UP IN THE AIR: INFORMING AND IMAGINING CLIMATE ADAPTATION ALONG THE NEW JERSEY SHORE

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ABSTRACT OF THE DISSERTATION

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In this dissertation, I examine the challenges posed by climate change to the New Jersey shore region as well as efforts to inform and support successful adaptation policies. The core argument of the dissertation is the region needs transformational change in the near term if a socially and ecologically vibrant future is to be achieved. Informing the design and supporting the implementation of sustainable transformational pathways requires engaging with the deeply entrenched cultural, economic, and political commitments that configure contemporary development within the New Jersey shore region. By drawing upon archival and historical research along with semi-structured interviews and participant observation, I demonstrate that historical and contemporary processes have contributed to material and imaginative path dependencies within the shore region that have led to governance and management prioritizing private property rights and economic growth over ecological and social sustainability. I argue that to support more just and sustainable pathways, practitioners working within the boundaries of science and policy must engage more with the political, imaginative, and normative dimensions of collective life in the New Jersey shore region.

In making this case, the dissertation is divided into two main sections. In Section One, I trace the historical development, entrenchment, and extension of the prevailing sociotechnical imaginary guiding development in the New Jersey shore region. In particular, I highlight how racism,

capitalism, politics, and technological innovation all intersected to produce the contemporary space of the region. In doing so, I elucidate how historical forces are still present in the New Jersey shore landscape in the form of material infrastructure, public policy, and cultural visions of desirable life. In Section Two, I examine how ongoing initiatives to inform the creation of successful climate change policies must grapple with myriad constraints—including the historical ones described in Section One but also emergent ones due to climate change. In light of the numerous constraints to effective adaptation, I develop a heuristic to differentiate and connect individual barriers in order to help distinguish which factors drive slow and ineffective policy responses. By identifying and addressing such constraints, I argue it is possible to foster cascading change towards more desirable social and ecological arrangements. Following this, I provide an in-depth examination of how one initiative to provide municipal government actors with tailored and usable climate information succeeded in getting climate change adaptation on the policy agenda. I highlight the crucial role that boundary objects played in not only supporting collaboration, but also convening the process, securing buy-in, and implementing policies. At the same time, while the examined effort did manage to get municipal government elected officials and staff to begin planning for sea level rise, coastal flooding, and powerful storms, it did not lead to the transformational change commensurate with the plausible impacts of climate change in the coming decades. Thus, more work needs to be done to support systemic change that targets the central constraints to sustainable adaptation. In the conclusion, I develop the concept of 'imaginative fit and interplay' to help guide collaborative knowledge production initiatives in producing transformative knowledge. I also discuss future research to building off these insights to support transformative change towards a more socially just and ecologically vibrant New Jersey shore region.

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Chapter 1—The Coming Transformation: Unavoidable Change in the New Jersey Shore

1—Up in the Air: How Climate Change Became Part of the Story of the Shore

During the spring of 2016, I traveled to a small, suburban municipality located on the Barnegat Bay's mainland shore. Like most of the New Jersey shore region, Superstorm Sandy caused significant damage within the community in 2012. Much of the development in the municipality had occurred during the middle of the 20th century—particularly in the decades after the Garden State Parkway opened up the region in the mid-1950s to suburban development. During those initial decades of development, no regulations prevented filling in lagoons and marshland to 'reclaim' land for housing. The municipality I visited that spring day was a legacy of this process. Thus, not only had the marshes that could have absorbed some of the record flooding been long removed, but homes had been built on now sinking land.

The purpose of my trip was to interview three members of the local government about municipal resiliency policy. These were the first three interviews of municipal actors I conducted during this research project. All three interviewees had little doubt that climate change was real, that sea level rise represented a significant problem, that future storms would cause extensive damage to property and infrastructure, and that, decades from today, every-day life in their community would largely remain the same. During each conversation, projections of sea level rise were discussed as a fact—including that three or four feet of increases were realistic possibilities by the end of the century. Each interviewee expressed real concern regarding the likelihood that another event would cause damage similar to Superstorm Sandy at some point in the not so distant future. Yet, at the end of each interview, when asked what they hoped the future would be

like in their community, the visions offered remained ones of a vibrant coastal community with development remaining along the waterfront.

This is not to say the municipal government actors did not have trepidations regarding the future. One of the interviewees highlighted that, while it was possible to elevate most homes, roads could only be raised a few inches; therefore, in the case of severe flooding, the municipality would need to become more effective at rescuing residents unable to evacuate on inundated roads. Another of the interviewees stated that the next few decades would include more flooding, more storms, and more rebuilding. In short, while all three municipal actors accepted the reality of climate change and the possibility of a wide range of plausible climate hazards, they could not imagine an alternative to the present—a present that already included increasingly frequent flooding and storm damage and that required expensive maintenance and recovery programs.

With few—though notable—exceptions, the other interviews I conducted with municipal actors broadly resembled that first day. Nearly every municipal government actor with which I spoke acknowledged that climate change in general—and sea level rise in particular—posed real, significant, and near-term challenges. Indeed, these actors were highly educated about climate change in part because of a number of well-designed initiatives to tailor and translate climate information into forms understandable and usable within existing decision-making processes. Yet, the prevailing vision of the future found in the shore region is one that resembles the present day.

In short, there was almost no denial of the science of climate change in regards to both drivers and effects. Municipal government actors overwhelmingly agreed that climate change would likely cause a range of significant impacts within their communities. Yet, most interviewees believed there were few alternatives to the status quo of vulnerable development patterns and

expensive recovery efforts. In this sense, it is possible to identify a prevailing sociotechnical imaginary that figures a future in which technology and policy makes possible the persistence of precarious and unsustainable development patterns. Jasanoff (2015a, p. 4) defines a sociotechnical imaginary as the "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology."

The future imagined by the municipal officials I spoke to was, to quote one flood plain manager, 'up in the air'. By which, I first interpreted as meaning uncertain and unclear, but later realized they were describing literally the future they envisioned. Homes, businesses, and infrastructure would be elevated into the air and above the increasingly frequent floods and out of the way of dangerous storm surges. Or, in a more extreme example, an entire island was envisioned as being gradually raised. In this case, two employees of a municipal government located on a barrier island explained their long-term plan was to raise the ground level of the island. Every time a storm destroyed property was an opportunity to not only construct more resilient housing, but also a chance to bring in additional sediment to raise the ground the home was constructed on. The only problem being that in the case of extreme storms, only two bridges connected the island to the mainland—making evacuation difficult. Thus, the future envisioned was one in which many existing social, economic, and technical processes were intensified.

Writing in the context of the emerging great extinction event now unfolding, the literary theorist Ursula K. Heise poses the question of, in the context of the unfolding extinction event: "How, when, and why do we invest culturally, emotionally, and economically in the fate of threatened species?" (2016, p. 4). In answering these questions, Heise argues that scientific narratives about the ongoing rush of species dying will only "gain sociocultural traction to the extent that they

become part of the stories that human communities tell about themselves: stories about their origins, their development, and their future horizons." To a certain extent, it can be argued that climate change *has* become part of the story that the municipal officials I spoke with told about their communities, development, and future.

The problem is that the story being told is rooted within a sociotechnical imaginary that places people at risk, propels ecologically destructive development, costs billions of dollars to maintain along with billions more to rebuild, accelerates beach erosion, and, in the medium-term, is likely to be overwhelmed by the cascading impacts of climate change. As Haraway (2016) states, in the Anthropocene, it is the story that needs to change. Or, as the novelist and writer Amitav Ghosh (2016, p. 9) states: "the climate crisis is also a crisis of culture, and thus of the imagination." In the case of the New Jersey shore region, visions of the future and practices in the present are structured by a prevailing sociotechnical imaginary that configures a coastal zone that, while increasingly exposed to climate change hazards and risks, can persist through engineering, disaster management, ecosystem services, and recovery programs. Central to this imaginary are the concomitant beliefs in the need for constant economic growth, the immutability of property rights, and the unending capacity of science and technology to secure a desirable future. Ultimately, pursuing such a trajectory is very likely to lead to accelerated beach erosion, the destruction of coastal habitats, placing thousands of people's health and lives at risk, and requiring billions of dollars in governmental spending for both general maintenance and recovery efforts.

Within this introductory chapter, I review the literature on climate change governance to highlight the seemingly intractable situation in which transformational change is considered necessary for achieving sustainable and just outcomes in coastal areas, yet implementing such

change often requires transformed governance arrangements. In other words, before transformational policies and plans can be designed and implemented, there is a need to transform the processes through which such policies and plans are designed. Because of this, I argue that efforts to produce climate knowledge that fits within existing decision-making contexts can run the risk of entrenching maladaptive governance arrangements. Thus, there is a need for more theorization of the concept of transformational knowledge. I suggest that more focus on the imaginative dimensions of climate change can help guide the creation and communication of transformational knowledge.

1.2—The Challenges of the Anthropocene: Misaligned Institutions and Imaginaries

That existing governance arrangements struggle to respond to the mounting impacts of climate change is not unique to the New Jersey shore region. As Oran Young (2017) recently argued, in the context of the Anthropocene, many existing and once effective institutional arrangements governing socioecological systems can no longer achieve desired outcomes. Instead, the rapidly changing social, ecological, and climatic conditions of the planet are creating critical mismatches between institutional design and socioecological processes. This lack of institutional fit is particularly pronounced within coastal regions. As the coastal scientists Pilkey and Cooper (2014) contend, many of the world's sandy beaches are at risk of disappearing due to the mix of poor management and accelerating sea level rise. Numerous case studies from around the world—including the United States, Australia, the Netherlands, and the United Kingdom—show that coastal management regimes continue to follow a 'predict-then-act' strategy seeking 'optimal outcomes' that is ill-suited to the deep, intractable uncertainty associated with climate change projections (Anderies et al. 2013; Hallegate 2009; Ramm et al. 2017; Walker et al. 2012; Weaver et al. 2013). In other words, it is increasingly the case that coastal regions exist within

maladaptive space and are managed through governance institutions structurally incapable of effectively and sustainably responding to climate change.

Escaping this trajectory requires transformational adaptation pathways that begin in the near term, rather than the medium- or long-term. As I will argue in this chapter, short-term efforts to produce and communicate ‘usable climate knowledge’ or ‘actionable climate services’ within the many coastal regions existing within maladaptive space run the risk of contributing to lock-in effects that create path dependencies, which, in turn, makes transformational change all the more difficult and costly in the future. Thus, ‘transformational climate knowledge’ and ‘transformative capacities’ need to become a central focus of decision-support initiatives that aim to reduce the drivers and manifestations of social and ecological precarity.

In light of this general need, this dissertation makes the specific case that more attention and effort ought to be placed on imagining, implementing, and supporting transformative change in the here and now of the New Jersey shore region. In working to accomplish this goal, evidence is presented that efforts to provide decision-makers in the region with high quality, tailored climate information has been well-designed and executed. Municipal government officials and staff members have learned a great deal about the causes and consequences of climate change in the shore region. This knowledge has contributed to many municipal governments beginning to think about and attempt to plan for future climate change impacts. Nevertheless, there have been few examples of transformational changes addressing the root drivers of vulnerability or of efforts to transition to more sustainable and just development patterns.

