critiquing nine proposed projects – three in Galveston, three in Norfolk, and three in New York City – that are intended to protect each city from future surge risk and climate change. I rely on primary sources, key informant interviews, and public documents to address a question at the core of this dissertation: how are philosophical tropes of nature reflected in design culture and, as a result, in the urbanism of coastal cities?

Drawing from the experiences of residents, planners, designers, and policy-makers in Galveston, Norfolk, and New York City, I posit that, for all its progress, design culture remains enamored with aesthetics over performance or, at the very least, that it privileges the art of resilience over the science of it. As this chapter will show, that creates issues for coastal cities where, for reasons entangled in Romantic ideas of nature and the need for its restoration, many of these post-disaster recovery proposals call for a recreation of landscapes lost during the 19th and 20th centuries – and which are no longer viable in this era of climate change and habitat migration.
But first it is important to note that the coalitions driving each city’s resilience planning are unique: engineers and marine scientists in Galveston, elected officials and city planners in Norfolk, and designers in New York. As this chapter will show, the proposals under consideration in each city clearly differ in ways that one might expect, given their differences in leadership. For example, conventional engineering methods of coastal resilience are at the core of Galveston’s projects while more programmatic and policy-driven ideas form the basis of Norfolk’s.

I begin in Galveston, where three major coastal protection projects are now under review by the Corps as a part of their statewide “Coastal Texas” study: the Ike Dike, the Centennial Gate System, and the Ring Levee System. Using the logic of the island’s seawall, the Ike Dike proposes a system of walls, levees, dunes, and other structural protections that extend across the entire length of the region’s coastline. It is an archetypal resistance-based approach to coastal resilience. The Ring Levee and Centennial Gate Systems proposed more modest interventions. Each calls for a series of nature-based restoration projects, including coastal wetlands and marshlands, to help stabilize the shoreline of Galveston Bay along with a few strategic structural protections – levees for the Ring Levee System and a surge gate for the Centennial Gate System – to fortify

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the most densely populated areas in the region. Slated to conclude in late 2021, the goal of the Coastal Texas study is to conduct an in-depth analysis of each project’s viability, to compare their tradeoffs, and to select one for further study and, eventually, implementation.

Next, I examine three proposals under consideration in Norfolk: the Vision 2100 Comprehensive Plan, the Chesterfield Heights Redevelopment Plan (CHRP), and the Fingers of High Ground proposal for the broader Hampton Roads region. Both plans eschew investments in major, structural protections. Instead, they call for a policy-driven approach to resilience that provides incentives for homeowners to build rain gardens and green infrastructure on their property and expansion of the city’s welfare system to better equip its working-class population for challenges and stress that sea level rise will bring to the low-lying, mid-Atlantic city. If Galveston’s proposals represent the structural pole of resilience-focused options for cities, Norfolk’s two plans occupy the opposite end of that spectrum. The Fingers of High Ground proposal – which calls for a strategic, managed retreat to sparsely populated areas of high elevation along the Virginia coast – rests somewhere in-between.

Finally, I assess three projects under development in New York City: the BIG U or Dryline proposal for Lower Manhattan, the Living Breakwaters proposal for Staten Island, and the Lifelines Proposal for the Bronx. The proposals vary as much as the conditions and culture of the three boroughs they traverse. The Dryline builds upon the Dutch legacy of coastal fortification by calling for a
massive, U-shaped surge barrier along the southern tip of Manhattan. Driven in part by that legacy – and in part by the economic imperative to protect the financial industry assets in the area – that project is closer to implementation than any other that is discussed in this dissertation. It also represents a rather advanced interpretation of naturalness, eschewing the tendency of designers to draw a line between what constitutes ecology and what represents culture. In this regard, it stands inapposite to many of the ideas about nature that are entangled in the Living Breakwaters proposal – which calls for a restoration of the once-vibrant bivalve population in New York Harbor as an instrument of resilience on Staten Island. But rather than building on – and extending the meaning of – the legacy of cultural natures in the region, this proposal tends to sentimentalize ecology and to reinforce dangerous tropes about where – and if – such a line should be drawn. The Lifelines proposal, like Norfolk’s Fingers of High Ground, rests somewhere between those poles in New York City.

But before I present the more detailed findings and insights that my fieldwork in each city provides for each of these projects, it is important to step back and reiterate how and why these proposals – and these three cities – are grouped together in this dissertation. One rationale for placing all of these projects together in this chapter stems from a question I posed in chapter one: how might the difference between the risks posed by storm surge and those posed by tidal and wind-driven flooding provoke different responses to coastal design in U.S. cities? It would be difficult to find a better grouping of cities to
answer that question than these three. Galveston, a barrier island completely exposed to the Gulf of Mexico, faces extraordinary surge-driven flood risks. Norfolk, conversely, faces little in the way of surge risk. It, as a well-protected and low-lying port city, is exposed to the risks posed by sea level rise – and the resulting increases in tidal and wind-driven flooding that will ensue. New York City faces moderate degrees of both risk types. Together, the three cities represent the full spectrum of flood risks facing coastal cities in the U.S.

Of course, the question of how experience with coastal storms and disaster influences urban adaptation strategies also serves as a link between Galveston, Norfolk, and New York City. As I discussed in chapter one, these three cities were selected purposefully and, in part, because their individual levels of experience with tropical storms ranged from very low (Norfolk) to very high (Galveston), with New York in-between. The matrix illustrated in chapter one is useful here, too.202

Finally, it is also important to underscore a critical point of differentiation between these three cities: their biogeographies vary widely. A stated goal of this dissertation is to develop a portable strategy for coastal resilience – one that can be deployed in cities like Boston, Savannah, and Tampa as well as Galveston, Norfolk, and New York City. Their internal geographic variations are not a mark against their usefulness as a group. Rather, it is a point of leverage in extending

202 See Image Appendix, Figure 1.
the findings of Galveston, Norfolk, and New York City beyond their municipal or regional boundaries and out across the whole of the Gulf and Atlantic coasts. As chapter five discusses in far greater detail, there is much that other barrier island communities, port cities, and global cities can learn from the projects discussed in this dissertation.

**Recovering Nature in Galveston**

Few cities are as experienced with disaster as Galveston. Since the federal government began recording tropical storm events in 1848, the barrier island community has been struck by at least fifty-seven tropical storms – one every 2.9 years. Outside of Miami and New Orleans, Galveston is the most storm-plagued city in the United States – a heavy burden for an island community with just north of fifty-thousand residents. It lacks both the internal financial resources of those cities as well as the state and national political clout that they demand in the aftermath of disaster. It is both a literal and a figurative island, unto itself, pushing against the ocean.

The Great Storm of 1900 marked the start of Galveston’s modern coastal planning era. In its aftermath, planners and engineers throughout southeast Texas turned to extreme earth-moving and massive structural protection projects to lessen the impact of storm events on the island. The coastal fortress they erected in and around Galveston withstood most of the twentieth century’s natural challenges – a series of powerful, unnamed storms in the 1910s failed to breach the island’s new seawall, inspiring a tourism-focused postcard series for
the region; a series of named storms in the 1950s and 1960s wrought havoc in the unprotected regions beyond the seawall, inspiring Galveston to extend its flood control system for more than one-hundred blocks; and Hurricane Alicia’s 1983 landfall stripped what remained of the island’s seawall beaches without overtopping any of its flood-control infrastructure. By the end of the twentieth century, Galveston’s surge protection system was considered complete – a massive triumph of technology that preserved the barrier island’s future. But its completion also signaled the limits of this grey-only approach to resilience. The wall could not be built any higher nor extended any further.

Tropical Storm Allison, a relatively weak system that made landfall in 2001, dumped nearly four feet of rain over the region and exposed one of the biggest flaws in Galveston’s approach – its seawall did little more than keep floodwaters in place. The extraordinary rainfall wrought by Allison – much of which fell on the mainland – filtered into Galveston Bay and then over the island, where it pooled, inundating the homes behind the seawall for weeks. But Allison lacked the surge height and wind velocity that could have transformed this local disaster into a catastrophe of national proportions – buildings were simply flooded, not blown off their foundations and swept to sea. Galveston would not be so lucky during its next storm event – Hurricane Ike.
On September 14, 2008, the Galveston Bay region lay in ruins unlike any time since 1900\textsuperscript{203}. Three-fourths of the island’s homes, businesses, and other structures lay scattered across the briny, post-Ike landscape\textsuperscript{204}. The low, undulating dune system that once rimmed the seaward edge of the Texas coast was now imperceptible. The once impenetrable seawall and surge protection system lay solemn in its first defeat. A clear path of erasure stretched from the beaches of Galveston Island to the Houston suburbs of Kemah, Baytown, and League City. Fish flopped and snakes slithered across FM3005, the westward evacuation route off the island that became washed out long before Ike made landfall\textsuperscript{205}. By the time the insurance agents and actuaries finished surveying the aftermath, Ike’s damage total rose to almost 150 billion dollars – the second-most in US history\textsuperscript{206}. Nature – however fleetingly – had wrest Galveston back from its inhabitants in one dramatic moment. Yet Ike and Galveston remain mostly absent from the discourse on landscape planning and resilience.

That’s because on September 15, 2008, Lehman Brothers filed for Chapter 11 bankruptcy protection and represented the opening salvo in what would become known as the Great Recession. As a result, the national press and the federal government quickly pivoted away from disaster recovery in Galveston and towards a desperate gambit to stave off national economic

\textsuperscript{203} “Major storms make landfall in the region once every eleven years” Federal Emergency Management Agency, “Disaster Declarations by Year,” \url{https://www.fema.gov/disasters/grid/year}.


\textsuperscript{205} Anonymous interview with local elected official, Galveston, TX, March 21, 2016.

\textsuperscript{206} TEES. 2012. “Hurricane Ike Impact Report.”
collapse. This deprived the region’s residents of the attention and resources that typically follow in the aftermath of a storm like Ike. Nearly a decade later, the region has largely recovered from the worst of Ike – homes have been rebuilt, roads cleared, and beaches re-nourished. But little has been done to deal with the vulnerabilities that enabled Ike – namely the region’s reliance on a single, aging piece of grey infrastructure to mitigate flood risk. Galveston remains one of the nation’s most vulnerable territories to storm events and sea level rise. More than half of the region holds an insurance policy through the NFIP – meaning that more than half of the region faces exceptionally high flood risks.

This section aims to accomplish two goals. The first is to provide a clear context for the issues facing the Galveston region. The sprawling, cheaply built residential development endemic to Texas, the dense cluster of petrochemical facilities rimming the Bay, and the resilience politics of Galveston are all critical to framing that context. The second is to describe, assess, and critique the three proposals for new resilience infrastructure that emerged in the aftermath of Hurricane Ike: the Ike Dike, the Centennial Gate, and the Ring Levee systems. I use semi-structured interviews, public documents, and public meeting minutes to do so.

The Contemporary Context for Coastal Resilience in Galveston

The Corps wastes a lot of money. They have to look at every alternative. All the crap they have to do is nonsense. I describe it like buying a house. There’s one-hundred to buy and I can get down to three or four pretty fast. I’ll look at those pretty hard, but
not all one-hundred. But the Corps has to – that’s part of their charge. It costs a lot more money that in should.207

Galveston Bay and its distributaries – the San Jacinto, Buffalo Bayou, and Trinity Rivers – represent the largest ecological system within the nation’s fourth-largest and fastest-growing urban region: the Houston Metropolitan area.208 More than six million people reside in and around the Houston-Galveston region. Half of those residents live in a marshy surge zone encircling the Bay. There, a sprawling patchwork of tract homes and wide, winding roadways blanket the low-lying, flood-prone landscape of Houston. This tapestry of low-density development has so overwhelmed the hydrological system of southeast Texas that seasonal flood events now trigger devastating floods throughout much of Houston’s suburban landscape.

While the presence of these homes in the surge zone is a problem unto itself, their vulnerability is complicated by the lax land development regulations that guide growth in and around Houston. Most of these homes were developed in flood-prone environments according to building codes that fail to account for that risk. Put another way, much of the new construction in Southeast Texas is built for a different landscape than the one it occupies. Simple inundation routinely devastates communities in the surge zone around the Bay. Tropical

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storm-driven flood events threaten to remove those communities from the Texas landscape altogether.\textsuperscript{209}

Though this might force one to ask why a city like Galveston would knowingly facilitate such a vulnerable development pattern, the rationale for building cheap homes in a flood-prone landscape is quite clear. The suburban communities surrounding Houston are simply vying for their share of the region’s population boom. Spurred on by the growth in the oil and petrochemical industries based there over the last two decades, Texas City, Kemah, League City, and many other communities hoped to capture the property tax receipts that these new residents could provide. In Texas, where property taxes are extraordinarily high in order to offset the absence of a state income tax, this led these suburban communities to compete in a race to the bottom for new residents – a lucrative and vital component of their municipal operating budgets.\textsuperscript{210} Nowhere is the process more evident than in the surge zone surrounding Houston. There, cheap land and cheap housing coalesced to pack hundreds of thousands of new residents into a high-risk coastal landscape.

Houston’s suburbs came to embody much of what Joel Kotkin refers to as “opportunity urbanism”, or the notion that a deregulated land development market is the key to creating an affordable, virtuous metropolis.\textsuperscript{211} If focused solely on

\textsuperscript{211} Joel Kotkin. 2014. Opportunity Urbanism: Creating Cities for Upward Mobility (Houston, TX: Center for Opportunity Urbanism).
housing affordability, Houston might be considered wildly successful – despite being the nation’s fourth-largest and fastest-growing region, its median home price sits at $162,000 – placing it in the bottom quintile for home prices amongst the 100 largest metropolitan regions in the US. But the problem with using such a simplistic measure for success is that it completely ignores what the quality of life for Houston’s residents is – and how the hidden costs of sprawl undermine whatever notion of affordability such an approach might use. Homes are cheap when land is plentiful, construction is deregulated, or amenities are scarce. All of these are true in Houston. There, it is also true that cheap housing comes at a tremendous cost – residents are forced to drive great distances for work and entertainment, resulting in the second-most congestion of any city in the US. The low-cost of the region’s housing market comes at a steep social and ecological price. Kotkin’s affinity for opportunity urbanism belies the precariousness of shuffling low- and middle-income families into poorly-built homes in a flood-prone landscape. If there is no such thing as a free lunch, neither is there such a thing as a cheap home – the costs are just borne in other, less obvious ways.

The magnet that has drawn to many people to the Houston region is the booming petrochemical industry headquartered in and around Galveston Bay. Multi-billion dollar private investments in oil refining capacity, petrochemical processing and storage, and port infrastructure has constantly pushed the region’s center of economic gravity towards the water’s edge. Workers followed that drift seaward, flooding the coast with hundreds of thousands of new
residents over the last two decades. As a result, Galveston Bay is emblematic of
the risks posed by climate change to most port cities: the social and economic
fortunes of Southeast Texas are dependent upon proximity and access to open
water. Prosperity and vulnerability are inextricable in Galveston.

The region already boasts the largest cluster of petrochemical activity in
the nation, with nearly 30% of all domestic refining capacity operating in and
around the Bay.\textsuperscript{212} It is the petrochemical capital of the United States, if not the
world. It is also home to the nation’s second (Houston), fourth (Beaumont),
thirteenth (Texas City), eighteenth (Port Arthur), and forty-ninth (Galveston)
largest ports by tonnage in the US.\textsuperscript{213} All of these port facilities are expected to
grow as a result of the Panama Canal expansion – a massive dredging operation
aimed at allowing larger container ships to traverse the waterway.\textsuperscript{214} Many of
them also abut, intersect, or otherwise conflict with the sprawling patchwork of
suburban homes that makeup the region.

Put another way, the fastest growing metropolis in the US is rapidly
pervading the nation’s densest cluster of petrochemical operations. Placing
residential homes alongside such heavy industry poses a unique set of problems
in Galveston, all of which are complicated by rising seas. As a result, the

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\item Greater Houston Partnership, “Houston’s Economy,”
\item Bureau of Transportation Statistics, “Tonnage of Top 50 US Water Ports, Ranked by Total Tons,”
\item Brian Davis, Rob Holmes & Brett Milligan. 2015. “Isthmus: Panama Canal Expansion,” Places Journal
https://placesjournal.org/article/isthmus-panama-canal-expansion.
\end{enumerate}
\end{footnotesize}
residents of Galveston Bay face more than the simple risk of inundation. They fact the risk of exposure to the petrochemical slurry stored within and around their communities. They face the risk of being left with a toxic, untenable neighborhood in the aftermath of the next storm. They face a risk that the seawall can no longer mitigate.

The Ike Dike and the Death of Nature

I’ve worked with the Dutch on other projects and when Ike hit…I remember mentioning to my wife that the Dutch would not have put up with this mess. Ike hit in September. In November, I wrote an op-ed saying we ought to build it – I called it the Ike Dike then…it was the first time anyone on the island put an idea on the table for a defense similar to what the Dutch have.\textsuperscript{215}

In this section, I aim to accomplish three goals. One is to provide a basic description of the Ike Dike surge protection system – where it will be located, how it will work, who is supporting it, and how much it might cost. Another is to connect the relationship between the Ike Dike and its environs with different ideas about nature and resilience – the provenance of its intellectual foundations, the environmental philosophies guiding its development, and the body of resilience theory from which it arose. The final goal is to then discuss its perception amongst the technical experts, public officials, and community leaders with whom I spoke for this dissertation – who is supporting, who is not, and why.

The Ike Dike is a proposed coastal spine spanning the seaward side of Galveston Island, Bolivar Peninsula, and San Luis Pass. It is a 50-mile-long

network of structurally reinforced dunes, extensions to the existing seawall, and flood gates at the mouth of the Houston Ship Channel all aimed as resisting and deflecting the surge energy produced by storms like Ike. Promulgated by Bill Merrell, the project represents a wholesale adoption of the resistance philosophy common to engineering-based theories of resilience.\(^{216}\) The Ike Dike is, essentially, a massive fortification project – one that stretches across the most densely-settled portions of the Galveston Bay region. Its cost estimates range from three to eight billion dollars, though none has yet determined how extensive its foundation will need to be.\(^{217}\)

The conceptual parallels between the resistance approach of the Ike Dike and the Dutch methods of flood control are obvious – and openly acknowledged by Merrell and other proponents of the project. In Holland’s coastal defense system, structural protections are deployed to keep water out of its major cities. Walls, levees, and hybridized dunes – though aesthetically varied – provide similar functions in the Dutch system. Though the Dutch methods have kept Amsterdam and Rotterdam dry for a half-century, their approach has also led to the creation of one of the world’s largest hypoxic zones – otherwise known as dead zones, where, as a result of pollution-driven algae blooms, oxygen levels are too low to sustain marine life. Merrell and his colleagues have yet to offer up


an explanation for how the Ike Dike might deviate from the destructive legacy of the Dutch.

The Ike Dike is mostly supported by the technical experts and consulting groups either working on it or that stand to profit from its construction – though they would likely disagree with that assessment. This is because, during the course of the project’s development, Merrell and others have been pitching the idea in communities along the seaside of Galveston Bay in public meetings and events. During those meetings, they often ask mayors and other community leaders to sign a letter of support for the Ike Dike – something they are quick to note that twenty-six communities have already done. But, as a state official in the GLO noted, that claim is dubious. “They have gone to these communities and said sign this form if you want hurricane protection, instead of saying is it OK if we block your sightlines or direct access to the beach with a beach structure that provides you some protection. That’s a bit different. They’ve been inflating their support for it…and I have concerns about why they’re doing that.”

One city councilor put it more bluntly, noting that “The Ike Dike is being driven by a small core of Galvestonians who have, I think, a personal financial interest in it. You have people who work in non-profits, sure, but they also sit on boards at all the banks in our region. When the Ike Dike gets built, who is going to be lending the capital for it? You have one person pushing it who has two firms named “Coastal Solutions” and “Beach Reconstruction, Inc.” You can’t tell me they’re not trying to

get their finger in the pie.”

Put another way, the Ike Dike is far from the foregone conclusion in Galveston that its progenitors often claim it is.

As a piece of physical infrastructure, the Ike Dike is emblematic of three philosophical positions – two pertaining to environmental thought and one to resilience theory. The first treats nature as a wild other – a dark, destructive force in need of human control. This is common to most surge protection infrastructure, as their necessity is premised on the idea that tropical storms and hazards are dangerous yet controllable phenomena. For most other barrier islands, a massive, multi-billion dollar defense system would be laughable. In Galveston, however, the Ike Dike has garnered significant attention because of the high-value petrochemical, shipping, and logistics operations on and around the island. “It would cost about 1/3 of what was spent in New Orleans. When you look at the shutdown of the petrochemical complex in Houston, that’s really nothing. We lose that network and you’re talking about percentage points of GDP lost – just billions and billions. The Ike Dike would cost far less than a single shutdown – and a coastal spine is the only way to control surge risk on a barrier island like ours.”

In a sense, the Ike Dike is viewed by its proponents as both a mechanism for controlling nature and flood risk and as a messianic force – one capable of sustaining the petrochemical-driven vitality of Galveston over the next century.

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The second philosophical foundation of the Ike Dike is the belief that nature no longer exists – that ecological and sociological forces are indistinguishable from one another. In Galveston, this flows from the extraordinary impact of industrialization and coastal erosion control projects on the physical landscape. The beaches rimming the island’s seawall must be nourished every eighteen months – without it, they would be scoured completely away in just a few years. The ship channel must be dredged every two years or it would quickly become impassable for large container ships. The bay is rimmed with acres of constructed marshland – projects that began during the 1970s and continue today to soften the region’s edge. One proponent of the Ike Dike argued that “it’s an excuse to restore the natural environment we’ve lost over the last century. If you haven’t noticed, people here are always saying we need to stop the Ike Dike and save nature. I’m like, where the hell is nature? This is not a pristine environment. Galveston Island is completely human-derived – the sand we’re sitting on top of right now was pumped here over one hundred years ago. The only way to get any of that naturalness back is to build a coastal spine – that gives you the opportunity to integrate major restoration projects into the defensive ones.”

This, too, hints at the messianic quality often ascribed to the Ike Dike by its adherents. They tend to frame it is an instrument for both saving the island and for saving nature.

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The third philosophical underpinning of the Ike Dike is driven by the resistance approach to resilience found in engineering. In this body of resilience theory, fracture-critical design – which involves developing massive, single-purpose, structural solutions to flood-risk reduction – is the primary mode of operation. In Galveston, the affinity for this sort of coastal engineering has roots in the success of the island’s great seawall. An engineer working on the Ike Dike described its viability in Galveston by saying that “avoidance is always your first line of defense. But it’s usually not politically feasible – and it certainly isn’t here. Then folks will often turn to wetlands. But in our research, they’re really good at reducing rainfall-based flood damage; not so much for surge-based flooding…because when the surge comes, it’s usually preceded by a forerunner, so that the water rises to submerge the wetland long before the real surge comes. The same is true for near-shore reefs – they just can’t provide the protection you need in a situation like this.\(^{222}\) Only a coastal spine can protect this region – and it needs protection. Simple avoidance or landscape approaches won’t be enough.\(^{223}\)

Support for the Ike Dike is mostly comprised of the technocrats who developed the proposal and the local elites in a position to benefit from its construction. Though there is a broad consensus in and around Galveston to build some form of surge protection, that general reservoir of support is not


specific to the Ike Dike – despite what its progenitors might claim. One of the marine scientists who first proposed the coastal spine project, noted that “I truly believe we ought to have a defense similar to what the Dutch have…I know that they worked there and they have proven themselves over many, many years. I don’t see a reason why we can’t do it [in Galveston].”

Though the influence of the Dutch on American coastal planning is well-known in New Orleans, New York, and even Norfolk, their outsized influence in Galveston emerged unexpectedly over the course of this project. Much of this is owed to the way that the USACE evaluates coastal defense projects and the proclivity of Dutch-like surge barriers to score well within their cost-benefit assessment framework. A local coastal engineer noted that “It’s just not very expensive…to build a coastal barrier. The Ike Dike might cost ten billion dollars – at the most – but it’s likely to only run about six billion…maybe even five if you let it be leaky. That’s just a rounding error for the Corps.” All told, supporters of the Ike Dike have invested nearly six million dollars in its development – $400,000 from the city of Galveston on its initial study, just over $1,000,000 to model its impacts in grant funding, and $5,000,000 to continue studying its environmental impacts via the National Science Foundation. While the project’s support is quite deep, it’s also very narrow – the Ike Dike is favored by a handful of ardent proponents, viewed agnostically by a significant portion of the region,

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and greeted with hostility by a number of other scientists, public officials, and community organizations in and around Galveston.

Opposition to the Ike Dike is driven by a coalition of pragmatists, who believe the project is unrealistic, and environmentalists, who believe that the project would obliterate the local fisheries and ecosystem services provided by the bay. Some of it is being driven by the resilience politics of the region. A public official in Galveston remarked that “To me, the Ike Dike is really fanciful… I know how DC works. There’s no fucking way we’re getting the Ike Dike. One of the things [its supporters] will say is that the defense industry is here and they’re right. But if you go to the refineries where the defense industry has contracts for fuel and petrochemicals, there are already dikes around them.”

The opposition to the project also includes those who are skeptical of the Corps’ ability to deliver it in a timely fashion. Another local elected official noted that “The current path for the Ike Dike funding is through a USACE program that has yet to produce a single funded project…I think they put it there just to get rid of it… People here think that if we go to DC and just shake some hands and make our case that there’s going to be some breakthrough – that a guy who’s worked in a senate office for three years is going to champion this to their boss… But I think the Ike Dike has as much a chance of happening as Disney opening up a theme park in Galveston.”

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Still others I met with over the course of my fieldwork expressed considerable doubt about the technical and economic challenges of building an island-wide barrier system. One marine scientist remarked that “the cost-effectiveness of [the Ike Dike] is dramatically bad when you consider that most of the high-value infrastructure in Galveston Bay has already mitigated its own hazards. The refinery complexes are already protected, so taking them out of the cost-benefit equation just makes it very unlikely that any analysis of structural flood protection is going to prove viable.”

Though the Ike Dike dominated the local discourse in the immediate aftermath of Hurricane Ike, its support waned as other ideas began to percolate. A GLO official remarked that “my cursory view is that the cost-benefit ratio of the Ike Dike is about half of what the [Centennial Gate and Ring Levee] projects show. Those would come in around 3.5 or 4.0 and the Ike Dike is about 1.7…But even if we did more analysis and those ratios came out to be even, there’s still a big environmental question with the Ike Dike that the others won’t face – and that could be the deal-breaker on the Ike Dike.” Put another way, the Ike Dike is unlikely to satisfy the USACE’s cost-benefit requirements for project selection and, even if it does, it seems unlikely to pass an alternatives assessment between it and other proposals for Galveston. The GLO official went on to say that “I try to be as objective as I can about this…but one thing I’ll note is that I’m

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concerned about the Ike Dike being a single system solution – and a very
dexpensive one at that. You have to put together the funding to build the entire
system at once because you need the whole system for it to be effective. But the
alternatives are more discrete projects that you could prioritize and tackle in a
manageable way with some immediate impacts. The Ike Dike concept just won’t
allow that.”

The Centennial Gate and the Recovery of Nature
I’ll tell you what’s really frustrating – the emphasis on or diversion of
attention that the structural hazard mitigation people have created
in the Ike Dike…despite the fact that non-structural methods are
more cost-effective and easier to implement in the short-term in
Galveston. But it’s hard to get any oxygen to those ideas because
they aren’t conventional and, at least so far, they haven’t had the
kind of financial backing that the Ike Dike has.

Formulated in response to the ecologically destructive potential of the Ike Dike,
the Centennial Gate System adopts a radically different approach to coastal
resilience. Rather than armoring the coastline with a single, monolithic
infrastructural barrier, the Centennial Gate System relies on several smaller
elements across the region. At the mouth of the Houston Ship Channel, it
proposes a retractable flood gate akin to the Delta Works installation in Holland.
Elsewhere, it relies on nature-based strategies to reduce surge impacts and
restore the hydrological functions of the coastal zone. Developed using the
results of SLOSH modeling analyses, it places oyster reefs, wetlands, and new
dune complexes in strategic places along the coast. Its cost estimates range from about $3-4 billion.233

Developed by a team of engineers and lawyers at Rice University, the Centennial Gate System treats much of Galveston Island and Bolivar Peninsula as sacrificial zones for the broader region. Drawing from ecological resilience theory, it uses the island as a buffer and shock absorber for the rest of the region.234 Historically, this role has defined the relationship between barrier islands and the mainland. But, of course, this precedent predates modern human settlement and its applicability to the industrial, petrochemical nature of Galveston is questionable at best. Nevertheless, the Centennial Gate System departs in several key ways from the resistance logic of the Ike Dike. It does so by focusing on increasing the storage and buffering capacity of the regional landscape.

The concept’s coalition of support is mostly comprised of Houston-based researchers and environmentalists working throughout the Galveston Bay region. A planner in Galveston noted that “It’s mainly…the SSPEED Center that are driving the Centennial Gate proposal…It includes the big gate at the ship channel, but it also uses dredge material to create islands, making a mid-bay…to

estimate storm-related damages in coastal communities. A more detailed description can be found at: http://www.nhc.noaa.gov/surge/slosh.php.


counter the Ike Dike. They’re also pushing for more conservation and nature-based strategies, most of which feed into what they’re calling the ‘Lone Star National Recreation Area’ – a Texas version of the national seashore by the Golden Gate Bridge.”

But the Centennial Gate has its own ardent opposition. Some are critical of the influence of researchers in Houston on the fate of Galveston Island. A marine scientist in the region remarked that “Rice is just driven by money. They’re funded by the Houston Endowment…they literally funded Rice just to contradict the Ike Dike for personal and political reasons…So we’ve pitted [Rice and Texas A&M] against each other and we’re wasting lots of time and money, duplicating efforts, and keeping findings secret…We shouldn’t be surprised that a bunch of folks in Houston want to use Galveston as a surge barrier for their city – but that doesn’t mean we should accept it.”

Others have been critical about the staunch, ideological opposition from environmental groups who, they argue, would try to block any major public works project in Galveston. “You have all these hardcore people…especially environmental attorneys…who get a lot of money to fight things. They wouldn’t make any money unless they were able to convince folks that we are out to

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destroy the world…But so far, nobody can tell me anything they’ve done that has stuck.”

Though the Centennial Gate is as conceptually and politically fraught as the Ike Dike in most respects, it does have some economic advantages. Its estimated cost-benefit ratio is nearly double that of the Ike Dike. It also spreads improvements around the entire bay, rather than isolating them along the Galveston Island waterfront.

The Centennial Gate System is archetypal of two philosophical positions – one derived from environmental thought and one from resilience theory. The first views nature – or, in this case, nature-based strategies – as instruments of healing and restoration. It views nature as a fallen thing to be recovered if humanity is to be redeemed. Amongst landscape architects, this is a familiar trope. Designers often deploy images of lush, verdant landscapes to win contracts from clients and support from communities for their services.

But many of these frames ignore the material benefits of urban greening – the ecosystem services that urban ecology can provide and, in flood-prone areas, the reduction in property damage they can facilitate. In coastal zones, the notion of restoration and healing – particularly in the petrochemical landscape of Galveston – is a powerful metaphor. A coastal engineer working on restoration

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projects in the area noted that “Over the years, Galveston Bay has lost thousands of acres of wetland…and our oyster fisheries have only recently begun to recover some of what was lost when the oil industry set up shop here.…There’s a lot of support for the National Seashore [component of the Centennial Gate System] because people can wrap their heads around it much more than they can the Ike Dike. Plus, few folks down here would have strong feelings against wider beaches, taller dunes, and better wetland and bay fisheries – and that’s really the core of the Gate proposal.”

The second philosophical position underpinning the Centennial Gate System is driven by the approach to resilience found in systems ecology theory. In this body of literature, design and policy interventions are considered optimal when they expedite a city’s return to normalcy after a disaster. In Galveston, the affinity for this approach to coastal resilience is a product of ecological nostalgia – or a desire amongst some to restore landscapes lost to industrialization over the last century. A planner in Galveston remarked that “The beaches here used to be much wider…and lined by all sorts of tourism destinations – hotels, restaurants, and that sort of thing. We still have some of that – but it’s all very kitschy and removed from the waterfront now…to enjoy the beachfront, you have to cross a six-lane highway, on foot, to get from most restaurants to the water. There’s nothing romantic about that.”