In the next section of this chapter, I review and synthesize strands of scholarly literature on the general maladaptiveness of coastal management and governance; institutional design principles theorized to better fit the emerging and deeply uncertain environmental conditions of the Anthropocene Epoch; and initiatives to produce climate science that decision-makers can readily utilize to successfully address the challenges associated with climate change. A key tension I draw out through reviewing and synthesizing these literatures is that, on the one hand, transformative climate science is needed to inform the design of new, transformative change within the institutions used to manage and govern many coastal areas; yet, on the other hand, transformative change is needed within management and governance institutions to produce effective and transformative climate science. In other words, transformed institutions are required to produce the transformative information necessary for transforming institutions (see figure 1). In light of this seemingly intractable situation, I conclude with a case for increased attention on the imaginative and political aspects of climate change, which I return to in the concluding chapter.

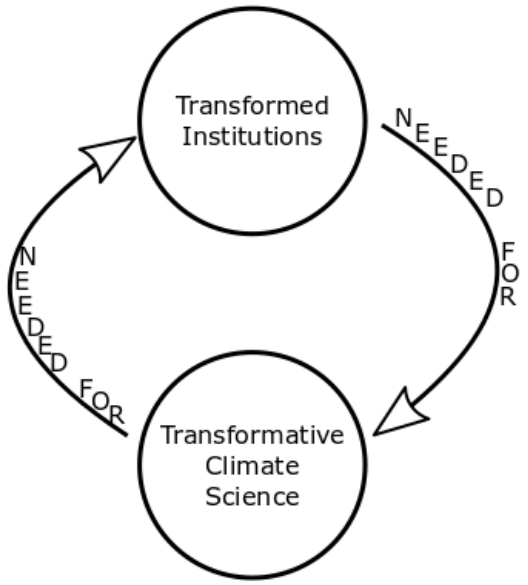

Figure 1 Simultaneous need to transform institutions and knowledge

After this literature review and synthesis, I provide a brief overview of each chapter and how they contribute to the overall argument that transformative change is needed within the New Jersey shore region. Each chapter builds towards making the case that fundamental and systemic changes are needed within a wide array

of social and material domains in the shore region and that, without such change, the New Jersey shore will be stuck in maladaptive space.

1.3—Informing Pathways out of Maladaptive Space: The Need for Transformational Change in the Here and Now

Transformational change is needed to prevent dangerous levels of climate change as well as to respond to unavoidable impacts (Bloemen et al. 2018; Klein 2015; O'Brien 2012a; 2016; 2018; Steffen et al. 2018; van der Voorn et al. 2017; Wise et al. 2014). Cascading environmental changes caused by the emission of greenhouse gases, overuse of fertilizers, destruction of critical habitats, direct harvesting of species, release of novel entities, and an assortment of other anthropogenic drivers present significant challenges to the development of a just and sustainable global society (Steffen et al. 2015). Climate change impacts are already being felt in the form of heat events, rising sea levels, the spread of disease vectors, shifting weather patterns, water shortages, wildfires, and agricultural stress (IPCC 2014; Zalasiewicz et al. 2010). Without rapid, transformational changes in collective behavior, governance, and values, the Earth System is likely to become locked into the 'Hothouse Earth pathway' in which compounding and cascading planetary changes will present a plethora of dangerous and severe risks to human health and prosperity (Steffen et al. 2018).

Defining transformation is difficult, contentious, and, ultimately, subjective (Fazey et al. 2017; Feola 2015). Generally, undergoing a transformative change entails the creation of something distinct from what existed before—however, within the climate change literature, it is generally held that determining whether of not "something is considered to be transformed is inherently subjective and relative" (Fazey et al. 2017, p. 2). According to Park et al. (2012, p. 119) incremental adaptation can be understood as actions taken to maintain the "essence and integrity

of an incumbent system or process at a given scale" while transformational adaptation entails "a discrete process that fundamentally (but not necessarily irreversibly) results in change in the biophysical, social or economic components of a system from one form, function, or location to another, thereby enhancing the capacity for desired values to be achieved." In other words, transformation entails non-linear changes that shift existing systems onto fundamentally new developmental pathways (Pelling et al. 2015). Fazey et al. (2017) identify three dimensions of transformation related to the 'depth of change', 'breadth of change', and 'speed of change' (see table 1). To help pursue intentional and positive transformations, scholars and practitioners have begun developing transformational approaches to adaptation and mitigation (Colloff et al. 2017; Fazey et al. 2017; Hölscher et al. 2019; Iwaniec et al. 2019; O'Brien 2016; Tàbara et al. 2017; Wolfram 2016; Ziervogel 2019). Transformational approaches to change have been conceptualized in a variety of ways (see table 2), but generally share the quality of being open-ended, iterative, pluralistic, and future oriented (see: Iwaniec et al. 2019 for a review). Additionally, transformational adaptation is often defined as being focused on the root causes of vulnerability to climate change (Pelling et al. 2015; Wise et al. 2014).

Table 1 Dimensions of transformative change

Dimension	Criteria for meeting transformational change
Depth of change	Marked change that results in something distinct, which can occur at different scales or in a variety of processes and systems
Breadth of change	Change occurs within a diverse range of processes and systems, such as technology, infrastructure, politics, beliefs, and practices
Speed of change	Change unfolds quickly
From: Fazey et al. 2017	

Table 2 Definitions of transformative adapation

Defining Transformative Approaches
Ziervogel et al. (2016, p. 4): "conceived from a non-equilibrium, non-linear view of systems, and is creative, adaptive, imbued with agency, and implemented through prototyping and social learning."
O'Brien (2016, p. 619): "involve deliberate actions and intentionality; that is, a commitment to changing the behaviors, structures, and systems that contribute to what many consider to be undesirable and potentially dangerous out- comes, including increased temperatures and climate extremes, rising sea levels, food and water insecurity, and other environmental and social impacts"
Colloff et al (2017, p. 88): "based on anticipatory approaches in which new options are co-created, explored and experimented with."
Hölscher et al. (2019, p. 792): "We define transformative climate governance as the processes of interaction and decision-making by which multiple actors seek to address climate mitigation and adaptation while purposefully steering societies towards low-carbon, resilient and sustainable objectives."
Pelling et al. (2015, p. 113): "Transformation as an adaptive response to climate change risks opens a range of novel policy options and positions adaptation as a component of development policy and practice. Within the range of adaptation options, transformation describes non-linear changes."

In many cases, the information and policy support needed to inform transformational change differs from those effective in informing and supporting incremental change (Park et al. 2012; Tabara et al. 2019; Wise et al. 2014). In part this is because incremental and transformational adaptation have different objectives; the former aims to maintain the existing system while the latter seeks to create something fundamentally novel (Park et al. 2012). Tensions can emerge within collaborative initiatives between scientists and decision-makers to inform the design and implementation of adaptation policies. This is particularly the case if the need for fundamental change is not explicitly explored within collaborations (Gorddard et al. 2016; Park et al. 2012; Wise et al. 2014). By bringing to the forefront discussions around the potential need for transformational adaptations, it is possible to open up the decision-space to new, more effective policy and development pathways while reducing the probability of maintaining maladaptive and unjust systems and processes (Pelling et al. 2015; Wise et al. 2014).

The need for transformational approaches is particularly pressing in urban coastal regions both because they are exposed to a wide range of climate hazards, such as sea level rise, altered storm

regimes, increased temperatures, and ecological change (Hauer et al. 2016; Moser et al. 2012; B. Neumann et al. 2015; J. Neumann et al. 2014; 2015) as well as governed by decision-processes, regulations, institutions, and value systems ill-suited to proactively and successfully respond to climate risks and vulnerabilities so as to achieve a just and sustainable future (Brown et al. 2017; Colloff et al. 2017; Gorddard et al. 2016; Pilkey and Cooper 2014). Left unchecked, plausible climate hazards are likely to irrevocably, dramatically, and negatively alter social, ecological, and material conditions along coastlines throughout the world (Clark et al. 2016; Hauer et al. 2016; Nicholls et al. 2018; Ramm et al. 2018), thereby bringing undesirable transformative change to the planet's coastal landscapes. Alternatively, addressing the proximate causes and root drivers of precarity and vulnerability within coastal communities requires deep and systemic changes within the collective organization of social, material, and ecological conditions (Moser et al. 2012).

Consequently, research must engage with questions of how to best inform the design, implementation, and monitoring of transformational change in coastal regions so as to achieve just and sustainable results under adverse ecological and climatic conditions (Bloemen et al. 2018; Brown et al. 2017). This entails designing adaptation initiatives that focus on changing decision-contexts (i.e. Colloff et al. 2017; Gorddard et al. 2016) as well as social, political, and economic structures (i.e. Eriksen et al. 2011; Eriksen et al. 2015; Nightingale 2015; O'Brien 2012a; 2012b). This challenge is urgent for three interrelated reasons. First, the most common institutional arrangements informing and structuring coastal governance generally do not support sustainable long-term adaptive actions (Colloff et al. 2017; Ramm et al. 2017; Young 2017); indeed, many coastal regions arguably exist within 'maladaptive space' in which any apparent conventional actions often lead to negative future states (Park et al. 2012; Wise et al. 2014).

Meaning that conventional approaches to planning and management are insufficient to achieving medium- and long-term objectives (Colloff et al. 2017; Gorddard et al. 2016; Tàbara et al. 2017; Wise et al. 2014). The persistence of mismatched and misaligned institutions stems, in part, due to path dependencies coalesced by existing power dynamics (Barnett et al. 2015; O'Brien 2018). This brings to the fore the need to transform coastal governance institutions.

Second, research has found that initiatives to inform and support adaptive actions are only effective in situations where micro, meso, and macro institutions line-up to support addressing climate impacts and vulnerabilities (Flagg and Kirchhoff 2018; Porter et al. 2015). For instance, Flagg and Kirchhoff (2018, p. 7) found through a review of research that sought to produce usable climate information in the water sector that scholars "are much less effective at bridging the knowledge-use gap where one or more factors at the micro, meso, or macro levels do not support use." Similarly, research on local adaptation in coastal regions has documented that the lack of financial and political support for adaptation at state and national levels contributes to a lack of attention at the local level—even when high quality usable information is available (Measham et al. 2011; Porter et al. 2015). Thus, the success of any effort to inform and support adaptive actions in coastal areas requires fundamental changes in how the interface between science and policy is configured as well as how climate knowledge is produced and communicated at various levels (Cornell et al. 2013).

Third, research documents that the focus in adaptation scholarship and practice on 'getting the institutions right' has frequently elided the fundamentally political nature of adaptation (Bassett and Fogelman 2013; Eriksen et al. 2015; Nightingale 2017). Hence, adaptation research has often overlooked the socially and spatially differentiated consequences of adaptive actions as well as how struggles for recognition and authority structure the actual implementation of adaptation

policy (Eriksen et al. 2015; Nagoda and Nightingale 2017; Nightingale 2017; Ojha et al. 2016). Thus, there is a crucial need to take seriously the political nature of adaptation, which entails recognizing that controversy, disagreement, and sociocultural differences "preclude the development of clear models of what transformational adaptation looks like since such models are always products of one worldview" (Eriksen et al. 2015, p. 524). Consequently, transforming governance institutions is an inherently political project and requires careful political practices—included addressing questions of whose views and knowledge are legitimate and valid (see: Tengö et al. 2014).

Taken together, this highlights the need for research and theorization regarding how to best inform the practical design, sequencing, and implementation of transformational change in the near term (Bloemen et al. 2017; Eisenhauer 2016; Tàbara et al. 2017; 2019; Wise et al. 2014). While there is growing acceptance for the notion that proactive transformative change is needed, there is still widespread uncertainty regarding how to spur and support systemic shifts in responses to climate change hazards. Research demonstrates that significant and entrenched cultural, political, economic, and material factors limit, constrain, and block meaningful action to address both the proximate and root causes of vulnerability to climate change and overcoming these factors demands fundamental social change. Without additional clarity regarding how to both produce and communicate the knowledge to initiate and support transformational pathways as well as design, sequence, implement, and monitor transformational pathways of responding to climate change, it is likely that the planet's coastal areas will remain stuck within maladaptive space (Colloff et al. 2017; Wise et al. 2014).

In the remainder of this chapter, I lay out some of the crucial challenges to imagining, designing, implementing, and supporting proactive, desirable pathways of transformational change in light

of the ongoing rush of urgencies facing coastal regions. Keeping the possibility open for a socially desirable and ecologically vibrant coastal future, I contend, requires that such transformational change occurs in the here and now. In light of this, I document scholarship on collaborative knowledge production techniques aiming to provide decision-makers with the information and resources needed to effectively respond to and plan for emerging, deeply uncertain climate future. As I demonstrate, though, a tension exists between, on the one hand, the need to provide decision-makers with information that fits existing institutional contexts and interplays with dominant knowledge systems and, on the other hand, the necessity of transforming the institutions, knowledge systems, and values that structure planning and development in coastal regions. Nascent approaches to generate transformative climate science can help conceptualize how informing transformative pathways might occur; yet, at the same time, producing transformative knowledge frequently also requires radically new institutional arrangements. In other words, transformational climate science is needed to inform the design of transformed institutions and transformed institutional arrangements are needed to produce transformational climate science. In the face of the dual challenges of needing transformative climate science in order to design and implement effective governance institutions and needing to transform governance institutions to produce transformative climate science, I briefly introduce the concept of 'imaginative fit and interplay' to guide initiatives aiming to inform pathways of transformational change.

1.4—Designing and Implementing Transformational Adaptation Pathways: The Need for Transformative Climate Science

The people, infrastructure, and ecosystems located within coastal regions are vulnerable to a host of plausible climate change impacts. During the past century, millions of people have moved to

the world's coasts seeking economic opportunity and environmental and cultural amenities (Boschken 2013; Moser et al. 2012). Along with this vast movement of people has come billions of dollars of investment in infrastructure, housing, and industry (Boschken 2013; Hauer et al. 2016; Neumann et al. 2015a). The vast majority of which was not designed to withstand the rising sea levels, changing coastal storm regimes, and other planetary shifts projected to unfold due to anthropogenic climate change. Indeed, many of the world's most economically, politically, and culturally important cities are keenly vulnerable to plausible climatic risks and hazards during the 21st century (Boschken 2-13). In the continental United States alone, more than thirteen million people could be impacted in 2100 if sea levels rise by 1.8 meters (Hauer et al. 2016). There exists a need, therefore, to reexamine and rethink the institutions governing coastal development as well as the priorities embedded within such systems.

Conventional coastal governance institutions are ill-suited to addressing the challenges of climate change (Barnett et al. 2015; Bloemen et al. 2018; Brown et al. 2017; Hölscher et al. 2019; Lawrence et al. 2018; Ramm et al. 2017; Walker et al. 2012). Moreover, research has demonstrated that many conventional approaches to coastal zone management currently contribute to beach erosion, ecosystem degradation, and socioeconomic vulnerability (B. Neumann et al. 2015; Passeri et al. 2015). This is particularly true in the United States, where policy and planning approaches typically prioritize protecting and enhancing property values, continued economic growth, and storm recovery at the expense of long-term ecological and social sustainability. These approaches have displayed path dependencies and lock-ins that make movement towards more robust pathways immensely difficult (Barnett et al. 2015; Brown et al. 2017; Pilkey and Cooper 2014; Ramm et al. 2017). As Hölscher et al. 2019 (p. 792) state: "Existing governance regimes inside and outside of the climate domain tend to be dominated by

incremental decision-making, short-term policy cycles and powerful interests favouring optimization in the short-term, thus precluding more disruptive changes in the long-term and perpetuating dangerous maladaptation." Within such decision-contexts, decision-makers are unlikely to be able to effectively and sustainably address the range of plausible risks and hazards brought about due to climate change (Gorddard et al. 2016; Lawrence et al. 2018; Young 2017). Indeed, as Lawrence et al. (2018, p. 100) argue "sea-level rise challenges those frameworks and the public policy tools and implementation methods which are currently used, such as coastal hazard lines, fixed review timeframes, and cost benefit analysis." The combination of existing and projected vulnerability, institutional mismatch, and path dependencies within values, rules, and practices greatly increases the likelihood of maladaptive and dangerous outcomes unfolding within the coming decades unless significant and systemic change occurs (Park et al. 2012; Wise et al. 2014).

In light of deep uncertainty regarding the timing, magnitude, and form of climate impacts, researchers and practitioners are increasingly advocating for pathways approaches to climate change adaptation in order to inform, spur, and support better long-term decision-making (Eisenhauer 2016; Haasnoot et al. 2012; 2013; Park et al. 2012; Reeder and Ranger 2011; Wise et al. 2014). This reflects a wider turn within the literature towards 'decision-oriented climate research' that aims to directly support policy, governance, and management practice through the production of services, resources, and information usable and useful to decision-makers (Clark et al. 2016; Dilling and Lemos 2011; Fazey et al. 2014; Kirchhoff et al. 2013; McNie 2013; Moss et al. 2012). As both a metaphor and planning heuristic, pathways approaches seek to guide climate change actions by focusing attention on the process of decision-making focused on managing change rather than on specific outcomes (Park et al. 2012; Wise et al. 2014). While a wide range

of pathways approaches exist (see: Eisenhauer 2016 for a review), they share the premise that "the best way to deal with uncertainty is to do what needs to be done now, and to watch out for changes that indicate that new decisions are required to address changed conditions" (Haasnoot et al. 2018, p. 273).

Thus, adaptation pathways approaches are planning techniques that aim to ensure the success of short-, medium-, and long-term policies despite deep uncertainties regarding future climatic, ecological, and social conditions (Bloemen et al. 2018; Eisenhauer 2016; Haasnoot et al. 2013; 2014; Hallegatte 2010; Walker et al. 2013). To achieve this, climate models are used to understand the range of plausible future climatic conditions that a region might experience. A plan is then created that includes multiple possible sequences of actions that each achieve a minimum level of desirable performance under particular plausible climatic conditions. A system of monitoring is then implemented to assess performance and, when conditions change, switch to a new, better suited pathway.

A strength of pathways approaches is their potential to coordinate short-, medium, and long-term actions within a flexible framework that allows for revision in light of collective learning and unexpected outcomes (Colloff et al. 2017; Wise et al. 2014; Colloff et al. 2017). Pathways approaches highlight that adaptation to climate change is a continuous process of learning, experimenting, and re-assessing (Haasnoot et al. 2012; 2013; Park et al. 2012; Wise et al. 2014). Within pathways approaches, decision-makers, stakeholders, and climate researchers can collaboratively generate and map multiple possible adaptive actions that are robust against alternative climate futures (Haasnoot et al. 2012; 2013; Park et al. 2012; Wise et al. 2014. Adaptation tipping points are identified that trigger a switch from a path no longer capable of maintaining a desired state to another path more suited to new conditions (Haasnoot et al. 2013).

Thus, by creating multiple potential sequences of action and identifying the conditions under which each might become either capable or incapable of achieving desired outcomes, pathways approaches foster a flexible decision-making process workable in light of deep uncertainty regarding the future (Haasnoot et al. 2013; Kalra et al. 2014; Raso et al. 2019).

Theorizations of adaptation pathways have argued for the need to include both cycles of incremental and transformative change (Abel et al. 2016; Colloff et al. 2017; Gorddard et al. 2016; Park et al. 2012; Wise et al. 2014). Transformational responses to climate change aim to alter the structure of prevailing governance, political, imaginative, and technical arrangements (Alaimo 2016; Colloff et al. 2017; Fazey et al. 2017; Gorddard et al. 2016; Heise 2016; Jasanoff 2010; Park et al. 2014; Pelling et al. 2015; O'Brien 2012a; 2012b; 2016; Wise et al. 2014). In the context of decision-support, transformational change often entails altering the knowledge, values, and rules that structure decision-contexts (Colloff et al. 2017; Gorddard et al. 2016; Tàbara et al. 2017). For instance, Gorddard et al. (2016, p. 60) argue that: "Many global problems are intractable within existing decision-making processes so addressing them requires change in the societal systems that structure decision making: political, legislative, bureaucratic and market systems that distribute responsibilities for decision making." In other words, many institutions lack sufficient 'fit' with the environmental and climatic systems they were designed to manage (Young 2016). Thus, transformative adaptation within decision-support initiatives seek to create new configurations of governance and management (Colloff et al. 2017; O'Brien 2012a; Pelling et al. 2010).

In an influential article, Wise et al. (2014) outline an approach for combining pathways of incremental and transformational change. Within their approach, pathways of adaptation are designed with the goal of remaining within 'adaptive space'. When a system is within adaptive

space, incremental adaptations designed within existing decision-contexts are likely to be sufficient to maintain desired functions. In other words, as long as a given system is performing adequately, and is expected to do so for a sufficient amount of time, small adjustments are likely to be able to maintain satisfactory outcomes. However, if a system enters ‘maladaptive space’ (or is about to do so), then transformational adaptations are likely to be necessary (Wise et al. 2014). Thus, assessing a systems position within adaptive/maladaptive space is crucial early step in designing alternative pathways. Further complicating decision making is that adaptive space is a moving target due to the emerging and compounding effects of climate change. What was once adaptive might become maladaptive as conditions change. Therefore, ongoing monitoring is necessary to assess whether or not selected pathways are performing properly or whether it is necessary to transfer to an alternative pathway (Haasnoot et al. 2018; Hermans et al. 2017; Wise et al. 2014)

In theorizing how to sequence incremental and transformational cycles, incremental actions are frequently situated as unfolding within the short-term, while options for transformational change are placed on longer time horizons (Bloemen et al. 2018). Thus, in the near term, when climatic impacts are assumed to be less severe, smaller adjustments are seen as being able to effectively reduce climate vulnerability; while in the long term, as impacts become more severe, larger, systemic interventions become necessary (Bloemen et al. 2018). This tendency to understand incremental adaptations as more feasible in the short-term and transformational adaptations as something to be pursued in the medium- or long-term is problematic for, at least, two reasons.