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The same goes for industry and economic concerns in Galveston. An economic development official on the island argued that “People here used to make a living on the water…but there aren’t many fisherman left in Galveston and our port, despite huge subsidies propping it up, isn’t able to compete anymore…Some people look at the [Centennial] Gate proposal and see a way to bring some of that back.”

In Galveston, support for the Centennial Gate System is inextricable from a nostalgia for a landscape and an economy that predates modernity.

The Ring Levee and the Control of Nature

That’s one of the weaknesses around the Ike Dike argument. The Ike Dike is saying that we’re going to go out there and put up this thing like they have in Holland to prevent the sea from coming in again. Well, we have the seawall and it has done a very good job of protecting us from the kind of flood the Ike Dike is designed to prevent. The thing is, during Hurricane Ike, the flooding came in from the bayside. The Ike Dike can’t fix that. We can just do a ring levee system around Galveston for about $250 million. The Ike Dike will cost at least $7 billion. Austin can pull the ring levee off. We need DC to pull the Ike Dike off – and I don’t see that happening in Texas.

Drawing on the popularity and success of Galveston Island’s century-old seawall, the Ring Levee proposal adopts a resistance approach akin to that of the Ike Dike. Unlike its more monolithic analog, however, the Ring Levee proposal does not aim to protect the entire coast evenly. Rather, it adopts a more strategic, nuanced posture by encircling the densest clusters of population with levees and treating the interstitial landscape as a sacrificial zone. It is a low-cost alternative

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to the Ike Dike and Centennial Gate systems, relying on neither a complex flood-grate operation nor the inclusion of any non-structural or nature-based strategies in its scheme. Instead, the Ring Levee system would simply raise and harden Galveston’s coastal edge, transforming the area from a fluid coastal zone into a static coastline. In a sense, this proposal is an implicit endorsement of the notion that nature and humanity cannot coexist – it is an argument in favor of them being harshly delineated.

If built, the Ring Levee system would be vulnerable to two sources of failure. One is that management of flood protection infrastructure is highly decentralized in the US. The USACE builds and operates most major coastal infrastructure projects while local governments are tasked with maintaining them. The problem with this model of governance is that few, if any, local governments possess the financial or technical capacity necessary to take on such maintenance. It is what undermined the levees in New Orleans long before Hurricane Katrina and it would likely undermine the Ring Levees in Galveston too. This lack of capacity is what inspired the Rockefeller Foundation’s 100 Resilient Cities Initiative – a global grant-making program that provides vulnerable cities with funding for Chief Resilience Officers to help marshal the financial and technical resources necessary to adapt to climate change.

Though it is a concern in all three proposals, it presents unique challenges to the Ring Levee System. Unlike the Ike Dike – which requires monitoring and maintenance on a single, large piece of infrastructure – or the Centennial Gate
System – which mostly requires that kind of attention on a single gate structure – the Ring Levee System is a complex patchwork of levees, most of which are disconnected from one another. Managing a multi-jurisdictional system is hard enough when it all ties into the same piece of physical infrastructure. The lesson from New Orleans is that, when those disparate parts are not tied together, such maintenance is nearly impossible.

The second source of potential failure is a product of the method used by the USACE to evaluate projects. Under this system, the Corps is forced to make the economic benefits of a project its primary concern – commercial activity, industrial operations, and property values specifically. The environmental impacts of a project are only considered qualitatively and, often, as an ancillary concern. Ecosystem services cannot be considered. Under this system, the only metric that matters it the cost-benefit ratio – which means that the heights of the levees in this proposal would not be determined by the amount of flood protection the community desires, but by the point at which the marginal benefit of additional height begins to decline. The result would be a cheaper, more economically efficient project that provides less overall protection to the Galveston Bay region. Though this would impact all three proposals, it would be particularly harmful to
the Ring Levee System given its wholesale reliance upon levees for resilience-making.\textsuperscript{243}

The Ring Levee system is a product of two design philosophies. One, like the Ike Dike, is that nature is a wild, chaotic force in need of human control. In Galveston, this ideology predominates the discourse on coastal planning – and has for more than a century. A public official in Galveston noted that “This debate has been going on since at least Hurricane Carlo in 1961. The USACE led a big study that went on for more than a decade…and it zeroed in on a ring levee system as the best solution for Galveston – which, by the way, was the initial plan for protecting Galveston before the 1900 Storm hit. But the city fathers and the business community saw the West End as their tax base and, because the levees excluded all the vacation homes out there, they wouldn’t agree to anything that left them unprotected. The Corps came back and said extending the levees that far wouldn’t pencil out – that they wouldn’t spend federal money just to protect rooftops. So the city passed on the ring levees a half-century ago and now here we are again – it’s always Groundhog Day on this island.”\textsuperscript{244}

The other is borne of a resistance-based approach to engineering resilience – one in which a fail-safe system is put in place to protect Galveston. In this regard, the Ring Levee system is also related to the Ike Dike – both


\textsuperscript{244} Anonymous interview with public official by author. Digital Recording. Galveston, February 23, 2016.
approach the issue of coastal resilience as one of control through structural interventions that keep water out at any cost. But as one city councilor noted, “neither one will get built – we have a chance if we get behind the ring levee right now. It’s an easier ask, a lower threshold, and it’s probably a better project – it’s certainly more strategic than a big dumb wall or spine across the entire coast. But until the next storm hits, neither one is going to get built.”

Settling for Nature in Norfolk

Few cities are as exposed to the risks of sea level rise and climate change as Norfolk. Though the region’s experience with tropical storm events pales in comparison to Galveston, its mean elevation – eight feet in Norfolk, ten feet in the Tidewater Region – puts millions of people and billions of dollars in military and freight operations at risk of inundation by 2100. Along the east coast, only New York and Miami face greater exposure to rising seas – both of which possess significantly more people and higher wages than Norfolk. This condition – along with declining wages and wealth – has dominated the climate change adaptation discourse in the city. As a result, there are no major structural interventions planned for Norfolk – just a series of small physical interventions overshadowed by a major, policy-driven approach to adaptation aimed at bolstering the coping capacity of the region’s residents.

Much of this is because, unlike Galveston and New York, Norfolk lacks any recent or significant experience with disaster and the crisis-driven urbanization that often proceeds it. Over the last half-century, no presidentially declared disaster has focused on Norfolk – though it is often included in such declarations due to its proximity to the more exposed community of Virginia Beach and the tendency of such declarations to include political, pork-barrel funding alongside disaster recovery funds.

As in the prior section on Galveston, I aim to accomplish two goals here. The first is to provide a clear context for the issues related to climate change that are facing Norfolk. The low-lying landscape, the density of major federal and freight operational assets, and the resilience politics of Norfolk are all essential to understanding that context. The second is to describe, assess, and critique three proposals for coastal resilience that emerged in Norfolk after Superstorm Sandy: the Chesterfield Heights Redevelopment Project, the Vision 2100 City Plan, and the Fingers of High Ground Proposal.

The Contemporary Context for Coastal Resilience in Norfolk

We don’t have the same kind of surge risk that, say, Virginia Beach does…and certainly not what Miami or New Orleans have. Norfolk mostly deals with N’oreasters – extratropical winter storms that dumps tons of rain and bring lots of wind-driven surge into the city…That’s our biggest risk – well, besides finding ourselves at the bottom of a slowly-filling bathtub.247

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The Chesapeake Bay watershed represents the largest ecological system within
the Tidewater Region of Virginia – for which Norfolk is the principal city. More
than 1.6 million people reside in the region, making it the thirty-seventh largest
metropolitan area in the US. Most of those residents live in homes with a
finished floor elevation of fifteen feet or less – placing at least one million people
and billions of dollars in property in the surge zone rimming the bay. The model
storm surge height used by the USACE in its disaster planning work is fifteen
feet.

In Norfolk, the precariousness of living in a surge zone is already evident
during monthly high tide events – when the Bay spills into the streets of
downtown Norfolk as it pushes its way through sewer outfalls that, as a result of
sea level rise, are now below mean high tide. When those monthly high tides are
coupled with small rain events, downtown Norfolk becomes a literal extension of
the Chesapeake – kayakers routinely paddle through the streets when the city’s
sewer system becomes overwhelmed by these dual forces.

Though the slow overwhelming of Norfolk’s stormwater infrastructure
began reaching a critical point more than a decade ago, Superstorm Sandy
brought national attention to the city’s issues. This is how Norfolk came to
receive its first substantial round of climate change adaptation funding in 2013.
Superstorm Sandy – which ravaged the Northeast megaregion in October 2012 –

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248 Hampton Roads Economic Development Alliance. 2015. “2015 Annual Report.” Available at:
left Norfolk relatively unscathed. But the post-Sandy disaster recovery appropriations included funding for the USACE to conduct a surge and flood-risk assessment for coastal communities along the majority of the eastern seaboard – Maine to South Carolina. Known as NACCS – the North American Coast Comprehensive Survey – the Corps' work focused on two outcomes. One was to measure and describe the risks posed by sea level rise along the east coast. This amounted to a straightforward mapping exercise, in which various sea level rise scenarios were overlaid with the results of SLOSH modeling to illustrate and define which areas faced the greatest risk of regular inundation. The second was to identify a series of design responses to those risks – a "project wish-list", as one member of the USACE described it. 249 Though it focused heavily on the conventional, grey infrastructure projects often associated with the Corps, it also became the first major USACE study to explicitly call for the use of nature-based strategies as instruments of flood-risk management. They received particular emphasis in and around Norfolk. The aim of that list was to provide the USACE Districts along the east coast with a rough work plan to guide their operations over the next several decades.

The NACCS proved important for at least two reasons. One is that it formally established nature-based strategies within the lexicon of the Corps. Though other initiatives preceded it, this post-Sandy moment became the push the USACE needed to begin considering an alternative approach to coastal

resilience. “We really…had to have some hard conversations [in the Corps] about what role some of our other, older projects might have played in making Sandy worse for some communities and how we might expand the kinds of projects we produce by considering non-structural protections like nature-based ones.”

The other is that NACCS provided a roadmap for other coastal districts to identify risk-mitigating projects going in the three-by-three-by-three era of the Corps. By breaking regional surge protection projects into smaller, discrete projects, NACCS allowed local districts to develop manageable work plans that avoided the expense and time of requesting waivers – a procedure that would have been necessary to design and construct any regional flood-risk management project after the reforms took effect. Coastal Texas – a similarly scaled and ambitious study of the state’s coast by the Corps – is modeled after NACCS and will include project recommendations in and around Galveston.

As the NACCS began to take shape, two additional, Rockefeller Foundation-funded initiatives began to focus on Norfolk: the Structures of Coastal Resilience (SCR) program and the 100 Resilient Cities (100RC) Initiative. Unlike the Rebuild by Design competition in New York, the SCR program was organized around funding more conventional design research in areas impacted by Superstorm Sandy. Built around four teams at Princeton University, the University of Pennsylvania, City College of New York, and Harvard University, it tasked interdisciplinary teams of engineers, scientists, and

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designers with developing prototypical ideas for climate adaptation in four urban areas: Narragansett Bay (RI), Jamaica Bay (NY), Atlantic City (NJ), and Norfolk (VA). In Norfolk, a Penn-led team developed a proposal known as Fingers of High Ground – a strategic retreat concept in which areas of existing high ground would be raised, reinforced, and then densely populated while low-lying areas in the Tidewater Region were sacrificed. As a local marine scientist remarked, “it’s what we would do if we planned for a retreat...Some version of this will probably happen, it just won’t be this well-organized. It will be market-driven and ad hoc.”

The other intervention in Norfolk came via the 100RC initiative. The Rockefeller Foundation recognized earlier than most that a limiting factor in which cities would be able to adapt to climate change and which would not was their capacity to marshal and analyze large and complex datasets. Put another way, a key factor in determining which cities would successfully navigate the subject of coastal resilience was their capacity – human and financial – to effectively plan with uncertainty. As a result, the 100RC initiative sought to identify cities in need of greater capacity and to provide them with the funding necessary to hire a Chief Resilience Officer, whose principal duty would be to work across local government agencies to develop a resilience plan for the city. In Norfolk, the result of the Rockefeller Foundation’s investment came in the form of Vision 2100 – a new city plan focused on the issue of sea level rise.

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Developed in concert with the USACE, the Dutch government, and experts in academia and private practice, the plan ultimately eschewed the kinds of big, structural interventions found in Galveston. Instead, Vision 2100 called for a series of modest, grey-green hybrid interventions in Norfolk’s most vulnerable neighborhoods and a much more ambitious programmatic agenda aimed at raising incomes and individual coping capacity amongst the city’s residents. As one of the planners who worked on the document described it, “Vision 2100 basically acknowledges that Norfolk is going under…and that the best thing we can do for our residents is to give them each the best tools for navigating a wetter, less certain future.”

One of the first projects to be developed from Vision 2100 is what has become known as the Chesterfield Heights Redevelopment Plan (CHRP). Chesterfield Heights is a mostly African-American, mixed-income neighborhood less than a mile from downtown Norfolk. Funded through a HUD appropriation as part of the National Disaster Resilience Competition, CHRP is emblematic of the broader resilience strategy in Norfolk: it primary focus is on parcel-level interventions, though the bulk of the HUD appropriation will go towards building a hybrid grey-green edge protection. As one of the architects of the plan described it, “CHRP is a pilot for the governing philosophy we’d like to push here in Norfolk – that resilience is best achieved here through individual actions…so we’d like to use this as a way to demonstrate that property-owners can mitigate much of their
own risk with a small subsidy and that [the government] should play a more passive, facilitative role.”

Together, these resilience strategies illustrate a key departure from the conventional approach to coastal planning in Norfolk – the recognition that large, structural protections cannot and should not be viewed as a panacea in flood risk mitigation. In this regard, Norfolk represents a sharp break from Galveston and the mega-projects dominating its planning efforts. Some of this is a product of the difference in the risks facing each city. Galveston is mostly concerned about storm surge – a product of both its recent experience with Hurricane Ike and its position as a barrier island. Norfolk is both less experienced with storm events and less exposed to wave energy – and thus it follows that its approach to coastal resilience would be less dramatic.

The Fingers of High Ground and an Ordered Nature

The fingers of high ground proposal – we’ll probably never achieve the level of implementation of effectiveness that’s in these documents, but, nevertheless, a version of that is probably the only practical way that one could manage the transition from what we have today to a functioning, human-occupied coastline in Norfolk.254

The proposal known as Fingers of High Ground is a strategic retreat concept that draws upon the forms and processes endemic to the Tidewater Region to create space for ecosystems to migrate and human settlements to shift from territories of high risk to ones of relative protection. It operates across two scales. One is as

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a relatively modest prototype intended as a proof-of-concept intervention over the short-term. At this scale, the proposal aims to identify areas of strategic high ground – places that will be dry and tenable through 2100 – and to direct or intensify new development towards them by raising or protecting them with new forms of hard and soft infrastructure. Around those high points, Fingers then calls for a variety of nature-based strategies in the lower-lying zones to restore floodplain functions, enable ecosystem migration, and provide continued access to the waterfront for Norfolk residents.

The second scale at which Fingers of High Ground proposes to operate involves a diffusion of its best prototypes across the Virginia coast over the next half-century. Because the concept is novel and viewed somewhat skeptically by the USACE, the proposal’s authors – Anu Mathur and Dilip Di Cuhna – argued that this prototyping approach is the best way create buy-in for the concept before deploying it at a much larger scale. They also argue that, at least in Virginia, this tactical, small-scale approach is necessary, given the complexity of the coastline and the paucity of physical, infrastructural options available to protect Norfolk. This proposal aims to coordinate those small actions into a system of flood protection that is greater than the sum of its parts.

Conceptually, this proposal is mostly without an analog in the US. In Galveston, the various proposals for coastal resilience are each predicated on dampening storm energy and, as a result, comprised of large, structural interventions. Many of New York’s RBD proposals are similarly designed. Those
that are not – including the Living Breakwaters proposal – are focused on restoring landscapes lost to urbanization over the last century, not creating a new, novel ecology for a wetter world. Based on my interviews and review of the public documents associated with the project, I believe this is the result of at least two underlying premises. One is that Norfolk is going under – no project can keep the city dry, not when its sewer outfalls are already sending seawater into the streets at high tide. Norfolk will always flood and, as time goes on, those floods will become more frequent and more severe as its stormwater management infrastructure is overwhelmed. The second is that it would be futile to work against the existing, crenulated landforms of the Virginia coast. The Fingers of High Ground proposal is, in essence, a plan to accentuate the peninsulas, spits, and ridges that traverse the Tidewater Region – to do for Norfolk what nature and conventional engineering could not: build a lasting refuge for human settlement on the coast.