First, as Bloemen et al. (2018, p. 1098) state, implementing incremental adaptations “may increase the transfer costs to a new or significantly modified system. Increasing the resilience of the present system may also lead to an increase of sunk costs…Continuing on the path of

incremental measures may enlarge path dependency." In other words, the more incremental adaptations are pursued, the greater the risk a system becomes further locked into potentially maladaptive outcomes. Reasons such lock-ins might occur include increasing economic 'transfer costs' (Haasnoot et al. 2019), creating perverse political incentives to further maintain the status quo (Gibbs 2016), and entrenching cultural expectations that conventional solutions are feasible in the long-term (Barnett et al. 2015; Tàbara et al. 2019). Therefore, while implementing transformational adaptation may indeed be a technical, political, and social challenge in the short-term, pursuing incremental adaptation might have the unintended consequence of increasing the difficulty of achieving transformational change in the future—particularly if incremental adaptations are not explicitly designed to open up space for transformational change.

A second, perhaps more fundamental, problem with first pursuing incremental cycles of adaptation and putting off transformational changes is that implementing a pathways approach to adaptation requires, in and of itself, systemic changes within how governance and management is conducted in coastal regions (Barnett et al. 2015; Bloemen et al. 2017; Colloff et al. 2017; Gorddard et al. 2016; Lawrence et al. 2018; Walker et al. 2013). That is, installing an effective pathways approach nearly always requires systemic changes in the goals, values, and rules structuring governance (Colloff et al. 2017). Effective pathways approaches prioritize flexibility, adaptiveness, and robustness over optimization and certainty (Haasnoot et al. 2013; Hall et al. 2012; Lempert and Collins 2007; Maier et al. 2016; Weaver et al. 2013); yet optimization and certainty tend to be privileged within contemporary coastal management (Kwakkel et al. 2016; Lawrence et al. 2013; Ramm et al. 2017). Moreover, robust decision-making processes demand forming iterative and open-ended collaborations between scientists and decision-makers that require significant institutional change throughout the science-policy interface. Consequently,

designing and implementing pathways approaches requires transformations within governance arrangement as well as the values and knowledges that support them (Colloff et al. 2017; Gorddard et al. 2016; Wise et al. 2014)

In short, evidence exists that transformational approaches are needed in the governance of coastal regions; yet, few examples exist of transitions to more flexible and robust governance strategies. This is problematic for three reasons. First, evidence suggests that coastal areas currently exist within maladaptive space in which incremental adaptations will be unable to address the drivers and effects of climate change vulnerability (Wise et al. 2014). Second, incremental adaptations might not only be ineffective but also contribute to sunk costs, lock-in effects, and path dependencies (Barnett et al. 2015; Bloemen et al. 2018). Third, implementing robust, adaptive pathways approaches theorized to be suited to operating within the deep uncertainties and unpredictable conditions brought by climate change requires transformational change in the first place. Thus, even before an incremental trajectory could be designed within pathways approach, decision-contexts need to be transformed to design, implement, monitor, and adjust pathways.

1.5—Producing Transformative Climate Science: The Need for Transformed Institutions

Part of the problem is that, until recently (i.e. Hölscher et al. 2019; Loorbach et al. 2017; Wolfram 2016; Ziervogel et al. 2016), there has been little examination of what mix of resources and information is optimally suited to spurring and supporting transformational adaptation pathways. While a wide variety of resources and capacities will be needed to help integrate transformational pathways within governance systems, the need to define, produce, and disseminate transformative climate information is of particular importance within decision-support initiatives (Fazey et al. 2017; Moser 2016; Tàbara et al. 2017; 2019). As Tàbara et al.

(2019, p. 810) point out, there is a practical need to explore "*how* the pathways of solutions are developed." By this, they mean that more attention and theorization ought to be placed on how to produce and communicate the knowledge and other resources needed to develop effective and sustainable pathways that depart from prevailing governance models. Similarly, Fazey et al. (2015, p. 6) argue that if "significant and rapid change in societies towards fundamentally new and more sustainable patterns is needed to respond to climate change, then questions also need to be asked about the effectiveness of current modes of knowledge production and use in contributing to change." In other words, there are growing calls for moving from conventional approaches to knowledge production towards "*transformative* approaches in the assessment and implementation of climate strategies and solutions" (Tàbara et al. 2019, p. 810).

These emerging calls for transformative approaches within knowledge production reflects in some ways and departs from in other ways efforts to produce usable and actionable climate information to close the 'knowledge-action gap' between what is known about the causes and consequences of climate change and the lack of concrete measures to reduce vulnerability (i.e. Dilling and Lemos 2011; Kirchhoff et al. 2013; Lemos et al. 2012; Tribbia and Moser 2008). Reflects those efforts in the sense that the goal of producing both transformative and usable knowledge is to address practical problems and support decision-making. Moreover, both approaches depend upon iterative collaborations and opening up knowledge production to include a diverse set of actors and perspectives (Hegger et al. 2012; Kirchhoff et al. 2013; Lemos et al. 2013). Departs from those efforts in the sense that the production of usable information largely seeks to fit existing decision-making contexts and interplay with prevailing knowledge systems while the creation of transformative climate information attempts to fundamentally alter decision-contexts and knowledge systems.

Consequently, there are both synergies and tensions between usable and transformative knowledge. Informing effective and sustainable pathways of adaptation to climate change in coastal regions likely will entail navigating these tensions and synergies through critically assessing when usable or transformative knowledge is needed. The remainder of this section examines how this can be accomplished by (a) reviewing the emergence and aims of 'usable climate information', (b) highlighting the challenges of informational fit and interplay in the context of institutional transformation, and (c) introduces recent scholarship on transformative climate science and compares it to usable climate information. I conclude this section by outlining a seeming intractable situation in which transformational knowledge is needed to inform the design of fundamentally new governance institutions, while, at the same time, transformed governance institutions are needed to produce and communicate transformative climate science.

Efforts to produce usable climate information aim to produce tailored information relevant to and usable by decision-makers by incorporating expertise, experience, and viewpoints from both sides of the science-policy interface. By cultivating relationships between producers and users of information, it is assumed that more useful and usable information will be generated (Cash et al. 2006; Lemos and Morehouse 2005; Meadows et al. 2015; Wall et al. 2017). Dilling and Lemos (2011, p. 681) define usable science as "that produced to contribute directly to the design of policy or the solution of a problem." Thus, usable science seeks to support "decisions as they exist today or in the near future" (Dilling and Lemos 2011, p. 681). Similarly, Moss et al. (2012, p. 696) argue that to be usable "scientific information must fit into existing contexts." In other words, making climate science usable entails translating and tailoring it into forms that fit current

decision-contexts and interplay with the types of information and value systems used in decision-making (Dilling and Lemos 2011; Lemos et al. 2012; McNie 2013).

For climate information to be 'usable', it must both *fit* existing decision-contexts as well as *interplay* favorably with the knowledge systems that are used within the decision-making process (Kirchhoff et al. 2013; Lemos et al. 2012). Fit relates to how well users perceive new information meeting their particular needs as well as their own capacity to deploy the new knowledge (Lemos et al. 2012). Users are more likely to see climate information as meeting their needs when they perceive it as accurate, credible, salient, and timely (Cash et al. 2003; Lemos et al. 2012; McNie 2013; Moss et al. 2012). Interplay, in turn, relates to how well users perceive new information interacts with current knowledge systems and information deployed within decision making (Lemos et al. 2012). Interaction between scientists and decision-makers is crucial to increasing fit and interplay (Lemos et al. 2012). The process of producing usable climate information avoids the pitfalls of the loading dock approach because rather than assuming decision-makers will search out and utilize quality scientific knowledge, scientists tailor, translate, and help coordinate scientific knowledge into forms that fit the needs of users. Additionally, because scientists collaborate in the generation of usable information, the problems of the knowledge deficit model are avoided because actors from both sides of the science-policy interface are presumed to possess their own valuable experiences and expertise.

Because usable climate information fits existing decision-contexts, it tends to be most useful in addressing problems that are already identifiable within decision-making processes and using prevailing knowledge systems. As Dilling and Lemos (2011, p. 681) state this "implies a much more specific, time sensitive role for science to be used in supporting decisions as they exist today or in the near future." Immediately usable information is important because it can help get

the ball rolling on adaptation planning and management in situations where decision-makers are amenable to taking action but lack the requisite information to do so.

Problems arise, however, when existing decision-contexts are ill-suited to effectively and sustainably address the problems climate change entails. For instance, in a review of research on the use of climate information, Flagg and Kirchhoff (2018) found that even when climate information is generated through iterative collaborations and possesses sufficient levels of fit and interplay, managers and decision-makers can encounter factors that stymie use (Flagg and Kirchhoff 2018). Barriers to using usable information include political concerns and the politicization of climate science (Kirchhoff and Dilling 2016; Rasmussen et al. 2017), lack of resources and capacity (Ekstrom et al. 2017; Kirchhoff 2013), and inflexible decision-making processes and rules (Lemos et al. 2012). Thus, Flagg and Kirchhoff (2018, p. 7) conclude that researchers "are most effective at bridging the knowledge-use gap when we couple usable knowledge production processes to those contexts where micro, meso, and macro factors support use." In situations where such factors do not line-up, usable climate information will be less effective (Flagg and Kirchhoff 2018).

As a way of ameliorating this problem, approaches to producing usable climate information typically incorporate iterative collaborations between 'users' and 'producers' of climate information (Dilling and Lemos 2011; Hegger et al. 2012; Nel et al. 2016; Sarkki et al. 2015). The purpose of including iterative interactions between targeted users and scientists is two-fold. First, by fostering face-to-face collaborations both communities gain a better appreciation of the needs and capacities of the other. This mutual learning can help scientists better tailor their knowledge to the contexts of decision-making as well as help decision-makers better understand the value and limits of scientific information. Second, long-term, iterative interactions can

produce changes within the practices, goals, and worldviews of actors on both sides of the science-policy interface as diverse actors learn more about the capabilities and concerns of others. As Moser (2016, p. 112) points out, empirical evidence has documented that through collaborative processes "pre-existing knowledge systems were not just amended, but challenged, integrated and thus altered to generate surprising new insights and perspectives." Thus, iterative collaboration can also contribute to changing the contexts in which climate information is both produced and used. Yet, it remains unclear to what extent iterative collaborations to produce usable climate information can result in transformational change to rather than incremental adjustments within conventional governance arrangements.