The proposal is built around the idea that natural advantages can be accentuated to build resilience in cities. For Norfolk and the Hampton Roads Region, this means pursuing a two-part strategy along the coast. The first is raise, reinforce, and structurally encase the existing – and somewhat sparse – fingers of high elevation along the Virginia coastal plain. Akin to the cruder, early-20th century grade-raising and seawall construction in Galveston, the success of the Fingers proposal depends on the ability to re-engineer the region’s entire coastal environment. Though the USACE has not placed the project into its
larger, mid-Atlantic study plans, several of its officers expressed an admiration for the project’s ambition – and skepticism, as a result of its extraordinary expense, towards its feasibility. One member of the Corps remarked that “if money weren’t an object…it’s probably the way we’d want to go. But there’s a reason why managed retreats – and especially managed retreats…coupled with big new infrastructure investments don’t get built much in this country: they’re way too expensive. We can’t really justify including it in our alternative assessment yet…because of that [high probable cost].”

The second element of the Fingers strategy is equally ambitious – and politically and economically fraught. It calls for abandoning the lowest-lying portions of the Hampton Roads region, both as a mechanism for removing the risk of living along the coast and for creating the housing demand necessary to densely populate the new fingers of high ground it would create. It is a textbook example of an avoidance approach to resilience – in which people are simply removed from risky landscapes whenever possible.

Avoidance or managed retreats are quite good at reducing coastal risk. But the reason they are rarely executed in the U.S. stems from their high expense and their impact on cultural cohesion. Such efforts often require buyouts or land swaps – policy instruments that involve the purchase of high-risk properties by government agencies, which, as one can imagine, adds up rather

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quickly. For instance, the average home price in Norfolk is about $200,000. Just to buyout a thousand homeowners along the coast – not to relocate nor to invest in any of the other necessary upgrades – would cost at least $200 million. An elected official in Norfolk remarked that “The thing about [Fingers of High Ground] is that it would reset the land development market…and create a new set of incentives for where to build and live in Norfolk.”

That sort of mass relocation also disrupts years worth of social capital and cohesion – a trait disaster researchers consider extraordinarily important to the recovery and adaptation process. A marine scientist whose work focuses on the Hampton Roads region noted that, “If you look at the current array of residential development, commercial development, and topography, you can pretty much figure out – no matter what we do to the shoreline – what parts will be wet and which will be dry. So if we ask ourselves ‘what’s the best way to manage or control that inundation’, then a managed retreat like [Fingers of High Ground] is probably our best-case scenario…But it gets difficult when you realize that whatever you do will be inequitable and will cause political problems – it will create winners and losers across the Tidewater Region…Norfolk and Virginia

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Beach might be OK…but Hampton and Portsmouth will be screwed because there’s no way we can coordinate an idea like this across such a large region.”

But Fingers also taps into the fatalistic sentiments expressed in chapter three. Norfolk is, for the most part, going to be inundated by sea level rise. The questions that the city’s leaders must answer now are: how long can that inundation be forestalled? Over the long-term, how can its impacts be minimized? A marine scientist went on to note that “The simple answer is that our landform is just not designed for massive defense structures. The shoreline is too crenulated and everything is too low – it would take a truly massive structure to defend it…something bigger than the Dutch or Brits have done…It also turns out that doing something like that in Norfolk…just wouldn’t do much for N’oreasters, which are the most common storm event here and which are mostly wind-driven events, so water heights would still rise in the bay.”

Despite relatively unanimous praise for the concept as a creative and high-performing work of coastal resilience, the policy-makers and technical experts I spoke with in Norfolk did not view Fingers as a project that is likely to be implemented. “The [proposal] is a planned version of the retreat we’ll have to make – where we make thoughtful decisions about where to invest, divest, and shift things around…The more likely scenario is that no such planning takes hold and we’re left with an ad hoc version of Fingers of High Ground, where some

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retreat occurs by those who can afford to move and everyone else is left to fend for themselves against rising seas." This is less an indictment of the proposal than of the politics of resilience, but it nevertheless underscores an important and often overlooked issue with most coastal design proposals: they tend to be agnostic towards the political actors, institutions, and economics that would govern their implementation. Without a political strategy of commensurate thoughtfulness and creativity, design intelligence cannot be translated from renderings and conceptual plans into reality.

The Vision 2100 Plan, Chesterfield Heights, and Dystopian Natures

The simple solutions here are hard to find. They’re there – but only if you’re willing to invest in things that might provide you with a century’s worth of protection but that are ultimately doomed to fail...low dykes or surge barriers in strategic places, for instance. But it’s really tough – you have much more flood risk to work against here than you do in Holland... the bottom line is that, for Norfolk, the high point is about ten feet above sea level. The SLR curves show about seven feet of rise by 2100, so the city is effectively doomed.

Norfolk’s Vision 2100 Plan – and the Chesterfield Heights Redevelopment Plan (CHRP) that emerged from it – are products of this fatalistic outlook on the city’s future. Developed by the city’s planning and public works staff, they are mostly devoid of any major structural interventions – there are no Ike Dikes or Living Breakwaters or Fingers of High Ground on the docket in Norfolk. Instead, the Vision 2100 Plan and the CHRP are focused on policy interventions that are, in essence, local anti-poverty programs. As a result, the plan has little to do with

environmental philosophies regarding nature – other than to tacitly acknowledge that humanity can neither fully understand nor fully control it. But its connection to resilience theory is worthy of greater discussion.

No other proposal – in Norfolk, Galveston, or New York – is as tethered to the principles of social resilience and coping capacity as Vision 2100 and the CHRP. This body of resilience theory argues that social bonding and capital are the most important factors in determining a community’s ability to cope with and recover from disaster – and that strong, relatively stable or improving neighborhoods are the best way to foster those relationships.

Vision 2100 focuses on those attributes by calling for new investments in community development programs that include job training, housing affordability, and strategic densification – all with the aim of providing residents with the tools they need, at an individual level, to cope with rising seas. A public official in the city remarked that “We’re basically looking at it and saying…there are areas that should be left alone, because they’re fine as they are or because there’s nothing we can do for them…but most of the city is in the middle, where we can make a 50- or 100-year investment in neighborhoods...from a public works perspective, but where it’s critical that find ways to keep people in their homes as insurance rates rise, the local economy changes, and the frequency of recurrent flooding
goes up…it doesn’t do us any good to keep the water away if there aren’t any people left.”

Only a few small, strategic infrastructural projects are planned. An engineer in Norfolk noted that “Where you’ll see [the city] doing work in Norfolk will be with nature-based strategies in areas tied to restoring floodplain function. So it will be in areas where models are predicting inundation or tidal inundation zones…where we can make a simple case around national economic benefit.”

Norfolk’s Vision 2100 Plan is built around the idea that neighborhood effects are key to promoting social resilience, and that social resilience is the key to producing urban resilience across the entire city. Only a few small, strategic infrastructural projects are planned.

The CHRP is an extension of that logic. Developed during Norfolk’s Dutch Dialogues, the CHRP received $120 million in HUD funding through the National Disaster Resilience Competition in the spring of 2016 – one of the largest awards appropriated. “Basically, we’re going to use that money to raise a couple of roads, raise the edge, and that will wipe out most of the grant. But we also have a living shoreline in the proposal and about $20 million set aside for an incentive program to encourage homeowners to do parcel-level water management with on-site green infrastructure…rain gardens, green roofs, that sort of thing.”

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microcosm of the city’s Vision 2100 Plan, the CHRP calls for a few minor structural protections buttressed by a much more ambitious, policy-driven intervention at the individual scale. “The hope is that Chesterfield Heights can become a pilot for the rest of the city…where we find a way to blend parcel-level stormwater management…with some strategic, nature-based strategies along the edge…that give us one-hundred years of protection.”

If the Fingers proposal suffers from an excess of ambition, then these two risk setting the bar for success so low that it will not matter if Norfolk attains it. Giving residents the tools – financial, social, and political – to cope with climate change is vitally important. In fact, planners and designers in other cities would be wise to learn that lesson from Norfolk.

But it cannot be the only thing – or, I would argue, the primary thing – that they develop. Individual level resilience strategies will only get most cities so far. At some point, more ambitious, physical design strategies must become part of the plan. Whether in the form of levees or dunes, seawalls or seagrass, the physical and social components of cities must come together to build resilience.

**Natural Chaos in New York**

The relationship between New York and Galveston and Norfolk, though important, is less evident than the relationship between America’s largest city and other coastal, global urban centers. Though there are clear political,
regulatory, and risk-based parallels between the three cities, New York stands apart for at least two reasons. One is that the stakes there are much higher. There are eight million people in the city and twenty-two million in the metropolitan region – 3.5 times larger than the Houston-Galveston region and nearly 14 times larger than the Norfolk-Tidewater Region.

New York is also the world’s largest urban economy; Houston-Galveston is 17th and Norfolk is unranked. Though New York will surely inform coastal planning efforts in the US, its locus of influence will mostly extend beyond our borders to other coastal, global cities outside of the US. What happens in New York will not always matter in other cities along the East and Gulf coasts.

Though New York has experienced a variety of disruptive and catastrophic events – the September 11, 2001 World Trade Center Attack chief among them – none exposed the sort of existential threat to the city that Superstorm Sandy did in 2012. Sandy – a massive and slow-moving, extratropical storm – made clear to the public what prior planning and design competitions had shown: the city’s population centers and primary economic assets were all highly exposed to rising seas and storm surge. It triggered an intense phase of crisis-driven urbanization – that forced public officials and residents to reconsider how New York’s relationship with the sea might evolve over the course of the next century. A

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variety of initiatives and efforts made up that process of reexamination, but two are of particular relevance to this dissertation: the Special Initiative for Rebuilding and Resiliency (SIRR) Report and the Rebuild by Design (RBD) competition.

This section aims to accomplish two goals. The first is to provide a fuller context for the flood-related risks facing New York – which areas are most vulnerable, what ideas about adaptation were circulating before Sandy, and how did the RBD organizers hope to exploit the post-storm moment to transform the city. The second is to describe, assess, and critique the three winning design proposals that received funding through the RBD competition: the BIG U or Dryline in Manhattan, Living Breakwaters in Staten Island, and Lifelines in the Bronx. I use semi-structured interviews and public document analysis to do so.

The Contemporary Context for Coastal Resilience in New York

Before Sandy, no one [in New York] really gave much thought to the risks posed by storm surge. Sure, we [and other designers] had played around with the impacts of sea level rise, but even that…was only loosely connected to reality. Sandy brought all that to the fore for the city…we had to turn towards our waterfront in a way that hadn’t been done since maybe the Dutch fortified Manhattan in the eighteenth century.266

New York’s urban ecology is characterized by a constellation of small, elongated islands, peninsulas, sounds strewn across the confluence of the Hudson River, East River, and Atlantic Ocean. With twenty-two million residents, the New York tristate area is the nation’s most populous metropolitan region.267 One might

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expect this to make the city a perpetual site for consternation and contemplation about the fate of coastal US cities as global climate change sets in. But, until recently, New York has not garnered the kind of attention on that subject that cities like New Orleans, Miami, and even Norfolk have. This is due to the relatively high mean elevation of New York – Manhattan in particular, where the average finished floor elevation is more than twenty-two feet above mean high tide. Recall that this elevation is six feet in Norfolk and eleven in Galveston.

The urgency facing those other cities simply was not present in New York before Superstorm Sandy. New York City has both a higher mean elevation than either Galveston or New York and much less experience with disaster than most cities along the Gulf and East Coast. Despite a vast reservoir of technical expertise and financial resources, New York placed relatively little emphasis on preparing for sea level rise and storm surge risk in its planning documents. Other aspects of climate change – including reducing urban heat and mitigating greenhouse gas emissions – received the lion’s share of attention in those documents.268

This vacuum of leadership on issues pertaining to coastal resilience and adaptation created space for artists and designers to begin speculating on New York’s relationship with rising seas. Their work became organized through the

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“On the Water” competition and the “Rising Currents” exhibition administered by the Van Allen Institute in 2009 and the Museum of Modern Art 2010. Wild and uninhibited by political, financial, or even technical constraints, the ideas generated through these two initiatives nevertheless developed three core principles that went on to frame all future work in the city: to soften the city’s edges wherever possible through green infrastructure, to create more permeable surface-level stormwater management in the city, and to restore and create a robust marine ecosystem in Hudson River Estuary. Of course the tactics outlined in On the Water and Rising Currents for meeting those goals proved somewhat fanciful – it seems both unlikely and, from a feasibility and a risk reduction perspective, unwise to invest in marshes along the southern tip of Manhattan or oyster reefs in New York Harbor.

Those ideas proved as impractical as they were improbable – oyster reefs might improve the water quality of the Harbor, but they would not impact the effects of sea level rise or storm surge\(^{269}\), and the Manhattan waterfront lacks the acreage necessary to build enough marshland to make a dent in either.\(^{270}\) As a participant in those initiatives described, these proposals were “more about Artists Against Climate Change than about solving any of the problems


associated with it…we were there to draw attention to the issue…I don’t think any of the proposals were particularly serious or effective works of resilience.”

But that frivolity was part of each initiative’s intent. They were not intended to result in shovel-ready projects for New York officials to pick-up and implement. On the Water and Rising Currents were designed to develop broad, thematic ideas about how, where, and when the city should focus on preparing its coast for climate change. In that regard, they should be viewed as highly successful and as influential precursors to the post-Sandy RBD competition.

RBD launched in the summer of 2013 as a four-stage, interdisciplinary design competition to “promote innovation by developing regionally scalable but locally contextual solutions that increase resilience in the region.”

The first stage, an RFP, generated one hundred forty-eight submissions, from which ten were chosen to proceed, including teams led by HR&A Associates, Sasaki and Rutgers University, WXY and West 8, Bjarke Ingels Group, Olin and the University of Pennsylvania, OMA, MIT’s Center for Advanced Urbanism, Waggoner & Ball and unabridged, SCAPE, and Interboro partners. The second stage provided each team with a unique site to research and the third stage challenged those teams to develop a series of design propositions in response to their respective sites. The fourth stage of the competition involved a juried review

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of those proposals and the selection of seven winners to receive a disproportionate share of the $1 billion allocated to RBD. That jury – comprised of international planning and design experts – made their selections in June 2014, marking the end of the competition. Their selections included proposals from the Bjarke Ingels Group team (Manhattan), the Olin and Penn team (the Bronx), the OMA team (Hoboken), the MIT team (the Meadowlands), the Waggoner & Ball team (Bridgeport), the SCAPE team (Staten Island), and the Interboro team (Long Island). Four of the winning teams – MIT, OMA, Waggoner & Ball, and Interboro – focused on sites outside of New York. Three others – SCAPE, Bjake Ingels Group, and Olin/Penn – were developed in one of New York’s five boroughs. Those NYC projects are the subject of analysis in this section.

The Dryline Proposal and Anti-Wildness in Manhattan

The big design flaw in RBD was that they did not find a mechanism to, in a way, continue with actually rebuilding by design within any of these proposals. There is very much a seizure between what RBD was and what this next phase of project development is going to be…and the rupture is proving to be really impactful…we don’t know what will happen with any of our work of if we’ll even be able to shape it going forward.\(^\text{273}\)

The BIG U or Dryline proposal for Southern Manhattan is a surge barrier system comprised of three key elements: (1) the Battery Berm, (2) the Bridging Berm, and (3) a retractable floodwall running parallel to portions of FDR Drive. If completed, the project would span some ten miles of waterfront, wrapping

around the southern tip of Manhattan from East 40th street, across the Lower East Side, the Village, and up to West 54th Street. Each berm would anchor a sweeping system of green, coastal infrastructure aimed at integrating recreation and risk reduction around one of the most densely populated and wealthy enclaves in the United States. The retractable barriers would serve as a connection between those earthen berms. Together, the three core elements of the U-shaped system aim to completely reshape Manhattan’s waterfront by creating a dry line of defense against future surge events. It also clearly builds upon and draws from the “New Urban Ground” proposal developed by dlandstudio during the “Rising Currents” exhibition. Susannah Drake, author of that project, noted that New Urban Ground “is more than a response to the need to control the input and outflow of water; it also provides an opportunity to transform the urban experience.”274 In many ways, Drake’s soft-U for Manhattan laid the intellectual groundwork for BIG to develop the Dryline. BIG’s proposal received $335 million in RBD funding, the highest amount of any project funded through the competition.275

But the project’s transformation of Southern Manhattan’s waterfront raises some important concerns about the proposal – and, more generally, the RBD competition. The first phase of the Dryline – a 2.5 mile segment running from

Montgomery Street to East 23\textsuperscript{rd} Street – is projected to cost more than $1 billion. Implementing that one, small section of the Dryline will take years – building all or most of the proposal is likely to take decades. This is problematic for at least three reasons. One is that RBD failed to identify a long-term funding or management strategy for its winning proposals. The more time that passes, the less likely the City of New York or its federal partners are to prioritize funding for the Dryline. Construction costs become more expensive, environmental regulations become more stringent, and political support becomes less intense as more time passes.