Indeed, the very purpose of usable information could make transformational change more difficult if power dynamics and existing system goals are not critically explored and questioned (Nost 2019). In situations where transformational change is needed information tailored to fit existing decision-contexts could have the unintended consequence of creating lock-in effects and path dependencies. Investing time and capital into producing usable climate information might create 'sunk costs' that create perverse incentives to maintain existing, maladaptive decision-making contexts. For instance, in the context of coastal management, producing climate information to inform benefit-cost analyses within long-term infrastructure planning could contribute to decision-makers continuing to utilize such tools even though more robust strategies better fit the challenges associated with climate change. Similarly, producing usable climate information might create mental lock-in effects, as decision-makers might assume that existing decision-making contexts are 'adaptive' if scientists are producing new information tailored to their needs. In other words, decision-makers might see the availability of usable information as a signal that conventional approaches are up to the task of managing the impacts of climate

change. Finally, the production of tailored climate information and services can entrench existing power dynamics and inequalities. For instance, Nost (2019) found that two collaborative programs to provide stakeholders with usable climate information had socially and ecologically maladaptive consequences because the stakeholders at the table were largely interested in preserving a 'working coast' oriented towards oil production. Thus, Nost (2019, p. 2) argues that "when climate data is made to be relevant for powerful stakeholders and framed within status quo budget constraints, services reproduce vulnerability and foreclose transformation."

In light of this, there have been growing calls from scholars, managers, and activists for producing and communicating transformative knowledge (Clark et al. 2016; Cornell et al. 2013; Fazey et al. 2017; Gorddard et al. 2016; Moser 2016; Jasanoff 2010; Tàbara et al. 2017; 2019). The production of transformative information aims to significantly alter decision-contexts (Clark et al. 2016; Cornell et al. 2013; Colloff et al. 2017; Cornell 2013; Fazey et al. 2017; O'Brien 2016). Clark et al. (2016, p. 4571) define transformative knowledge as "radical new knowledge that challenges existing ideas, technologies, and practices". Producing such novel information requires initiatives to "not simply to 'translate expert knowledge to various audiences'…but to allow for alternative ways to frame problems, develop more complex forms of agent engagement and interaction, and implement concrete solutions" (Tàbara et al. 2017, p. 32). In recent years, a small, but growing, number of visions for transformative approaches to climate knowledge have emerged (see table 3). Generally, approaches to producing transformative knowledge prioritize focusing on the process of collaboration, the bringing together of multiple and diverse communities, defining socially relevant problems, and supporting societal transformations (Cornell et al. 2013; Tàbara et al. 2017; 2017). Generally, this is seen as 'opening up' knowledge systems (Cornell et al. 2013; Stirling 2007). Accomplishing this task requires a fundamental

change within science-policy interactions, configurations, and practices (Cornell et al. 2013; Jasanoff 2010; Moser 2016; Stengers 2018; Tàbara et al. 2017; 2019).

Table 3 Defining transformative science

Tàbara et al. (2019, p. 813): "Transformative climate sciences can be understood as a transdisciplinary endeavor aimed at providing some practical guidance to both climate scientists and practitioners to develop concepts, tools, and methods that are more fit for the quest of developing robust strategies and solutions to the fast accelerating and closely intertwined climate and sustainability challenges…[It] is mostly about identifying the processes and key elements that would be needed to share insights, support social learning, and improve the societal relevance and quality of the assessments aimed at supporting societal transformations so that they take climate and sustainability challenges into account."
Tengö et al. (2017, p. 23-24): "Effective collaboration across knowledge systems is sorely needed to ensure inclusive and equitable pathways for governing ecosystems within planetary boundaries in the Anthropocene…Achieving such collaborations will require moving from studies 'into' or 'about' indigenous and local knowledge systems, to equitable engagement with and among these knowledge systems to support mutual investigations into our shared environmental challenges."
Cornell et al. (2013, p. 61): "Our starting point is that the challenges of achieving sustainability require radical and deliberate changes in knowledge systems. In particular, the interactions between scientists and other actors in diverse knowledge systems must be intensified, with scientific practices becoming more oriented toward the societal arenas in which sustainability problems being tackled…[T]he quality and validity of knowledge systems for sustainability depend on ensuring plurality, transparency and independence; furthermore, sustainability scientists have a responsibility to collaborate openly in knowledge co-production and its translation to action with other social actors within knowledge systems."

Tàbara et al. (2019, p. 807) define "transformative climate science as the open-ended process of producing, structuring, and applying solutions-oriented knowledge to fast-link integrated adaptation and mitigation strategies to sustainable development." For science to be transformative, those involved in knowledge production should use a long-term perspective of more than five generations; use a global view that examines connections and tradeoffs between the local, regional, and global; and work to overcome cultural dualism, such as nature/society and human/non-human (Tàbara et al. 2019). Crucially, Tàbara et al. do not argue that all climate science has to always or even predominantly be transformative in orientation—indeed conventional approaches are still needed—but rather that "if science is to contribute not only to

describing the problems [of climate change] but to the design of credible and robust assessments of its possible solutions, a more transformative approach is needed" (Tàbara et al. 2019, p. 814). Therefore, radically different forms of knowledge production are needed (Cornell et al. 2013; Stengers 2018; Tàbara et al. 2019).

As mentioned earlier, transformational approaches to climate science build off insights from scholarship on the production of usable climate information, such as the importance of long-term and iterative collaborations, joint development of problems and goals, and bringing together a wide array of perspectives and knowledges. However, rather than translating climate change information to be usable within existing decision-contexts, transformative approaches aim to produce knowledge that will support the creation of new institutions that better fit the challenges of climate change while also achieving socially just outcomes. Examples of approaches to produce transformative climate science include creating 'transformative boundary organizations' that are "specifically oriented to assessing and implementing solutions…[and] address the critical normative challenges embedded in taking the very difficult decisions that might be necessary to implement truly transformative solutions" (Tàbara et al. 2017); the 'Multiple Evidence Base' approach that facilitates "cross-fertilization among a diversity of knowledge systems…[and] proposes parallels where indigenous, local and scientific knowledge systems are viewed to generate different manifestations of valid and useful knowledge" (Tengö et al. 2014); and the 'Backcasting-Adaptive Management' methodology in which diverse stakeholders and scientists work together to collaboratively develop future visions, goals, and potential solutions (van der Voorn et al. 2017).

Crucially, and much like the transformational pathways approaches outlined earlier, transformative climate science remains largely theoretical and speculative. Partially, this is due

to the newness of such approaches. Additionally, though, there is the issue that producing and communicating transformative climate science requires significant institutional change in both the social worlds of science and policy as well as the relationship between them. Such challenges also exist within the production of usable climate information and are heightened within transformative climate science because the objective is to create something fundamentally new.

This leads to a seemingly intractable situation for areas existing in maladaptive space. On the one hand, transformative climate science is needed to inform the design, implementation, and monitoring of effective and sustainable governance institutions. On the other hand, transformations in governance and scientific institutions are needed to produce transformative climate science. In other words, transformative knowledge is needed to transform institutions *and* transformed institutions are needed to produce transformative knowledge. Consequently, it is difficult to identify how to start the process of transformation—especially in light of the well documented issues of lock-in effects and path dependencies that exist in environmental governance institutions.

During the past few years, scholars have begun to argue that breaking out of such situations requires engaging directly with individual and collective imaginations (Longhurst et al. 2016; McPhearson 2016; Page et al. 2016; O'Brien 2012a; O'Brien 2015; Tyszczuk and Smith 2018; Vervoort and Gupta 2018). Implicit (and sometimes explicit) in much of this work is a belief that "producing more democratic and sustainable imaginations of future social and technological trajectories" requires new visions and aspirations that depart from the prevailing order (Strand et al. 2018, p. 1849). However, to date, efforts to achieve this have been experimental and results remain ambiguous. In the following section, I briefly outline an approach for better organizing these imaginative interventions.

1.6—Escaping maladaptive space: Opening up through the imaginative

As suggested earlier, Heise's (2016) contestation that narratives about the ongoing rush of ecological and social urgencies need to become part of the stories that communities tell about themselves and the worlds they inhabit can be understood in two fashions. First, that scientific narratives about climate change, species extinctions, toxic pollution, ecological change, and so forth must be brokered, tailored, and translate to fit within existing social imaginaries and structures. Second, and alternatively, the social imaginaries and structures that configure the stories people tell about themselves, the communities to which they belong, and the nature of the worlds they inhabit must change in response to the unprecedented, novel conditions of the Anthropocene. Tensions exist between these two efforts; however, they are not in contradiction to one another. Instead, it is imperative to both draw upon the imaginative capabilities of individuals and collectives to articulate and weave alternative visions of the future that are more socially just and ecologically sustainable.

Indeed, as the above review of transformational adaptation and transformative knowledge documented, achieving fundamental changes in social, political, and material systems resulting in just and sustainable arrangements despite increasing precarity requires building off resources located within the present to achieve thriving futures that remain plausible. Accomplishing this require imaginative practices. In light of the seeming intractable challenges to informing, implementing, and achieving transformational change, imagination can illuminate what remains plausible and create a sense of direction for action. As Vervoot and Gupta (2018, p. 104) argue: "In light of the Paris Agreement's aspirational goal to hold global average temperature increases to 1.5˚ C by the end of the century, mechanisms and processes by which to imagine and govern diverse climate futures are increasingly coming to the forefront of sustainability debates and

practice." Moreover, Ziervogel et al. (2016, p. 2) argue that the capacity of agents to deliberately transform themselves and the communities they belong to depends upon "the capacity to imagine, enact, and sustain a transformed world and a way of life that is in balance with the carrying capacity of our earth, and where all life flourishes."

A wide variety of governance tactics have been experimented with during the past few years to support such an imagining—including, 'visioning', 'storytelling', 'foresight exercises', and 'scenario planning'. Much of this work is based upon the contention that there is a need for 'positive visions to guide decisions for…sustainability transitions and transformations" (McPherson et al. 2016, p. 33). Thus, it is important to not only highlight the potential for climate change and other forms of environmental change to negatively alter future conditions, but also to illuminate the possibilities for alternative and desirable futures. At the same time, accomplishing this requires engaging with and critiquing the dominant narratives currently shaping visions of the future (McPherson et al. 2016). This includes, but is not limited to, beliefs in the predictability of natural systems, the intrinsic benefits of economic growth, the primacy of private property rights, and individualistic notions of agency and subjectivity. However, imagining alternative futures also requires moving beyond critique to also articulating alternative imaginaries and stories of the future (Brand et al. 2017; Escobar 2015; Gibson-Graham and Roelvink 2010; Longhurst et al. 2016; Strand et al. 2018).

There exists, then, tensions within creating positive visions of the future. On the one hand, the visions must be considered positive within existing imaginaries in order to gain sociocultural traction. On the other hand, the visions must also critique basic aspects of prevailing imaginaries that are considered to be driving unsustainable development. This imaginative tension can be grounds for creativity and change. Research within the humanities and interpretive social science

have long stressed “the imagination as authentically creative rather than as merely reproductive or imitative” (Adams et al. 2015, p. 16). In this sense, imaginative practices are of great value in situations where tensions and contradictions pervade within existing modes of doing things. Moments of intractability are moments in which creativity comes into play (Connolly 2017).