For this project in particular a partially built Dryline would be devastating for residents of Southern Manhattan. One of the project’s designers remarked that “the compartments [of the Dryline]...while something in and of themselves, are connected to each other and create a system of flood protection that is greater than the sum of all its parts.”\textsuperscript{276}

The Dryline proposal is comprised of a several one-to-three mile long compartments that, unless connected, cannot provide any real degree of flood protection. That’s because the project is designed using a resistance-approach to resilience, pushing water away from the neighborhoods protected by the Dryline. All of that displaced water must go elsewhere and, until the entire U is completed, that elsewhere will be the neighborhoods of Southern Manhattan that

are adjacent to its completed segments. At its best, the Dryline will be of great benefit to the residents of Southern Manhattan and incredible cost to their neighbors. At its worst, it will protect a few wealthy pockets of people in and around the Financial District and leave the rest of Manhattan to fend for itself.

Of course, some areas must receive the first round of protection over others. But who receives it – and who does not – is a political choice, a product of the resilience politics of coastal design. Giving that first round of protection to the wealthiest enclave in Manhattan means that other, lower capacity neighborhoods will remain exposed to storm surge and climate change longer – and bear the considerable risk of being among the neighborhoods included in the Dryline plan, but excluded from whatever portions of it are actually built. This is not the fault of the designers, per se. City officials are the ones who will ultimately make that decision. But the Dryline proposal – and its compartmentalized nature – lends itself to this kind of political exploitation and, in that regard, presents a cautionary tale for other designers.

The second issue is a product of the programmatic structure of the RBD competition. Because only one team worked on the Southern Manhattan site, New Yorkers have mostly been denied an opportunity to debate competing proposals for how best to protect the borough. Though this became a competition-wide issue, it is acutely troublesome for the Dryline given its high cost – no other funded project is expected to approach its massive price tag. It is also disappointing, given that, in all likelihood, whatever was proposed for
Manhattan during the RBD competition would have been awarded substantial public funding. There are simply too many people and too many commercial assets there to leave unprotected. A designer from a competing RBD team noted that “they were always going to build something there…that’s why so many teams wanted the Southern Manhattan site. They knew they could propose almost anything and it would get built…because that’s the locus of financial and political power in this city and that’s who we all knew would get protection first.”

The notion of competition implies that, from a set of competing ideas and arguments, the Dryline emerged from RBD as the best possible design concept for Southern Manhattan, yet, the reality of the competition’s one team, one site structure ensured that no such competitive process could occur.

The final challenge presented by the Dryline is both philosophical and functional: it treats nature as an ornamental quality instead of an instrumental process. By that I mean that the project is emblematic of the shift in design culture to portray resilience and climate change adaptation as problems easily solved through green-washing. Projects can certainly do both – project an image that romanticizes nature and delivers on its promise of resilience. But that is a fine line to walk.

Though verdant and socially vibrant renderings might appeal to clients and portions of the public, they often elide past the more serious technical and

functional issues that must be addressed in coastal resilience projects. A public
official in New York City noted that “Developers love [the Dryline] because it’s a
plan to completely redevelop the Lower East Side – that’s not the LES any of us
in New York know. They’re going to erase life as we know it and replace it with
architectural objects. It will beget a huge number of new higher-end residential
buildings, and yet the Governor and Mayor and the designers will all come to the
Alfred Smith houses to hold a press conference about the project...It’s not going
to work out well for their community partners...but they weren’t really interested
in them anyway. This is a tool for redevelopment, not resilience.”

There is a playful frivolity is much of BIG’s other work, and they rely on
spectacle, style, and programmatic novelty to good effect. But it’s unclear how
well that approach will translate to New York’s waterfront. As its core, the Dryline
uses a fairly conventional approach to coastal protection. It employs berms and
floodwalls to reduce surge risk. That those structural protections are adorned
with lush landscape plantings, public art, and playful recreational programming
has less to do with coastal resilience and more to do with extending the long-held
desire of New York City’s planners to further amenitize the coast.

The greatest risk facing the Dryline, then, is that its core elements will be
built – in part of whole – while its other, more compelling components are
stripped away. It is easy to imagine the city or its federal partners cost-

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engineering away the parks, gardens, and architectural interventions in the proposal and building a fairly simply – and droll – berm and wall system along the coast. Because the proposal’s most compelling parts are layered on top of those core, protective elements – rather than integrated into them – they risk being discarded if and when the project’s costs become a political liability.

The Living Breakwaters Proposal and Re-Natured Coasts on Staten Island

The core idea of Living Breakwaters is taking the destructive force out of wave action…Rebuild by Design did not ask anyone to consider retreat. In other countries…that’s the first thing on the table. That simply wasn’t part of our program. So I see this project as stepping down risk and moving the loss of life from the equation…So it’s resilient in a sense that there can be some still-water flooding…but it will mean that you can just wear your Tevas and walk around in it because the water will be cleaner and slower, and one can recover from that condition much more easily.\(^\text{279}\)

The SCAPE proposal for Staten Island is organized around a series of oyster reefs and other designed ecologies along the shore. The reefs – first proposed as a part of Kate Orff’s “Oyster-itecture” project in the “Rising Currents” exhibition – are relatively simple propositions.\(^\text{280}\) The Living Breakwaters act to reduce wave energy and to improve local water quality by using human-built reef structures to attract oysters and shellfish that can both filter pollutants and revitalize a long-lost fishing and eco-tourism-based recreation industry. The near-shore interventions are then coupled with architectural and programmatic elements along the beach in an attempt to “stitch the culture and ecology of

Staten Island’s waterfront together.”281 Those “water hubs” – or community and recreational facilities along the shore – would act as social anchors, providing waterborne recreation opportunities, new public space, and marine education programming to the neighborhoods of Staten Island. One of the project’s designers described it by saying that “the hope is that these core elements – the breakwaters and the water hubs – could become like a toolkit…that the City of New York could then take and distribute all along the outer boroughs…so that this one small pilot in Staten Island becomes a blueprint for recovering a marine ecology that used to thrive here.”282 SCAPE’s project is an exercise in prototyping that is intended to spread, over time, across the coastal edge of the Northeast. The Living Breakwaters proposal received $60 million in funding through RBD.

It is certainly true that the modularity of SCAPE’s proposal hews closely to one of the central tenets of resilience theory – that robust systems are comprised of redundant, overlapping elements that each provide a multitude of functions. Its creative use of shellfish as an organizing device also clearly fulfills the RBD competition’s desire for design innovation. But the project’s reliance upon oysters and other bivalves creates a troubling vulnerability in its logic. Ocean acidification – a chemical process in which atmospheric CO2 is rapidly dissolved into the ocean, raising its pH level – is one of the first global climate change effects to

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materialize. It is also one of the most difficult to address. It is already wreaking havoc on the oyster and mussel fisheries of the Pacific Northwest and the North Atlantic. There, increasing oceanic acidity is dissolving the shells of bivalves, making it harder for them to live long enough to breed and to provide the kinds of water quality benefits that are part and parcel to the Living Breakwaters proposal. These effects are projected to escalate over the next century, potentially collapsing the oyster and mussel fisheries of North America.

Though there is merit in investing in solutions that buy communities 20 or 50-years of protection – and Living Breakwaters may do that – this proposal is being framed as a solution to flood risk, not an instrument for forestalling the inevitable.

Living Breakwaters also faces some vexing technical questions. I interviewed more than a dozen marine scientists and engineers about the use of near shore reefs to reduce storm-related flood risks, and their response to the performative ability of such an idea was unanimous: it would provide some shoreline stabilization benefits, but it would not do much to reduce surge risk. This is mostly due to the hydrodynamic characteristics of coastal storm events. Their maximum surge – the maximum flood height delivered by the storm – is always preceded by a forerunner. A forerunner is the pre-surge – a dramatic increase in wave heights that can reach as high as 75% of the maximum surge.

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height and arrive days in advance. A marine scientist in New York noted that
“One of the reasons near shore reefs don’t do much for surge heights is that, by
the time the big surge arrives, they’ve been completely overwhelmed by the
forerunner…If the peak surge is fifteen feet, it’ll have a forerunner of at least
seven or eight…and as soon as you put that on top of a breakwater, it loses all of
its frictional qualities.”

The marine science literature largely confirms this assertion. “Breakwaters
can provide a number of important services for coastal communities…they help
stabilize rapidly eroding shorelines…and when combined with ecosystem
restoration projects [like oyster beds] they can contribute to local water quality
improvements…But they are not well-suited to reducing surge-driven flood
risks.”

Some coastal engineers argue that breakwaters can be a component of
a large surge suppression system, but the scientific literature is bereft of
evidence indicating that they can serve as the primary or sole instruments of
surge risk reduction.

Another marine scientist noted that “[breakwaters] can do a lot for you in
terms of reducing the everyday wave action…that’s driven by wind and tidal
action…That reduces coastal erosion, so you can certainly make an argument in
their favor that way…But they aren’t going to do you any good during a major

286 Committee on the US Army Corps of Engineers Water Resources, Science, Engineering, and Planning:
National Academies Press.
storm event. When you run the SLOSH models, it’s like they’re not even there.”287 A designer working in New York, but unaffiliated with the proposal, also said that “I don’t think that oysters and mussels are going to save us. They don’t live past the spat stage around Staten Island, so they don’t form those crusty reefs that are shown in all of their drawings…and you’d need so much width or horizontal area just to get a one or two foot reduction in surge heights…Besides, the final proposal didn’t even place the reefs where ARCADIS told them would be most optimal – about ¾ of a mile offshore – because it wouldn’t be as sexy.”288

The risk in this project, then, is less about whether enough of it can be built to fulfill its mission than in whether it can actually perform as it has been advertised. Staten Island would surely benefit from a more stable shoreline and improved water quality. Though those are part of the justification for constructing Living Breakwaters, suppressing surge risk is the stated goal of the project – and a service that the scientific literature and the marine experts I interviewed for this dissertation doubt it can perform.

The Lifelines Proposal and Social Natures in the Bronx

The Penn/Olin proposal for Hunts Point is comprised of four overlapping elements: (1) The Flood Protection Levee Lab, a commercialization incubator for testing new materials and methods of risk reduction; (2) the Livelihoods Initiative, a local job-training program aimed at coupling new neighborhood development

with a local, underemployed workforce; (3) the Maritime Emergency Supply Line Hub, a ship-based logistics hub for coordinating relief efforts during future storm events; and (4) the Cleanways tri-generation facility, a local and CO2 neutral power generating plant. It also includes a series of modest levees aimed at protecting the neighborhood’s food distribution center – a critical node in the region’s food supply. Nearly twenty million people in and around New York receive a portion of their daily food supply from Hunts Point – and it came within about eighteen inches of being inundated during Sandy. The Lifelines proposal received $20 million through RBD – the least amount amongst the six winning projects.290

The Penn/Olin project’s blend of physical infrastructure, social and economic policy, and energy production clearly delivers on the principal aim of RBD: to create innovative design solutions to the problem of climate change in New York’s most vulnerable neighborhoods. But it also suffers from three unique issues that threaten to derail the proposal.

One is that the Levee Lab creates organizational tensions between the community members, the city, and the academic institutions that might administer it. This is because the proposal never resolved the management or operational questions that such a facility engenders, such as who might manage

289 Rebuild by Design. “Finalists.” Available at: http://www.rebuildbydesign.org/winners-and-finalists/. Hunts Point is a working-class community in The Bronx and is home to the New York Region’s primary food distribution center. Every perishable food item available to the region’s 22-million residents passes through this center.
290 Ibid.
the conventional flood-control systems protecting Hunts Point, who might direct the Lab’s research agenda, and how those two disparate systems might intersect.

A second is that the proposal’s workforce development recommendations will be difficult to square, both financially and contractually with local labor unions. As one of the project’s designers remarked, “tying the success of new development in a community to the wealth and health of its residents is the only way to ensure that whatever physical improvements are made [in the Bronx] actually benefit its inhabitants…and aren’t just another instrument of displacement.”

The third and final concern is a product of the competition’s insistence on producing ideas that are regionally scalable yet contextually appropriate. No other proposal generated during RBD was as attuned to its community as Lifelines. An administrator of the competition remarked that “no one did it better than in Hunts Point…there are plenty of things we’d probably change about it now, but they were as engaged with their community…and as responsive to their needs as any of us could have hoped.” But Lifelines exposed the paradoxical nature of RBD’s aim – its local focus meant that few of the proposal’s ideas could be transferrable to other neighborhoods.

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**Remaking the Coast**

Forging new ground – in this case, literally and intellectually – brings with it a certain unevenness of execution; a blend of incredible innovation and incredible failure. This is certainly true of the resilience propositions under consideration in these three cities. Design often takes its cues from science, and the science of resilience is relatively new. We should not expect the first wave of resilience propositions in the U.S. to be perfect. But to ensure that future projects are closer to that ideal, it is important to articulate which elements of these nine proposals are of use to future design projects, which are not, and why.

It is important to begin that act of parsing by reiterating the differences in flood risk and experience with flood-related disasters in each city. As the first chapter of this dissertation explains in some detail, these three cities were chosen because they represent critical points along the spectrum of high-risk and low-to-high experience cities in the U.S. Galveston is the most experienced city of the three with flood related disasters – with at least one major tropical storm making landfall on or near the island each decade since 1900. New York City occupies a middle-ground between the two, while Norfolk has the least amount of experience with flood-related disaster.

That difference in experience helps to explain some of the differences in the approach to resilience-making being considered in each city. In many ways, the projects under consideration in Galveston are the most ambitious. The Ike Dike is, at its most basic level, an island-wide barrier – a literal fortification
against the sea. The Centennial Gate and Ring Levee Systems, though less intensive along the edge, are of similar scale and scope in their desire to re-engineer the ecology of Galveston Bay. This is not a coincidence. Rather, it is an indication of the urgency and the imperative created in recent years by Hurricanes Ike and Rita set against a centuries-long backdrop of storm surge and destruction. The residents of Galveston Bay are organizing around some or all of these proposals because the risk of becoming complacent is coupled with the risk of erasure. Whether or not they build one of these projects, future storms are coming – and everyone there knows it.

Norfolk’s comparatively modest proposals reflect the city’s limited experience with disaster. It would be strange – remarkable even – if the city were contemplating projects similar to those in Galveston. But, with the exception of the Fingers of High Ground proposal, Norfolk’s proposals rely on parcel-level interventions and are intended to simply manage – not mitigate – future flood risks. If crises beget action, it is easy to see why the proposals for coastal adaptation in Norfolk remain programmatic elements of a city plan instead of the inter-jurisdictional, complex infrastructure projects proposed in Galveston.

New York City, far greater in size and much more diverse in its geography than either Galveston or Norfolk, boasts proposals spanning the spectrum of ambition – from the massive and complex Dryline in Southern Manhattan to the relatively Spartan Living Breakwaters proposal along Staten Island. Though some of the city’s projects are now elements of its comprehensive plan – PlaNYC
they began in both the RBD competition and in the city-led SIRR exercise. If nothing else, New York City’s model of using a design competition to generate ideas that are then incorporated into a comprehensive plan – which carries significant legal weight and opens up new financial instruments – is a useful one for other American cities to consider. The projects in Galveston, which span multiple jurisdictions, will require approval from the USACE and remain largely outside the city’s control. Those in Norfolk risk meeting a common fate – collecting dust on a shelf, never to be built – amongst elements of comprehensive plans.

But they also face different kinds of risks which, in turn, require different kinds of responses. Galveston and New York face considerable surge-related risks. As a result, each of the proposals under consideration there employs some form of large, resistance-based infrastructure – there is both a need to deflect surge energy and a lack of horizontal space to consider doing so through wetlands, mangroves, or other green infrastructural strategies. The densely settled waterfronts of Galveston and New York City demand a performative quality to their coastal infrastructure that only walls and other barriers can provide.

In Norfolk, the risk is borne almost entirely of sea level rise and climate change. The city is well-protected for storm surge, but it has a very low topographic profile – the mean elevation of Norfolk is less than ten feet. Nearly all of its sewer outfalls, which empty into the Elizabeth and Lafayette Rivers, are
now below the monthly high tide line. This means that, for at least a brief window every month, seawater is bubbling up through Norfolk’s stormwater system and into its streets. When that is coupled with rainfall, the city’s streets fill up like a bathtub. This issue will only grow worse as sea levels rise and precipitation-driven flooding intensifies. The city’s physical geography is not suited to the big, structural proposals found in Galveston and New York City. The water cannot be kept out of Norfolk. Instead, the city’s plan to develop a patchwork of inland green infrastructure to help manage the problem reflects the nature of the risks facing Virginia’s coast – and the options available to a city without the focusing power of a crisis.

In the final chapter of this dissertation, I turn away from the politics of resilience and toward its performative qualities that help differentiate where – and when – nature-based strategies merit serious consideration in coastal cities. From this, I begin to develop an evidence-based approach to resilience-making.
Figure 33: The Experience-Exposure Matrix (author). These matrices show where the cities outlined in chapter one fall along the experience-exposure spectrum. Galveston, Norfolk, and New York City hold similar levels of exposure to and differing degrees of experience with disaster.
Figure 34: The Ike Dike (Texas A&M-Galveston). This image shows the conceptual plan for the Ike Dike – a coastal barrier running the length of the region’s beachfront.
Figure 35: The Ike Dike (Texas A&M-Galveston). This image shows some of the more detailed features of the proposal – including how the barrier system and tie-ins would work.
A new plan

Rice’s SSPEED (Severe Storm Prediction, Education and Evacuation from Disaster) Center has released a plan for a mid-bay gate that could provide storm-surge protection for communities on the west side of Galveston Bay as well as the industrial areas around the Houston Ship Channel.

Figure 36: The Centennial Gate System (Rice University). This diagram shows the interventions called for in this particular proposal. It includes the construction of a massive surge barrier (Bolivar Roads Gate), a new mid-bay of oyster reefs and sand spits (Mid-Bay Gate), and an emergency gate at the port of Houston (HSC Gate).
Figure 37: The Ring Levee System (GCCPRD). This diagram shows the layout and proposed elevation for the network of levees in and around Galveston.
Figure 38: The Ring Levee System (Gulf Coast Counties Surge Protection District). This map highlights the restoration components of the levee plan for Galveston.
Figure 39: The Fingers of High Ground Proposal (Structures of Coastal Resilience). This diagram illustrates how the existing strips of high ground in and around Norfolk could be accentuated and repurposed as sea levels rise.
Figure 40: The Fingers of High Ground Proposal (Structures of Coastal Resilience). This diagram illustrates how the proposal would be used to strategically hold flood water and relocate critical assets and people in Lambert's Point, a community just outside of Norfolk.
Figure 41: The Fingers of High Ground Proposal (Structures of Coastal Resilience). This diagram illustrates how the proposal would be used at Willoughby Point, a sparsely populated sand spit on the outskirts of Norfolk.
Figure 42: The Fingers of High Ground Proposal (Structures of Coastal Resilience). This maps shows how and where Mathur and Di Cuhna envisioned executing their design strategy.
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Figure 46: The Dryline Conceptual Plan (Rebuild by Design). This rendering shows the proposal wrapping around the southern tip of Manhattan, with the yellow line indicating areas of raised/structural protections.
Figure 47: The Dryline Conceptual Plan (Rebuild by Design). This rendering shows the reshaped Manhattan waterfront, including the raised berms and new museum and public buildings.
Figure 48: The Dryline Conceptual Plan (Rebuild by Design). This rendering shows the proposed height and construction methods for the proposal’s berm system.
Figure 49: The Living Breakwaters Conceptual Diagram (Rebuild by Design). This rendering shows the construction methods and ecological features of the proposal.

Figure 50: The Living Breakwaters Conceptual Plan (Rebuild by Design). This rendering shows the proposed locations of breakwaters and on-shore water hubs in the SCAPE plan.
Figure 51: The Lifelines Proposal (Rebuild by Design). This map shows where the structural protections (yellow) would be used to protect the critical assets of Hunts Point.

Figure 52: The Lifelines Proposal (Rebuild by Design). These renderings show the proposed waterfront condition for Hunts Point.
CHAPTER 5 — The Beginning: Coastal Green Infrastructure and a Naturalized American Coast

In this final chapter, I lay out what I believe can serve as a framework for building nature-based strategies and resilience, together, along the American coast. I begin metaphorically, discussing the notion of naturalization in other, unrelated fields and how it can apply to resilience-making along the coast. Next, I discuss the ways in which Galveston, Norfolk, and New York City’s lessons can apply to other cities. Then, I draw from the cutting edge of marine science and coastal engineering to describe how, where, and why nature-based strategies can become a more effective part of coastal resilience planning. Finally, I speculate on the prospects of naturalizing the American coast or, as I call it, making space for the sea.

But first it is important to place this framework within the broader context of coastal development in the U.S. – to insert it into the debate between designers, planners, engineers, and scientists. One of the greatest tensions amongst landscape architects, city planners, and policy-makers is embedded in the conversation between restoration ecology and novel ecology.\(^\text{293}\) It is, in a sense, a continuation of the debate between nature and culture, naturalness and unnaturalness that defined four prior centuries of American development. The former tends to focus on recovering landscapes lost to climate change and

urbanization during the twentieth and twenty-first centuries. In coastal zones, restoration ecology often means rebuilding the marsh and wetland habitat filled in by the Corps or slowly inundated by sea level rise. As I wrote in chapter three, the Corps own system of wetland regulation is premised on this idea of restoration and balance along the coast.

One can imagine this kind of work as analogous to that of FEMA in post-disaster planning: rebuilding, in place, using slightly improved construction methods and materials. Galveston’s Centennial Gate System – especially the oyster beds and shoreline amendments – is emblematic of this approach. So too is Staten Island’s Living Breakwaters project. There, the designers explicitly call for restoring oyster beds and marine habitat lost during the nineteenth and twentieth century around New York. However well-intentioned efforts like these are, that approach, in those locations, misunderstands what it means to be natural or unnatural in the Anthropocene. As I discussed in chapter four, the conditions that enabled shellfish to thrive near Staten Island during the colonial and pre-industrial periods of American history are no longer present. Even if near-shore breakwaters could reduce storm surge – and the evidence is stacked against that assertion – it is unlikely that a sufficient population of mature shellfish can survive off the island’ coast under current conditions.\(^{294}\) This

challenge will only grow as the effects of ocean acidification continue to, quite literally, erode the viability of shellfish in the Mid- and North-Atlantic.

The latter group – urban ecological designers and novel ecologists – are often less entangled in the nostalgic and romanticized tropes of nature. Their work is characterized by a focus on performance and function, and on developing an aesthetic language that breaks from the picturesque tradition of landscape design. Galveston’s Ike Dike and Manhattan’s Dryline are both emblematic of this approach. In each city, the proposals aim to restore a coastal floodplain function through new, designed means. The Ike Dike aims to rethink the region’s once-prevalent dune system, replacing it with a technological landscape of walls, levees, dunes, and seagrass. The Dryline does much of the same, proposing retractable flood walls, berms, and sponge parks along the tip of Southern Manhattan – an area that used to serve as a buffer for the rest of the island from coastal flooding. Nature and technology are inseparable in these projects because their distinction is artificial. Even the Corps’ moniker, nature-based strategies, implies this. They are not natural strategies, which might imply a nostalgic or restoration-driven approach to intervention. Rather, they are based on natural landscape systems and recreating the functional and performative attributes it can provide.

One of the key contributions from this dissertation’s case study work is that, in an era of resilience and adaptation, a novel approach – and not a nostalgic one – is key to helping cities, landscapes, and the people who inhabit
them to stay in place. But design culture tends to interpret arguments in favor of novelty and innovation as antithetical to notions of generalizability and standardization. They are not. The question to the urban and design professions going forward is not whether we must choose between invention and nostalgia or whether there is room for art and science alongside one another. Those are old debates with old, predictable answers.

Despite calls from some scholars about the need to renew these conversations – and to pit the establishment of a landscape science against the provision of designed wonderment – there is very little to be gained from such discussions for the professions and for the people we purport to serve. There is no art or science – nor is there a true divide between the poetics or performance – of resilience.

Instead, the challenge for designers, planners, and policy-makers is to do now for coastal resilience what we have long-struggled to accomplish in sustainability: to develop a set of principles and strategies for integrating nature-based strategies into the marine environment. Put another way, we must move beyond the rhetoric of resilience and into its production across the coastal landscape of the US.

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Metaphors: Naturalizing the Coast

The metaphor of naturalization is a potential source of power for planners and designers working on coastal resilience projects. In literal terms, to naturalize something is to convert it to or into something else by a custom or habit that is natural or familiar to a person. In horticultural science, the term is used to describe the habitat range of plants. It connotes the geographic area in which one could reasonably expect to find unplanted trees, shrubs, or herbaceous plants. Take the Southern Magnolia, for example. The dense, broadleaf evergreen tree has a *native* range that is fairly small – it only includes small portions of the coastal plain in the Southeast US. But the US Department of Agriculture estimates that its *natural* range extends much further and includes portions of the Piedmont in the Carolinas, much of the Ouachita foothills in Arkansas, and nearly all of the Appalachian Mountains in Tennessee. The Magnolia’s natural range is defined as the geography in which a coalescence of fires, forestry management, and climate change have allowed it to spread into new, once-unsuitable areas.

The north and westward drift of the Southern Magnolia is instructive here for at least two reasons. One is that it dismantles the sanctity of naturalness that is embedded in the language and practice of restoration-driven resilience. Coastal environments are dynamic, evolving places, 

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many of which are at the forefront of planetary climate change – they are the sites currently experiencing dramatic and irrevocable change. As such, coastal communities are the last territories on Earth where designers should spend their time and expertise endeavoring the restore a landscape of generations-past. No feat of engineering or investment of design intelligence can counteract the changes underway. Instead, planners and designers should be looking for new ways to restore the functions of those landscapes – the nature-based flood risk reduction, the benefits to human health, and the economic benefits of a thriving landscape.297

The other takeaway from horticultural science is that it speaks to the idea of exportability in ways that are useful to design. Though RBD aimed to accomplish this goal in New York City, much of its work became less about exportability as the competition wore on. Developing a set of principles and strategies for coastal resilience-making that can still be applied in highly nuanced ways is critical to naturalizing the coast. Design is – and must remain – attuned to the eccentricities of the sites in which it operates. But it can be organized around a broad set of principles or values that flow from the science of poetics of resilience.

A similar analogy can be drawn from the process of naturalization that is enforced in the US by the Citizenship and Immigration Services branch of the Department of Homeland Security. There, it is defined as a legal status given to foreign citizens once a series of requirements are fulfilled. If we think about how that might extend to coastal resilience – a field far from that of immigration policy – it’s useful to begin with the idea of rule-making and performative benchmarking as instruments for establishing naturalness.

One way to do this would be to establish a set of performative standards that coastal communities could achieve to earn a naturalized designation – a status that could grant them access to special funds or financing that is targeted towards the most vulnerable places in the US. Much as there are National Parks, National Seashores, and US Forests, there could also be special designations and appropriations for Naturalized Coasts. Those standards would have to include metrics for monitoring the reduction of flood risk. But they could also include measures that tracked the creation or restoration of other ecosystem services: water quality improvements, recreational opportunities, and broader improvements in human health, including reductions in chronic and environment-dependent disease incidence. Naturalization, then, could be both a metaphor for designing novel, coastal landscapes and a
regulatory distinction aimed at channeling the necessary federal investments into resilience and adaptation strategies along the coast.

Naturalizing the American coast, then, could come through three mechanisms. One involves stripping the nostalgia and green-washing from designed and engineered resilience projects. Restoration implies a past, ideal condition – a tenet which stands inapposite to everything we now know about ecological science and ecosystem services. Rebuilding marshland and oyster beds for the sake of rebuilding them is not enough. Restoring the services they once provided, however, is. It is the functional or performative qualities, rather than the physical landscapes themselves, that designers must focus on going forward. The Dutch Sand Engine – a project that involves creating massive, near-shore sandbars that slowly erode and replenish the region’s beachfront – is archetypal of this function-driven approach.

The second is that designers must become better consumers and instruments of the science behind coastal resilience-making. Design culture must do more than simply call for better science – the reality is that much of what designers need to know about coastal resilience is already known. But we must be willing to seek it out and, if necessary, to change the way we operate in coastal environments. An example that I have discussed at length in this dissertation is worth revisiting here: the Living Breakwaters project on Staten Island. The use of oyster reefs as a nature-
based approach to resilience-making is, in some cases, an excellent idea. In the placid waters of coastal estuaries or along the edge of most fore and mid-bays, oyster reefs can reduce shoreline erosion and filter pollutants from the water column. But along the more exposed, seaward edge of the coast, their ability to suppress surge-related risks has been vastly overstated. Any reliance on a reef to suppress storm surge is likely to end in disaster. Worse, it squanders what may be the only chance designers are given to lead coastal resilience projects by undermining their credibility on the subject.

The final mechanism is cultural – designers and planners cannot continue maintain an agnostic posture towards the politics of coastal resilience and design. We must instead wade, neck deep, into them. If readers take nothing else from this dissertation, it should be that no amount of persistence, creativity, or charisma can overwhelm the ability of the Corps to thwart resilience. Designers have much to offer politically. It is simply up to them to take more risks and engage in a world once – and mistakenly – deemed outside of our profession.

Exports: Reshaping the Coast in the Image of Galveston, Norfolk, and New York

A central challenge for any case study research is grappling with how the knowledge gained from focusing on a particular place might be transferrable to other places. As a result, I must now ask: what about
sociological scholars have developed methods aimed at precisely this issue referred to as grounded theory. For this dissertation, that response must take at least two forms. The first requires that I begin at the level of each individual city. Galveston is a barrier island at the entrance to large estuary, rimmed with industrial facilities and constantly traversed by global shipping and logistics operations. Its approach to resilience and nature-based adaptation strategies should find relevance in similar geographies across the American coast: North Carolina’s Outer Banks, Sandy Hook and Ocean City off the coast of New Jersey, Ana Maria Island along Western Florida, and many others. Norfolk is a low-lying, industrial hub – a blue-collar city that depends on its proximity to and relationship with the sea. Its lessons should find an audience in places like Biloxi, Mississippi, Corpus Christi, Texas, and Newark, New Jersey, among others. Finally, New York is a global financial center and, though its approach should certainly inform cities like Miami and Boston in the US, its audience is more international: Shanghai and Fuzhou in China, Barannquilla in Colombia, and Alexandria, Egypt.

So what does my analysis of Galveston hold for other barrier island and industrial communities along the Gulf and East Coasts? One important takeaway for those communities is a recognition of the political power behind massive works of infrastructural protections in the US – both in their durability over time and in the culture of technology that they engender. More than a century after the Great Storm of 1900 and the massive upgrades that followed, Galveston remains committed to the idea of resistance-based coastal resilience. Locals still refer to themselves as BOIs – born on island. They place the moniker on their business cards, their homes, and they infuse it into their language – all in the service of creating a non-island-born other, whose ideas and culture can be readily dismissed as not of this place. “It is not uncommon to meet people here…who tell you stories about how their great-grandparents built the seawall…and how magnificent it is. That wall is as much about the protection it provides as about the pride and culture that emanates from it.”

Cultural and ecological legacies are hard things to discard – and perhaps they should be.