In the context of urbanized coastal regions, implementing the governance arrangements theorized effective within the deep uncertainty and dangers of the Anthropocene requires shifts within what is imagined as desirable and achievable. Implementing robust governance systems entails switching from a prevailing imaginary that aspires towards optimized outcomes and maximized growth to a new imaginary that is content with sufficiently robust outcomes. Pursuing a pathways approach necessitates transitioning from an imaginary that values long-term certainty and predictability to one that expects fundamental change and surprise. Creating opportunities for co-productive governance in which scientists and policy-makers collaboratively produce and tailor knowledge for solving practical problems entails moving away from an imaginary that places a distinct demarcation between the worlds of science and politics and towards one that appreciates always entwined, co-emergent ways of knowing about and acting within the world (Wyborn 2015). Moreover, within both robust and pathways approaches, coastal retreat might be necessary in many cases. Carrying out managed retreat will need profound changes within entrenched imaginaries that prize private property rights and coastal development in order to accept the necessity of moving away from hazardous areas for the common good (Abel et al. 2011; Gibbs 2016; Pilkey and Cooper 2015).

At the same time, collective coastal imaginaries are hardly lacking visions, values, and aspirations that can be drawn upon in the pursuit of more sustainable, just, and effective coastal governance. Within the imaginaries of many that reside in or visit coastal regions, there exists

deep care and concerns about the fate of species, ecosystems, communities, landmarks, and livelihoods that are imperiled by climate change, sea level rise, and other environmental changes. As will be documented within this dissertation, dissonances are emerging between established ways of valuing, planning, and maintaining coastal New Jersey and the growing sense that something needs to change to secure a desirable future. These moments of wavering between the prevailing order of things and a nagging sense that something else is needed is an opportunity for interventions to occur.

In light of this, I contend that imaginative fit and interplay can be used to help design and conduct collaborative efforts aiming to reduce the drivers of vulnerability and produce more just and sustainable societies. I will develop and apply imaginative fit and interplay further within the concluding chapter of this dissertation. For now, I will briefly describe what I mean by the concept as well as how I foresee it aiding in designing and conducting interventions aiming to produce more just and sustainable outcomes. The aspect of 'imaginative fit' refers to how narratives about climate change resonate within existing senses of belonging, or the norms, disciplines, and imaginaries that structure individual and collective behavior, identity, and values. For William Connolly (2017, p. 81) belonging entails "the feeling of comfort that comes with the sense of layered fit between self and world and between collectivity and world." That is, increased imaginative fit helps close what Veland et al. (2018, p. 42) refer to as the 'narrative gap' of climate change by composing information that "weaves into pre-existing cultural narratives, or metanarratives about how the world works and where it is headed." Without having resonance within such imaginaries and stories, it is highly likely that narratives about climate change will be rejected or ignored.

Without engaging directly with these imaginative dimensions, transformational change towards more robust and flexible governance arrangements are unlikely to become a reality in many coastal regions. Engaging with the imaginative dimensions of social life does not guarantee such transitions will occur; however, it likely increases the possibility that sustainable transitions will occur—perhaps in ways not foreseen. In the concluding chapter of this dissertation, I argue that addressing these tensions within the space of imagination opens up opportunities for transformational change within New Jersey.

1.7—Outline of Dissertation

The remainder of the dissertation is divided into two broad sections. Section One focuses on describing the contours of the prevailing 'sociotechnical imaginary' (Jasanoff 2015) of the New Jersey Shore region and tracing the key events and forces that played a role in its emergence, spread, and entrenchment. Chapter Two begins this effort by describing how Superstorm Sandy was a monumental event in terms of damage and destruction, yet failed to act as a transformative event. Instead, the preponderance of post-storm effort was placed on restoring the shore as quickly as possible. I argue that this response was due to a sociotechnical imaginary that trusts in technology and policy to not only protect property and lives from most coastal hazards but also believes that technology and policy also make possible rapid recovery when defenses fail. Thus, the chapter documents how the projected impacts of climate change fit—sometime easily and other times haphazardly—into the existing sociotechnical imaginary of the shore region. In light of this, I argue that it is necessary to change the story of the shore to better reflect the growing precarity of the region. By drawing upon a mix of spatial theory and environmental humanities scholarship, I present a general framework for understanding the emerging conditions of the Anthropocene and identify resources for composing a more desirable future.

Chapter Three provides a historical overview of how the prevailing sociotechnical imaginary of the shore region coalesced during the past two centuries. I highlight how slavery, discrimination, capitalism, ideas of democracy, coastal science, and technological innovation all played important roles in the emergence of the material and imaginative landscape of the contemporary New Jersey shore region. By doing so, I stress the importance of critically assessing the values and visions embedded in the sociotechnical imaginaries that inform beliefs about what a possible desirable future looks like. I conclude by arguing the long history of fighting for a more inclusive and just shore region provides valuable resources for configuring an alternative future.

Section Two of the dissertation examines in more depth ongoing policy challenges and opportunities within the contemporary shore region as well as efforts to provide municipal government actors information and resources to create and implement more sustainable and resilient policy pathways. Chapter Four focuses on the various constraining factors that make implementing successful and sustainable adaptation policy difficult in the New Jersey shore region. Within this chapter, I develop a novel heuristic for differentiating and connecting constraining factors. I argue that doing so makes it possible to locate the critical factors at the core of slow and ineffective responses to climate change. In the New Jersey shore region, many of the most fundamental constraining factors stem from the prevailing sociotechnical imaginary described in Section One. In the conclusion of the chapter, I place more attention on the constraining factors at the center of ineffective responses to climate change that, if addressed could contribute to cascading and transformative change.

Chapter Five examines how one initiative to provide municipal government actors with tailored and usable climate information used a bundle of boundary objects to overcome some of the barriers to adaptation in the coastal region of New Jersey. I document how the successes of the

staff of the Jacques Cousteau National Estuarine Research Reserve (JCNERR) in acting as knowledge brokers were, in part, due to their effective use of various boundary objects, such as the concept of resilience, sea level rise maps, and a jointly written recommendations report. Through this work, the JCNERR staff were able to place climate change adaptation and coastal resiliency planning on the policy agenda of local governments. At the same time, I conclude that more attention still needs to be placed on informing transformational change in the region. In this regard, I contend that boundary objects can play an even greater role in supporting collaboration among a diverse array of actors working towards fundamental change in the region.

Chapter Six concludes the dissertation by returning to the question of how policy relevant climate science can support transformational change through increased political fit and interplay. This chapter brings together insights from the broad sections of the dissertation to present an argument for decision support initiatives to engage more with the imaginative and political dimensions of change. As the concept of sociotechnical imaginaries makes clear, politics has both material and imaginative dimensions. Thus, in this chapter, I draw upon the evidence provided in the other chapters to draw out the imaginative aspects of knowledge fit and interplay. In particular, I contend that knowledge about climate change must simultaneously fit within existing stories communities tell about themselves as well as interplay with emerging narratives seeking to inspire becoming something else.

Section 1—Placing the Anthropocene in the New Jersey Shore Region

Introduction—Acceleration in the Jersey Shore

In 1905, Henry Ford arrived at Cape May to compete in an automobile race (Dorwart 1992). Various cultural and economic dreams intersected during this event at the southern tip of the New Jersey coastline. Boosters of the resort hoped automobiles would reinvigorate the struggling, century-old tourist destination. Cape May had been suffering ever since the Civil War disrupted the flow of southern vacationers, the rise of Atlantic City diverted Philadelphian pleasure seekers northward, and a series of national economic panics wrecked local banks and businesses (Dorwart 1992; Mazzagetti 2018). To demonstrate the potential of the automobile to transform Cape May, city leaders held a variety of races at the turn of the century (Dorwart 1992). Some races, like the one Ford competed in, were just a few miles long and occurred on the resort's wide beaches while others began in Philadelphia. All shared the purpose of proving Cape May had the potential to be an automobile-friendly destination.

Ford had his own goals. Still struggling to make a name for himself, Ford hoped winning a race would prove that his designs superior to his competitors. Reportedly, Ford did leap out to an early lead. When a wave surged from the ocean and hit his automobile, Ford fell behind and was unable to recover (Dorwart 1992). Not only was this a blow to Ford's goal of demonstrating the superiority of his design, but it also left him in a financial hole. Winning the race would also have allowed Ford to cover his hotel bill. Stuck in Cape May, he was forced to sell his automobile to leave the Jersey Cape by train (Dorwart 1992). Thus, Ford's trip to Cape May was, by any measure, a failure.

In the following decades, city boosters' dreams of a reinvigorated resort also floundered. Few cars arrived in the Jersey Cape because the swampy terrain made for poor driving conditions. Trainlines also made traveling to Atlantic City, Asbury Park, and other resorts easier and faster (Mazzagetti 2018). For both Ford and Cape May leaders, initial visions of widespread automobile travel were hindered by a lack of infrastructure and the recalcitrance of natural forces.

By the middle of the twentieth-century, things were vastly different. Ford Motor Company was now breathtakingly successful. Ford's company became a symbol of American innovation and industrial prowess. Furthermore, the cultural salience of the personal automobile was quickly becoming central to the American identity. This achievement was evident in few places more so than in mid-century New Jersey. With the completion of the Garden State Parkway in the late 1950s, millions of vacationers arrived at the Jersey Shore by car (Cunningham 1958). After decades of economic stagnation, Cape May—famously 'Exit 0' on the Parkway—returned to being a desirable tourist destination. Not only did the Parkway carry tourists to the shore, but it also opened up the region to residential development. In the years after the completion of the Parkway, rapid suburban development occurred along the entirety of the coastline (Bates 2016; Dorwart 1992; Simon 2004). Once remote, backwater communities, such as Toms River, suddenly became sprawling suburban communities. This swift economic and demographic growth included Cape May. In 1900, 13,201 people resided in Cape May County. By 1970, that number was 59,554; by 2000, more than 100,000 people lived in the county (Bates 2016). This dramatic increase in population over the 20th century was more than double the population growth rate of New Jersey as a whole (Bates 2016; Mazzagetti 2018).

By the beginning of the 21st century, the New Jersey Shore had become a sprawling, urbanized landscape with development frequently abutting the water's edge—and, in some cases, extending over the water (see figure 2). Even narrow barrier islands were transformed into year-round communities. Only thirty-one miles out of one hundred twenty-seven miles of coastline remain undeveloped (Bates 2016). Slightly more than eighty percent of the coastline is stabilized through hard structures (Psulty and Ofiara 2002). The rapid acceleration of development and land change in the region was largely a consequence of the emergence of a political and economic project of post-war suburbanization centered around the personal automobile (Bonneuil and Fressoz 2016). Thus, the visions of Henry Ford and Cape May boosters in 1905 did, ultimately, come to pass. The New Jersey shore region now is crisscrossed by seemingly endless roads and highways.