The challenge, then, to Galveston, the Outer Banks, New Jersey’s barrier islands, and other similarly situated communities along the American coast is in finding ways to inflect their coastal and infrastructural trajectories away from massive works of grey infrastructure and towards

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more nature-based and hybridized systems of protection. The Ike Dike, whatever its other flaws, is a good example for them to follow. It is both easily recognizable as a technological instrument to the BOIs living there, and an experiment in nature-based strategies – a structural non-structure, if such an attack on the English language might be permitted. But, at the moment, the Ike Dike is an un-nuanced work of coastal infrastructure – a massive, resistance-based barrier occasionally adorned with vegetation.

If done differently, the Ike Dike has the power to demonstrate the performative value of nature-based strategies, without asking communities to abandon their more familiar, resistance-based approaches before they are ready. A towering, coastal spine integrated with dunes, reefs, wetlands, and new beachheads could begin to shape a new culture around the idea that natural features are more than ornamentation. If done right, the Ike Dike – and projects like it across the East and Gulf coasts – can create their own legacy of high-performing, risk reduction landscapes. In so doing, they can create a new constituency for coastal green infrastructure. Defensive structures do not have to be pure structures – and their non-structural components do not have to be viewed as frivolous or decorate contributions to the more serious work of risk reduction. They can – and, in fact, they must – be all of those things at once.

In Norfolk, we must ask: what insight does its fatalistic approach to coastal resilience provide for other industrial and logistical hubs along the
East and Gulf Coasts? A key takeaway for those cities it that, in most instances, there are no solutions to the challenge of sea level rise – at least not in the way that designers and engineers often frame them. Rather, coastal cities of Norfolk’s ilk will have to find methods of forestalling and, ultimately, relocating. Their interventions will have to focus on minimizing the impacts of rising seas and providing communities with the time they need to cope with the coming coastal erasure. After all, you cannot build a wall across the entirety of the American coast’s population centers, nor can you do as Galveston did a century ago and raise their elevations with dredge material. Some places are simply going under – all that designers and planners can do is find a way to intervene and slow that process down to open new pathways for human and ecological migration. Though its practicality remains a valid concern, the Fingers of High Ground Proposal certainly exemplifies this approach.

Nature-based strategies can certainly do that work. Softened edges – be it with marshland or dunes – can provide space for habitats to migrate and slow down the everyday, erosive tidal forces. Parcel-level green infrastructure – the kind that Norfolk is emphasizing so heavily in its Vision 2100 plan – can also help to lessen the burden on cities’ antiquated storm-water management infrastructure. The Fingers of High Ground proposal certainly flows from this logic, too. But where Norfolk’s use of nature-based strategies may be most important for designers is in shifting
the professions’ conversations away from notions of problem-solving and certainty and towards less messianic narratives. Put another way, nature-based strategies can become a method for talking about timescales in a more generative way. The parcel-level green infrastructure in Norfolk may be a 20- or 30-year solution for the city’s storm-water management – but it is not the solution to flooding there. It is an instrument for forestalling the inevitable, not for solving sea level rise and moving on.

The focus on growing the coping capacity of individuals through well-tested instruments of social and economic mobility may also prove useful to Norfolk’s peer cities – and, I would argue, all cities facing new risks as a result of sea level rise. They are particularly salient for those cities that choose to abandon the idea of fortification and resign themselves to a wetter, less certain future. Even in cities where a proposal like Norfolk’s Fingers of High ground is implemented, it will require a complete reorganization of the region’s social and ecological systems. People moving to higher ground will do so at the expense of diminished social capital – some will lose that social cohesion and still find themselves in high-risk landscapes. Design must find ways – whether through memorialization or other means - to lessen that burden. The challenge is, and will remain, that cities like Norfolk and Biloxi simply are not of a scale appropriate for dealing with climate change – and there are no national or state institutions willing or able to fill that gap.
What, then, of New York City? The proposals developed during RBD were developed to be exported across the region and, then, the nation – but can they? At a basic, conceptual level, the answer is yes, with some caveats. Other global capitals will turn to the BIG U or Dryline and its luxury take on resistance-based resilience to encircle their most critical assets. They are likely the only other places that could afford such a massive, architecturally adorned project. Some places will require massive structures like the Dryline. Wall Street cannot relocate, nor can the commercial hearts of Shanghai or Barranquilla. There are massive, sunk costs associated with those districts and it will almost always be cheaper to build walls around them than it might be to move them elsewhere.

But the concern with such an approach must be that, in most of those global capitals, housing markets already price out low- and middle-income residents. They are, as others have noted, “sites of luxury…and commercialized products for the global elites…and no one else.”301 One of the Dryline’s own designers acknowledged it would likely trigger a new round of displacement during our conversations about the project. City officials in Galveston discussed the same in regard to the Ike Dike. That is not to say that cities like New York should avoid investments in big, infrastructural upgrades like the BIG U. I simply mean to reiterate the

designers must abandon their agnosticism towards politics and policy, and create proposals that are more than just physical objects detached from the sociological realities of a place. For all the bluster amongst design scholars regarding the importance of understanding and drawing upon the idiosyncrasies of a site, the professions remain enamored with the idea of transporting physical design responses between cities. It is why post-industrial cities continue to chase casino and sports stadium projects and it is why coastal cities continue to pursue aesthetically pleasing fortifications along their waterfronts.\textsuperscript{302}

Another concern must be that other cities – of considerable size and wealth, but nowhere near that of New York – will adopt the resistance-based approach of the Dryline when investing in their coasts. Global cities like New York are uniquely positioned to build luxury design projects – whether they \textit{should} do so is another question. But New Yorkers – and the designer who operate within it – often view themselves as a model for the rest of the nation, if not the world. There is real danger in the veterans of RBD and its related events attempting to export their ideas and plans from New York to cities like Baltimore, Tampa, New Orleans, and Charleston – places without the financial or technical capacity of a global city. One could argue that no American city needs a project as expensive and highly

designed as the Dryline to make it resilient. All should recognize that, if it belongs anywhere, the only arguable location for such a project is the Financial District of New York City.

But there is some potential in exporting the concepts found in the Living Breakwaters and Lifelines proposals. Though the latter deploys shellfish and oyster reefs in ways incongruous to the local context of Staten Island, there is undeniable merit in pushing bayside communities to invest in near-shore, living breakwaters. They improve local water quality, they help stabilize shorelines, and the bolster marine fisheries – which, in turn, bolster local economies. They just cannot be the primary instrument of resilience in any of those communities – ocean acidification threatens the viability of most shellfish, making the long-term applicability of these concept questionable at best. When one considers that Living Breakwaters is located in an area of New York where shellfish do not typically reach maturity and that it cannot perform the surge-reduction function on which it was marketed to the public, you could actually argue that it is the most portable concept to come out of RBD. Ironically, it may be less appropriate for New York than it is for other communities along the East and Gulf coasts where the marine life associated with its structures have a far higher probability of flourishing.

Lifelines, like the Vision 2100 plan in Norfolk, is as much about social mobility and individual coping capacity as it is about big, structural
resilience infrastructures. Though it represents a break from the convention of designed resilience projects—especially those that are funneled through international design competitions—I hope that it signals a shift in the way that our professions think about what it means to live with risk. Lifelines breaks from the idea of design as an instrument of real estate speculation and, instead, treats it as an investment in the Bronx residents. “Ultimately…we knew that whatever investments were made here— if they went through the conventional channels—that the people living [in Hunts Point] would not be the ones to benefit…Without mechanisms for keeping them there and ensuring that the benefits of whatever is built flow to them and not some future population…you have to invest in both the physical assets and the people themselves.”

A second response to the question of how Galveston, Norfolk, and New York’s lessons might be exported requires treating them as a set—or, rather, something approximating one case rather than three. Though there are important variations between the three— their biophysical conditions, their ecological legacies, and their political and design cultures—they underscore a critical contribution from this dissertation: that coastal adaptation and resilience is not a question of science or design or politics. They are questions of science and design and politics—at all times and in

all places. Reforming the policy framework within which coastal resilience projects are developed is therefore just as critical as exporting ideas from the design projects proposed in each city.

The most important reform to initiate involves an overhaul of the USACE’s operations along the American coast. As chapter three of this dissertation makes clear, the Corps’ process for assessing and delivering coastal resilience projects is not working. There are three critical reforms to their project development process that must be enacted if coastal cities hope to receive the resources they need to adapt to climate change.

The first is that the Corps must modernize its approach to cost-benefit evaluation. Though others have advocated a risk-based approach to project assessment, such a shift is unlikely in the US. That is because a risk-based approach is a form of the precautionary principle employed by most European nations in regulating risk. It calls for setting very high standards of risk mitigation and enforcing it – no matter the cost – on polluters and commercial enterprise. However reasonable that sounds, it stands little chance of being realized in the US – where private property rights are sacrosanct and where the mythology of rugged individualism is considered a core national value.

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Instead, the Corps should simply amend its existing cost-benefit method to include ecosystem services – also known as ecological economics – in its calculations. This would involve assigning an economic value to four categories of ecological benefits that coastal resilience projects can provide: provisioning services or the products of an ecosystem, which might include boosts to local fisheries; regulating services, which might include improvements in water quality as well as reductions in flood risk; cultural services, which might include a boost to tourism and recreational revenues; and supporting services, which might include fixing synthetic nitrogen flowing into a bay through a river's tail-waters.

Twenty years ago, an argument could have been made that the science behind such an idea was too new and unproven. That is no longer the case. Ecosystem services are now a mainstream idea and a well-established method of assessing planning and design projects. The US Green Building Council assesses them through the SITES program\(^{305}\), the scientific literature on the subject has grown so large there is now an international journal for ecological economics\(^{306}\), and even President Obama’s White House issued guidance to the Corps on how to integrate


the calculation into its efforts.\textsuperscript{307} The time has come for the Corps to modernize its methods and integrate ecological economics into its evaluative process. Doing so would radically shift the balance of their work away from grey infrastructure – which scores well under the current system – and towards green infrastructure and nature-based strategies – the benefits of which are not currently captured by the Corps. The Corps – and their Congressional overseers – could choose to remedy this by creating an experimental component to their work. In it, the Corps could invest small amounts in new, nature-based projects along the East and Gulf coasts, hire coastal researchers to monitor and assess them, and fold the results of that work into a more progressive approach to their coastal resilience work. The green revolution has permeated nearly every other aspect of American life. It is well past time for it to sweep through the Corps, too.

The second reform to the Corps’ evaluative process should be to abolish the three-by-three-by-three reforms that took effect in 2013. Though well-intentioned, the imposition of such draconian limits on the USACE – which was already struggling to manage complex projects – effectively ended its ability to take on large-scale, resilience-driven work

\textsuperscript{307} Committee on Environment, Natural Resources, and Sustainability of the National Science and Technology Council. 2015. “Ecosystem-Service Assessment: Research Needs for Coastal Green Infrastructure.” Available at: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/cgies_research_agenda_final_082515.pdf.
along the coast. It also contributes to the Corp’s struggle to build nature-based alternatives to safer, conventional grey infrastructure projects. This is because alternative projects are less established, and the Corps – like all other large institutions – operates through a series of well-established norms and behaviors. Though they are well-established and effective and delivering physical works of grey infrastructure, the Corps has not yet established a set of norms around building coastal green infrastructure. That means it will need more time to engineer, design, and assess nature-based strategies along the coast – and the three-by-three-by-three reforms inhibit their ability to do so.

The third and final reform to the Corps’ coastal operations ought to come in the way that projects are funded. The existing system places odd and arbitrary limits on the number of projects that can be underway at any given time by all of the Corps’ districts – a literal hard-cap on how many studies or projects can be going on, in total. That means that a flurry of projects along the Gulf Coast limits the number of projects that can be initiated along the East and West Coasts. While reasonable in theory, this approach is incongruous with the decentralized nature of the Corps – and the federalist devolution of federal power to the states in the US. A regional cap might be more suitable, if limiting the scale and scope of the Corps’ work is a sacred principle amongst its overseers in Congress. But a better approach would be to simply abolish the cap, on the off chance that
the needs of coastal communities vary from year-to-year and location-to-location.

Even with these reforms in place, the questions about how to build coastal resilience would still inevitably turn towards two subjects: how to fund and finance their implementation, and how and when to best use them. The former is a question best left to experts in public finance. However, there are a number of compelling proposals to consider. Some are based on state-level, revolving infrastructure bank funds in which low or no-interest loans are provided to local governments to help fund small projects and to cover the cost-sharing burden often associated with larger, federal projects. This seems like a reasonable approach for building coastal green infrastructure too. The money necessary to capitalize the revolving funds could come from a variety of sources: a state or regional carbon-market, akin to RGGI in the Northeast\textsuperscript{308}; a new levy on oil and gas businesses doing extractive work along the coast; or an incremental increase on hotel and motel taxes in establishments located in the NOAA-defined coastal management zone.

The latter is a question of performance – and the science of resilience and nature-based strategies along the coast. Though less

established than the broader literature on ecosystem services, this growing body of knowledge is precisely what designers and planners need to more effectively intervene in coastal cities.\textsuperscript{309} It is the focus of the next section.

**Principles: The Performative Potential of Nature-Based Strategies**

The necessity of integrating the science of resilience within the practice of coastal planning and design has never been more important. A century of mismanagement and misguided interventions by engineers along the coast has created a unique opportunity for landscape architects and planners to take on a leadership position in the re-making of our nation’s shore. That means that our professions must do two relatively simple things over the next decade: we must be honest brokers in the resilience-making efforts along the coast, and we must change the way we operate within those territories.

The former requires a concerted effort amongst the profession to better understand what we know – and what we do not – about what makes cities resilient and what role nature-based strategies have to play. So what can the science of resilience and performative landscapes tell us about how to design the coast? The first, and perhaps most important,

step is to understand how, in economic terms, structural and nature-based strategies for risk reduction compare. The structural, resistance-based approach to coastal resilience employs seawalls, bulkheads, jetties, revetments, groins, and levees. They are generally viewed by coastal managers and the USACE as the easiest kinds of projects to implement. There is a long history of building coastal grey infrastructure in the US and our tools for evaluating, designing, and constructing it are well-established.

That long, grey legacy also means that we know a considerable amount about the costs and benefits associated with such projects. For instance, we know that, depending on project specifications and local constraints, the capital cost a vertical seawall can range from $600,000 to $44 million per mile, the cost of a levee averages $28 million per mile, and that the average cost for a bare-bones barrier system is more than $100 million. The operational costs for such systems range from $3 million per year to as much as as much as $20 million – a heavy burden for the local governments saddled with the cost. It's important to note that barrier systems should be evaluated per mile, as they must be built in their

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entirety or they offer little to no protection.\textsuperscript{312} That is why systems like the BIG U are only viable in very densely settled areas – the cost-benefit ratio of a massive barrier system just does not compute in less developed zones.

We also know that, in addition to their high economic costs, there are major environmental and spillover effects associated with coastal grey infrastructure. It is associated with coastal ecosystem denudation and habitat loss, contributing to the rise of invasive species in the intertidal zone. They also create scouring effects along the shore, eating away at beachfronts and, over time, undermining their own geo-engineered foundations. As a result, the USACE now recommends using seawalls and barrier systems only in areas already experiencing very high erosion.\textsuperscript{313} Levees and barriers in particular “change the hydrodynamics of an estuarine system and can decrease the accommodation space for floodwaters, increasing the likelihood of flooding in adjacent areas.”\textsuperscript{314}

Part of those spillover effects includes the moral hazard of building large, structural protections without an ability to regulate land development around them – a process which often induces dense development behind


seawalls and barriers that, without exception, will catastrophically fail during major storm events. I do not mean to minimize the economic benefits of such projects. That value is real and important and, in many places, coastal grey infrastructure should be the form of protection that communities opt to construct. The challenge at present is that there is very little choice available to coastal cities.

As I have noted ad nauseam in this dissertation, many of the environmental and spillover effects are not considered by the Corps. When they are, they are often given less weight than the basic capital and commercial cost-benefit calculations. Even when the spillover and ecological impacts are assessed by the Corps, they are measured qualitatively and, thus, de-emphasized in their decision-making process. The Corps simply is not equipped to build much of anything beyond coastal grey infrastructure, despite what we also know about the performative value of nature-based strategies.