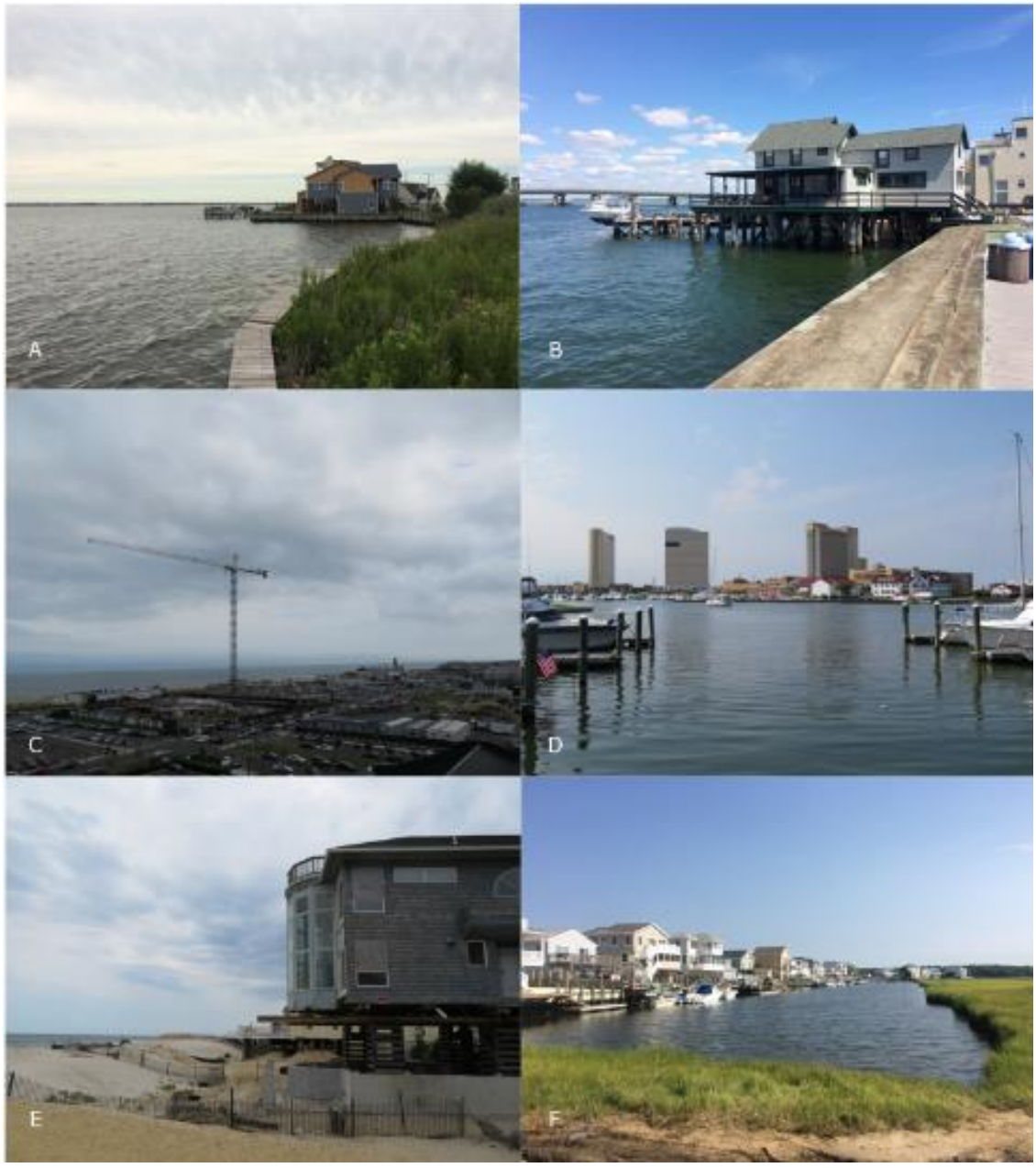

Figure 2 Development along the New Jersey Coast. A: Mainland development on the shore of Barnegat Bay. B: Barrier Island development on the Barnegat Bay shore. C: Start of construction of a mixed-use, luxury condominium in Asbury Park. D: Atlantic City. E: Barrier island development on ocean front. F: Mainland development constructed on in-filled marsh. All photographs by author.

Now this success is eroding, though more literally than figuratively. Literally because accelerating sea level rise, land subsidence, more frequent flooding, changing coastal storm patterns, and shortsighted hard engineering projects have contributed to amplifying the historical beach erosion rate in New Jersey. Over the last two centuries, development has occurred along

nearly the entirety of the state's coastline—including its barrier islands. As beaches attempt to move landward in response to sea level rise, they meet the firm barrier of coastal development. Thus, the beaches that Ford once raced down are rapidly eroding—requiring increasing expensive beach nourishment projects to stay in place (Pilkey and Cooper 2014). Eroding not figuratively, though. Instead, the cultural, political, and economic achievements wrapped up in the visions of Ford and coastal resort boosters remain robust—even in the face of the unfolding, cascading environmental changes found in the Anthropocene (Bates 2016; O'Neill and Van Abs 2016; see also Chapter 3).

Chapter 2—Sociotechnical Imaginaries of the Anthropocene: Intersecting Stories of the New Jersey Shore

2.1—Imagining the New Jersey Shore: Technology, Politics, and Culture

The trajectory of the Jersey Shore over the last century encapsulates what increasingly is referred to as 'the Great Acceleration' (McNeill and Engelke 2016; Steffen et al. 2007; Steffen et al. 2015) of consumption and environmental impact that has unfolded during the past six decades and is culminating in the tipping of the Earth System into a new geological epoch—known as the Anthropocene (Steffen et al. 2011; Zalasiewicz et al. 2010; Waters et al. 2016). Stretching back a little further to 1800, patterns in the region reflect narratives about the roots of the Anthropocene in the Industrial Revolution, capitalism (i.e. Moore 2015), and colonialism (i.e. Haraway et al. 2016). Between 1800 and 2000, the Jersey Shore transformed from a few isolated fishing villages and resorts that catered to a small population of largely wealthy and religious urbanites into a dense landscape of suburban development, industry, highways, and consumption. In this regard, the modern Jersey Shore exemplifies the emerging spatial and temporal relations of the Anthropocene Epoch.

It is not just the physical landscape of the Jersey Shore that reflects the emerging nature of the Anthropocene. Throughout the region, a pervasive social and technical imaginary exists among residents, politicians, and business leaders who envision the future of the shore as persisting largely unchanged despite projected environmental transformations (Bates 2016; O'Neill and Van Abs 2016). As will be more fully explored in Section Two, widespread agreement exists among decision-makers and the public that climate change is real and will negatively impact residents in the future, yet few actors are discussing possibilities for transformative change. Rather, the projected impacts of climate change—more frequent flooding, rising sea levels, more

powerful storms, and ecological change—are seen as problems that can be managed through conventional approaches to coastal governance and management. While some in the region bemoan the fact that property rights, laws, and economic incentives have created seemingly intractable barriers for adequately responding to climate change (see: Bates 2016; Leichenko et al. 2014; 2015), there are few visions of alternative futures for the region that depart from the broad contours of the present.

Scholars have noted that such an imaginary of the future is common across various cultural and material contexts with regards to climate change (Haraway 2016; Jasanoff 2010; Latour 2015; Norgaard 2011; O'Brien 2012a). That is beyond those that simply deny the reality of climate change, another—perhaps more pervasive—phenomenon is what Connolly (2017, p. 9) refers to as the 'passive nihilism' of accepting the fact of rapid climate change while not taking or demanding strong action to combat the causes of it. Elsewhere, Haraway (2016, p. 39) describes the Anthropocene as a time "of refusing to know and to cultivate the capacity of response-ability; of refusing to be present in and to ongoing catastrophe in time; of unprecedented looking away." Empirical studies demonstrate that this widespread acceptance of the fact of climate change coupled with a lack of urgency pervades collective imaginaries within a wide range of cultural and political contexts (Bates 2016; Callison 2014; Norgaard 2010). In response to this, a growing group of scholars is calling for developing strategies for transforming not only the precarious physical landscape but also the collectively held social imaginaries that contribute to the problems of global environmental change as well as hinder response to emerging social and ecological catastrophes (Bai et al. 2016; Brondizio et al. 2016; O'Brien 2016). How such processes constrain adaptation planning are examined in Chapter 4.

The concept of a ‘sociotechnical imaginary’ (Jasanoff 2015) helps elucidate the factors contributing to socially organized denial and passive nihilism in the face of mounting climate risks. Jasanoff (2015, p. 4) defines a sociotechnical imaginary as the “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology.” This expands upon Jasanoff’s earlier work on the idiom of coproduction, which stresses the always entwined development of social and natural orders (Jasanoff 1995; 2004), by incorporating the ways in which normative concerns regarding how such orders ought to be organized become materialized through and within social and technical visions, practices, and infrastructures (Jasanoff 2015). Sociotechnical imaginaries highlight how the social and scientific, the immediate and highly mediated, as well as the local and the global are always already imbricated within collectively held imaginaries. Science and technology are crucial factors in shaping visions of what is possible and desirable; while visions of the future influence how science and technology develop. The durable, material, and extensive networks of technoscience are part of the stories that people tell about themselves and the communities to which they belong. Consequently, changing the story is not a simply a matter of changing the script of social narratives, but also requires transforming entangled material, technological, and scientific relations (Alaimo 2016; Haraway 1997; Jasanoff 1987; 1995; 2004; 2016; Latour 2017; Star 1991)

Examining sociotechnical imaginaries offers at least three valuable insights for understanding the novel conditions of the early Anthropocene. First, by outlining the particularity of sociotechnical imaginaries, it is possible to begin untangling how and why responses to ecological and climatic change diverge in different political, cultural, and material contexts. The disruptive events of the

Anthropocene will unfold within variegated social and technical imaginaries, which will, in turn, contribute to a plethora of diverse, divergent, and distinct responses. Second, sociotechnical imaginaries can help illustrate how material configurations play a part in the revisioning of hopes for the future. In this regard, goals and visions of the future within the Anthropocene are conditioned by past achievements manifested within material and cultural infrastructures, such as roads, power plants, norms, and laws. Without engaging with these material and social infrastructures, transformation is a difficult, if not impossible, proposition. And third, sociotechnical imaginaries highlight that space is "coproduced in part through the spread of ideas and practices—and indeed ideologies—across time and territories" (Jasanoff 2015, p. 22). In other words, notions of what is technologically and scientifically feasible in present and future is an important factor within the production of space. This holds of the present and future space of the Anthropocene, which has been produced through the extension of technological ideas and practices and will continue to unfold as new innovations and dreams spread as well.

Within this chapter, the focus is on documenting the broad contours of the prevailing social technical imaginary of the New Jersey shore region as well as exploring how it is increasingly out of synch with the conditions of the Anthropocene. Indeed, as I seek to demonstrate, the challenge of apprehending the emergent and extensive spatial dynamics of the Anthropocene is, in part, contributing to the difficulty in responding to the urgencies of this new geological epoch. Developing the capacity to respond to the urgencies of the Anthropocene and intervene within the landscape of forces that compose the Jersey Shore depends upon being attentive to how both the local and planetary, specific and general, intensive and extensive, historical and emergent, directly experienced and highly mediated all come together to create precarious spaces (Alaimo 2016; Heise 2008; Povinelli 2016). Without a spatially attuned and attentive approach it is

impossible to address the question Connolly (2017, p. 22) poses of: “What sites and modes of attachment are appropriate to an era when planetary forces impinge with cataclysmic effect upon so many dimensions of life?”

To help guide answering this question in the context of New Jersey, I end the chapter with a discussion of the Anthropocene Epoch in general and its frequently bewildering spatial and temporal dynamics. Following this, Chapter Three provides a historical examination of the emergence and entrenchment of this imaginary through spatialized practices and politics.