The interventions typically included in the Corps’ definition of nature-based strategies include beach nourishment programs, dune restoration and construction, and the conservation, restoration, and design of salt marshes, seagrass, mangroves, and oyster reefs. They are generally viewed by coastal managers as exceptionally difficult projects to construct – though that is mostly a function of the regulatory framework
and not the engineering or literal construction work. Though their costs and other characteristics are less established, they too have some operational principles worth considering in any discussion regarding coastal resilience.

The capital costs for nature-based strategies that provide levels of protection comparable to more structural alternatives are often significantly lower. But they do not always provide the same kinds of risk reduction or ecosystem services as grey infrastructure. In fact, only dune restorations and beach nourishment projects are able to provide that service to communities – marshes, mangroves, reefs, and the others cannot. Building to the same 100-year flood standard used in the structural estimates above, we know that beach nourishment projects average $4 million per mile – and building entire beachheads can cost up to $18 million per mile. This is slightly less than the capital cost seawalls and substantially less than that of levees or surge barriers. But it is the operating and maintenance costs that provide the clearest advantage for this sort of nature-based approach to resistance-driven resilience – often requiring a half-million dollars or less each year.

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However, there are a number of complications to such a strategy. Dunes and beaches do not typically perform as well in areas with significant port traffic. Space is more limited there, meaning the dunes and beaches are unable to be built large and wide enough to provide a level of protection that is comparable to structural alternatives. There are also major ecological challenges to this approach. They can also alter near-shore sediment transport and marine fisheries.\textsuperscript{317} It is not as simple as merely replacing seawalls and levees with dunes and beaches. Rather, it is a question of finding a better balance between where and how those measures are deployed.

After all, dunes and beaches provide a vast array of benefits that their structural relatives do not. Widened beaches create habitat for migratory and terrestrial birds, macrofauna, and invertebrates. They can also bolster the recreational and tourism opportunities for communities – a point to which I will return shortly. The opportunity in dunes and beaches for designers is that most of these second-order benefits – those outside of flood risk reduction – are of little concern to engineers. Most constructed dunes and beaches in the US do not properly integrate or accentuate those kinds of services. Yet they are often the most important consideration for local decision-makers – and a skill uniquely possessed by landscape architects and planners. Working with coastal engineers to

\textsuperscript{317} \textit{Ibid.}
find the proper sites for these nature-based alternatives is only the beginning. After that, the task for designers is finding ways to enhance the ecosystem services those projects can provide, but often do not.

The other, nature-based strategies available to designers have not been shown to have a significant effect on surge and storm-driven risk reduction. Though they are relatively cheap – in the low-to-mid six-figures per mile to build or restore – the central challenge to using salt marshes, wetlands, reefs, and seagrass beds for that purpose is two-fold. One is that storm surge is always preceded by a forerunner – meaning that, by the time the actual surge makes landfall, the shore zone will already be under several feet of water. That effectively eliminates the frictional qualities of these interventions – which is the source of their ability to attenuate tidal wave action.

The second is that these kinds of nature-based strategies require incredible amounts of surface area to be effective. Rather than deflecting wave energy as dunes and levees might, reefs, wetlands, seagrass, and marshes absorb it through surface friction. Deploying any of them as the primary source of surge risk reduction is dangerous and disingenuous – there is simply no evidence that any of them can perform that particular service.
But they are particularly useful instruments of coastal resilience outside the desire to reduce storm-driven damages. Designing, conserving, and restoring salt marshes and seagrass beds are excellent ways to minimize tidally and wind-influenced shoreline erosion. They are relatively cheap to construct – $13 million per mile of seagrass and $14 million per mile of salt marsh – and cost almost nothing to properly maintain. This is a major strategic advantage for these nature-based strategies over structural solutions like revetments, groins, and other stabilization projects. The structural ones are significantly more expensive to maintain and nearly all of that cost is borne by local governments – the level of government least able to marshal the financial and technical resources necessary for such a task. Cities like Norfolk – with large, crenulated shorelines and high exposure to N'oreasters and tidal events – should find them especially useful. Given the properties that impact their ability to perform shoreline stabilization services, their principal challenge will always be spatial – as in finding enough room to build or restore a large enough salt marsh that it can have a meaningful effect.

Oyster and shellfish reefs can provide a similar service – though their effects are less pronounced. Evidence shows that near-shore breakwaters – oyster-populated or not – can have a small effect on

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coastal erosion. They also provide significant, local improvements in water quality when located in estuarine environments. But there are significant challenges to siting and constructing them properly. One is that any reef close enough to shore to help with stabilization will have other unanticipated effects in the sediment transport zone along the coast. Put another way, reefs stabilizing one section of a community’s coast will often destabilize others. Also, despite advocacy for oyster and shellfish reefs in coastal resilience projects like Living Breakwaters, the evidence shows that “oyster reefs are quickly overtopped during storms and are not effective at dealing with the storm surge and wave heights common in tropical storms…and they can modify the geomorphology and bathymetry of surrounding areas…creating more downstream risks.”

Shellfish reefs are also much more expensive than other nature-based strategies – ranging from as little as $25 million per mile to as much as $34 million. Their highest use will likely be in bay cities like Galveston.

So if one of the central tenets of a resilience-based design practice includes integrating knowledge from the scientific frontier into our work, what exactly do we know about the usefulness of nature-based strategies along the coast? For dunes and beaches, the evidence is clear that, in all

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320 Ibid.
but the densest of cities, they provide a reasonable alternative or supplement to the more conventional seawalls, levees, and grey infrastructure favored by the Corps. They may not be suitable for cities like New York and Miami, but Norfolk, Charleston, Savannah, and others could benefit greatly from their inclusion in the coastal landscape.

Landscape architects and planners are uniquely positioned to develop these kinds of projects, given that their primary advantage over structural protections is their ability to provide comparable degrees of surge risk reduction and a suite of complimentary ecosystem services. In cities like Galveston, these kinds of vertical nature-based strategies also provide a form of psychological congruency with the seawalls and structural barriers built there a century ago. It is also less jarring – and likely more politically acceptable – to build dunes and beaches there than to move towards a radical, horizontal-only intervention that cuts against a century’s worth of faith in technology and barriers.

Somewhat ironically, beach nourishment projects are a frequent source of derision amongst landscape architects and ardent environmentalists. Their motivations are understandable – it can seem preposterous to support a process in which sediment is continuously

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pumped and dispersed along the nation’s coast to keep pace with shoreline erosion. But this elides past a few of the critical benefits that such nourishment efforts provide. One is that most small and medium-sized communities along the East and Gulf coasts rely on their beaches as a source of revenue from tourists. In many of those communities, that revenue is the only thing keeping their local economy together. Designers can certainly engage in a theoretical discussion about the merits of building a local economy on such a wobbly pillar, but it begs an important question: what would their alternative be? To end the nourishment program and watch as those communities’ beachfronts – and economies – rapidly erode? Is plunging those places into deep poverty worth whatever self-righteous point we’d like to make about what is natural – and what is not? Going down such a path would undermine the very resilience designers and planners purport to desire.

The other key point regarding nourishment projects is that nearly all of the material used in them is recycled. It is not as if the Corps is involved in some bizarre shell game of moving sand between Florida and New Jersey and Texas to try and balance things out. Most of that material comes from two sources: offshore sand pits, which were created by the Corps when they began dumping dredge material there; and dredge-and-pump operations, which take material from ship channels and waterways that have to be dredged regularly anyway and send it to eroding local
beaches. Sending that dredge material to beaches instead of the open ocean is precisely the sort of loop-closing, systems-thinking approach to resilience that designers should be engaging.

Those horizontal strategies – salt marshes, oyster reefs, and seagrass beds – cannot be the primary focus of any credible resilience strategy that purports to reduce surge-related risks. They can and should, however, be at the heart of any project that aims to stabilize wind and tide-drive shoreline erosion, to restore estuarine ecosystems, to enable upland habitat migration as sea levels rise, and to deliver a series benefits that more conventional projects – like groins, revetments, and bulkheads – cannot. These are the kinds of strategies that will be most effective where storm surge is not a major risk. Cities like Norfolk and Savannah – well-protected, estuarine cities whose primary risks are via wind-driven flooding from N’oreasters and increasing backflow and flooding through their stormwater management systems as sea levels rise – should be the primary sites for these kinds of projects.

Using an evidence-based approach to coastal resilience is critical – both to the future of the American coast and to the relevance of landscape architecture and planning. Designers may only get one chance to lead the resilience era in this country. If we squander that by investing time, money, and political capital in ideas that we know will not work, we will only have ourselves to blame when our position and authority diminishes.
This seems particularly important for landscape architects – a profession that spends a considerable amount of time and energy asserting its societal importance and relevance. Though those assertions are not always aligned with reality, the profession does have a unique and valuable role to play in leading coastal resilience efforts.

Getting it right means moving away from a model of practice that prioritizes luxury and wonderment as the primary contribution of landscape architects to the planet. There can and should be room for such endeavors in the profession. But placing them at the forefront of our coastal operations risks trivializing the very real challenges and devastation our cities and coasts can expect to face over the next century.

Recall that one of the participants in MoMA’s *Rising Currents* and the RBD competition framed them as little more than “exhibitions that should have been titled ‘Artists against Climate Change.’” This cannot be framework in which designers and planners operate going forward. As I have discussed throughout this dissertation, I do not mean to imply that landscape architects alone can save the coast. Indeed, it seems clear to me that there is no saving the coast. It is going to be transformed radically by sea level rise and climate change. The task before us now is to find ways to forestall that transformation – to make the transition more gradual.

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and manageable; to give communities the time they need to cope with that coming erasure; and to give decision-makers and scientists the time they need to devise a longer-term approach to rising seas. If we fail to meet this moment, we risk becoming marginalized in the broader project of resilience-making along the American coast.

**Prospects: Towards a Naturalized Coast**

Naturalizing the American coast will not be easy. But, now more than ever, it is necessary to conserve and enhance the vitality of this nation’s cultural and economic engines: its coastal communities.

Simply extending the logic of the twentieth-century’s hard, linear coastal infrastructure will not be enough to meet the challenges of the twenty-first. That approach is prohibitively expensive, is time-consuming construct, and is nearly impossible to maintain. Worse, the evidence shows that it can create more risk than it actually removes by inducing new development and creating a moral hazard along the coast. Grey infrastructure will always have a role to play in coastal resilience and adaptation planning. But the time has come for its hegemony to dissolve and for a softer, nature-based strategy to proliferate.

That is because a coast that is better balanced between structures and nature-based interventions is better-suited to the challenges posed by sea level rise and climate change. To borrow from the language of Ian
McHarg and landscape ecology, there is fitness or competitive niche component to nature-based strategies that simply cannot exist in the inertness of coastal grey infrastructure.

Prior to the 2016 Presidential Election, the scientific community was skeptical as to how much climate change mitigation might be possible over the next century. Given that the critical 400 parts per million threshold was crossed late that year, it seemed unlikely that humanity would be able to geo-engineer or fuel-switch its way out of this mess. That’s in part because carbon dioxide takes more than one-hundred years to dissolve from the atmosphere, meaning that the incredible volumes we have emitted since the Industrial Revolution are not going anywhere anytime soon. It is also because such a Herculean task would require tremendous cultural shifts away from high rates of resource consumption – something Western nations have, thus far, proved unwilling to do. But, especially after signing on to the Paris COP-21 agreement, there remained a fain glimmer of hope that there might be a pathway for this nation and the West to stave off the worst impacts of climate change.

The election of Donald Trump extinguished that hope. Within days of being sworn in as the forty-fifth President of the United States, Trump announced that the US would be withdrawing from COP-21 – ending any hope for an international effort to mitigate climate change. Whatever efforts continue on that front will be localized and incremental – admirable,
yes, but completely out of scale with problem at hand. That approach is derived from the framework of sustainable development which, this dissertation argues, is ill-equipped to face the challenges of the new century.

Adaptation to climate change is all that is left now – and it is where designers’ efforts should be focused. Derived through the framework of resilience, climate change adaptation is better-suited to the challenge of coping with – rather than trying to offset – the effects of climate change. Fortunately, the American system of governance is designed precisely for such an approach. The federalist system is premised upon a devolution of power to the states. The challenge for planners, designers, and policy-makers now will rest in devising a series of tactics and strategies suited to the task of coastal climate change adaptation. To borrow from the horticultural and policy language introduced in this chapter, their task is to find ways to naturalize the American coast. Nature-based strategies must become part and parcel to such efforts.

Not only would a naturalized coast restore and create ecosystem services lost to a century’s worth of industrialization, but they can create the time and space needed to allow for the migration of marine ecologies, the reorganization of cities around risk reduction, and the adaptation of the American coast more broadly. Recall that, in Holland, a similar process took place along the watershed of the Rhine River. The Dutch sought to
blend structural and nature-based strategies together in the service of restoring floodplain functions lost to urbanization. The plan, known as “Room for the River”, reorganized the entire watershed around that purpose.

The same can be done along the American coast. But rather than making room for a river, planners and designers operating in those communities must make “Space for the Sea.” But how much space? The answer to that question have several parts. The Gulf and Atlantic Coasts span some 46,650 miles including the tidal zone. Around 510 miles of that belongs to Galveston, with 328 and 520 to Norfolk and New York City, respectively. That comes to nearly, 1,400 miles of coast between them. If you include the other twenty-four cities that I considered as a part of this dissertation – which represent all of the coastal communities in which we might expect there to be a need and ongoing work on resilience strategies – that figures climbs to nearly 13,000 miles of tidally influenced coastline.

To estimate the cost of fully armoring those coastal communities, we can use the rule-of-thumb calculations discussed earlier in this chapter. If seawalls run between $600,000 and $44 million per mile, the cost of investing in such an approach along the East and Gulf Coasts

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would run between $7.8 billion and $572 billion. Levees and floodwalls, which run between $8.4 million and $28 million per mile, would cost between $109.2 billion and $364 billion to construct. Surge barriers systems would bleed top $1 trillion. None of these figures include the costs of the engineering studies and plan-making necessary to develop them, nor do they include the annual operations and maintenance costs.

Comparable investments in nature-based strategies would be considerably less. Beach nourishment and dune construction, which run between $6.3 million and $18 million per mile to develop, would range from $81.9 billion and $234 billion to complete. Seagrass beds and salt marshes cost around $14 million per mile to construct, requiring an investment of $182 billion. Reefs are the most expensive nature-based strategy. They cost between $25 million and $34 million per mile to complete, for a total investment of somewhere between $325 billion and $442 billion. The economic and ecological benefits of investing in nature-based strategies are clear.

Of course, this is not an either-or proposition. We must invest in both forms of infrastructure – grey and green, hard and soft, alongside one another. As this chapter makes clear, there are some contexts in which

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nature-based strategies simply are not an option. Whether due to high density development or large-scale port operations, some communities will need to invest in walls and barriers in lieu of dunes and beaches.

The World Wildlife Fund and Allianz Insurance estimate that $7.4 trillion in assets – including homes, businesses, public lands, and infrastructure – along the northeastern coast of the U.S. are at risk of loss or damage due to sea level rise and coastal storms over the next century. Trillions more are at risk along the Gulf Coast – in cities like Houston, New Orleans, Biloxi, and Pensacola – and the mid-Atlantic coast, in cities like Savannah, Charleston, Norfolk, and Baltimore. If we conservatively estimate that $15 trillion in assets along the East and Gulf coasts must be protected through government-led, physical resilience projects – and we assume the standard cost-sharing agreement of a sixty-five, thirty-five percent split between federal and local sponsors – then we can estimate that the Corps will need nearly $10 trillion to construct these projects and local governments will need just less than $5 trillion. This, of course, ignores the fact that significant, pre-construction expenditures are required to study, plan, and design the projects and that the Corps does the majority of its work inland, along rivers and reservoirs, instead of the

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coast. It is a daunting, yet necessary, challenge for the Corps, their local partners, and designers to meet.

But the task before designers, planners, and policy-makers now is to seek out those areas where a nature-based or hybridized approach to coastal resilience is viable, to reform the Corps and other coastal management institutions to enable their construction, and to get on with the vital work of naturalizing the American coast. Sea level rise, like death, is coming for us all. Nature-based strategies represent our last best hope for adapting to the coming flood and making Space for the Sea.

Image Library: Chapter 5
Figure 53: The increase in Average Annual Losses (AAL) due to climate change (Nature Climate Change). This map illustrates the global cities most at risk – as measured by projected annual commercial and economic losses – as a result of sea level rise and climate change.
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