2.2—Superstorm Sandy and Sociotechnical Imaginary of the Jersey Shore

Superstorm Sandy was, by most any measure, a monumental event with significant consequences in terms of both loss of life and property damage (Bates 2016; New Jersey Department of Community Affairs 2013; O’Neill and Van Abs 2016; Sobel 2014). While Sandy was not a particularly powerful storm—it hit New Jersey as a tropical storm—it was the largest storm in terms of size observed in the decades since reliable measurements have existed (Sobel 2014). Just before making landfall, Sandy merged with an early winter storm, which caused it to slow down (Sobel 2014). The size and slowness of the storm along with above average tides contributed to its overall destructiveness. In total, Sandy caused at least thirty billion dollars in damages and killed thirty-seven people within the state (New Jersey Department of Community Affairs 2013). The storm brought record coastal flooding to nearly the entirety of the New Jersey coastline. Waves broke through the Barnegat Peninsula at Montoloking—connecting the bay to the ocean. During the storm, the Toms River Public Works conducted more than five hundred rescues (Bates 2016). Even neighborhoods further inland suffered flood damage. Neighborhoods in Sayreville and South River Borough, a few miles inland from the Raritan Bay but situated along the South River, suffered significant flood damage, with some homes being completely

destroyed (Solecki et al. 2017). After the storm, images of the devastation Sandy caused to New Jersey and New York were pervasive and unavoidable. The image from Seaside Heights of a roller coaster half submerged in the waves was ubiquitous. Power was lost across much of the region, including parts of eastern Pennsylvania. Gas rationing was implemented. The majority of the damage, though, was along the coastline—and especially on the state's barrier islands (Bates 2016). Within days of the storm, President Barack Obama toured the New Jersey shore—along with Governor Chris Christie (Katz 2016).

However, while Sandy was a monumental event, it was not a transformative one (Bates 2016; O'Neill and Van Abs 2016). In the aftermath of Superstorm Sandy, little was done to address the underlying causes of coastal vulnerability (Bates 2016; O'Neill and Van Abs 2016). Instead, the main thrust of policy responses was to rebuild and restore the shore as fast as possible (Bates 2016; Mazzagetti 2018; O'Neill and Van Abs 2016). Residents located in high flood risk zones that experienced significant damage fought for—and ultimately received—a reversal of recent changes in the National Flood Insurance program that would have reduced payouts to those that choose to rebuild in areas likely to flood again (Bates 2016). Moreover, Governor Chris Christie's administration rallied the state behind the slogan "Stronger than the Storm" and promised to make sure that crucial tourist attractions would be open by the start of the summer season (Katz 2016). During the months after Sandy, Christie's pledge to rebuild and restore the shore earned him the highest public approval ratings of his tumultuous tenure—a factor that helped him win reelection in the generally Democratic state (Bates 2016; Katz 2016). In the rush to rebuild and recover, few systemic changes occurred (O'Neill and Van Abs 2016).

In the immediate aftermath of the storm, Bates (2016) contends that the Jersey Shore exhibited 'socially organized denial' in regards to climate change. Socially organized denial refers to the

ways in which collective beliefs, values, norms, and practices contribute to a distancing from information that leads to people not acting on information (Norgaard 2011). Bates (2016) argues that, even though the majority of New Jersey residents believe that climate change is real, caused by humans, and is likely to negatively impact their lives in the short-term (see: Koning and Redlawski 2016), various engrained cultural practices and norms impede actions to meaningfully respond to climate change. Van Abs and O'Neill (2016, p. 260) largely agree with this assessment and argue that Sandy was not a transformative event because "there has been little leadership in government and other major institutions to frame it as a transformational event" and that "[w]ithout support from large-scale institutions for lending, planning, and regulating, even the people who became concerned because of Sandy will have difficulty finding the ideas, tools, encouragement, and policy frameworks to take action." Some changes have occurred, though. For instance, homes elevated upon pilings as well as concerns about marsh and dune ecosystems are now more common within the region. Yet, to the extent that adjustments have been made within development and policy approaches, the prime objective within the Jersey Shore remains to stem erosion and preserve property rights (O'Neill and Van Abs 2016).

These dynamics are explored in more depth in Chapter Four and Chapter Six. At this point, though, it is worth emphasizing that climate change impacts largely fit within the prevailing sociotechnical imaginary of the shore region. That property and infrastructure will be destroyed by future storms is not a departure from the past. Indeed, the response to Sandy fits quite easily within the history of the New Jersey shore. As Mazzagetti (2018, p. 176) states: "Jersey Shore resorts in the 1800s faced constant threats of fire and the seasonal threat of storms. After each storm, no matter the devastation, the vast majority of those who lost everything returned and rebuilt. So it was with Superstorm Sandy in 2012." For more than two centuries, residents of the

shore region have been deploying technology and policy to stabilize the coastline with the expectation that storms would bring destruction. Yet, technology and policy always allowed the shore to rebuild. As climate change brings higher sea levels and changes in storm patterns, this pattern will be increasingly challenged. History, though, suggests that another powerful storm will not be sufficient to dislodge this sociotechnical imaginary—a point returned to in the conclusion.

The broad contours of this sociotechnical imaginary are not novel. The vision that private property and, by extension, property taxes ought to be protected through engineering solutions stretches back more than a century. As early as 1922, the New Jersey Board of Commerce and Navigation stressed "the importance of the protection of the New Jersey beaches, realizing their tremendous value to the State and to the nation at large" (NJBCN 1922, p. 5). The Board supported this claim by pointing out that property tax revenue in the shore region grew by 425% between 1899 and 1922, which was greater than the statewide increase of 310% (NJBCN 1922). In the nearly one hundred years that have unfolded since, the claim that property tax revenue from coastal properties was too important to risk would be used countless times to justify more and more state involvement in coastal management—despite an understanding that development patterns in the New Jersey shore region were inherently hazardous and environmentally destructive.

The view of residents that the shore region is a desirable place to reside even after experiencing destructive storm events has long been found in the Jersey Shore. For instance, Burton et al. (1969, p. 157) found that after the devastating Ash Wednesday Storm of 1962, which killed ten people and caused up to four hundred million dollars of damage in New Jersey, there was a pervasive "gap between experience and future expectation" along the Atlantic Coast. They found

that two prevalent responses to the storm were to either deny the possibility of another similar storm by claiming the nor'easter was a freak occurrence or to argue that another storm would only happen far in the future (Burton et al. 1969, p. 160). For instance, in Harvey Cedars on Long Beach Island, half of the homes were destroyed and a gap was created on the island connecting the ocean to Barnegat Bay; yet locals immediately worked to close the gap and by Saturday—just four days later—the Army Corps of Engineers arrived to complete the task (Mazzagetti 2018). This pattern of immediately going about rebuilding after storms has played out dozens of times during the past sixty-years of life along the New Jersey coastline (Mazzagetti 2018).

The history of seeking to prevent beach erosion and protect development in coastal New Jersey through engineered solutions has also been long criticized. Writing in the mid-20th century, the historian John Cunningham (1959) wrote that the popular tactic of placing jetties along the shore in an effort to stabilize beaches was proven to make the situation worse rather than better and that preventing beach erosion was impossible without regional coordination. By the late 1970s, coastal scientists like Orin Pilkey derisively referred to the spread of erosion control techniques developed in New Jersey as the 'newjerseyization' of the American coast—a phrase derisively referring to the aesthetically and ecologically unpleasant state of New Jersey's shore. During the 1970s, the state Department of Environmental Protection released multiple reports highlighting the problem of management techniques that sought to stabilize the New Jersey coastline as well as warned that development on the state's barrier islands was already too dense (Brown 1977; NJDEP 1977). Despite this discontent, coastal development and governance has continued to unfold in risky, unsustainable ways and the trends criticized nearly a half century ago have become more deeply entrenched (Bates 2016; Mazzagetti 2018).

Indeed, as will be demonstrated in greater depth within the Chapter Three, few concerns now discussed post Superstorm Sandy are truly distinct from what regulators and scientists warned about in the 1970s or earlier. As one example, in a report entitled 'The Future of the New Jersey Shore' (Brown 1977) that came out of a conference jointly sponsored by Rutgers University and the state government of New Jersey, the following conclusion was made in regards to development in the state's coastal region:

> "There is growing concern about the folly of developing on the shifting sands of the shore zone, especially on our dynamic barrier islands…Development on barrier islands should be regulated to reduce lives and property at risk in the event of a catastrophic storm" (p. 11).

Moreover, the report noted:

> "Inevitable sea level rise, coastal erosion, and the westward migration of the barrier islands characterize the unstable nature of the shore zone. It is becoming increasingly clear to coastal managers and local decision-makers that their plans are effective only if they recognize that the constructions of society in the shore zone will be encroached upon by the migrating shoreline. Attempts to stop these natural processes have been expensive and largely ineffectual" (p. 37).

Addressing these problems, the report contended, would have required legislation that at the state and regional level to guide development in the ecologically sensitive and risky shore region.

In short, most of the concerns about the shore region that exist today have been known and widely recognized for at least forty-years. But, while most concerns are not new, what is novel is the intensity and rate of change. Due to anthropogenic climate change and other forms of human interference within the Earth System, the precarity of the New Jersey shore region has deepened. Sea level rise has accelerated. Storm patterns are changing. Flooding is becoming a regular occurrence. Species are moving. Thus, while the concern about coastal development in New Jersey is not new, there are new reasons for concern about coastal development.

2.3—The Fragility of Things along the Jersey Shore

Connolly (2015, p. 10) draws upon developments from complexity science to explore the growing 'fragility of things' connected to the "growing gaps and dislocations between the demands neoliberalism makes upon several human activities and nonhuman force fields and the capacities of both to meet them." That is to say, the expansion of market logic to other spheres of activity, such as education, politics, and environmental management, has exacerbated mismatches between various open and imperfectly self-regulating systems that "interact in ways that support, amplify, or destabilize one another" (Connolly 2015, p. 25). The Anthropocene, then, is a time marked by the accelerating rate of crossing critical thresholds and tipping points due to historical, current, and future human activity so that ways of living and understanding in the world have become tenuous, fragile, and precarious (Chakrabarty 2009; Connolly 2015; 2017; Eisenhauer 2017; Haraway 2017; Serres 1994; Tsing 2015).

Projected impacts due to climate change are likely to adversely impact the Jersey Shore in both the short- and long-term. Current international policy efforts largely center on preventing a 2°C increase in temperature, which research in climate science suggests is the threshold between dangerous and extremely dangerous climate change (Anderson and Bows 2011; Hansen et al. 2016; Smith et al. 2009). However, analysis by climate scientists Anderson and Bows (2008; 2011) suggests that mitigation pathways for preventing 2°C of warming are extremely unlikely. Consequently, there are growing calls for planning for 4°C of warming during the 21st century (Hamilton 2010; New et al. 2011; Stafford-Smith et al. 2011). Warming of 4°C would likely entail an increase in global sea level between six and twelve meters (Dutton et al. 2015; Levermann et al. 2013). It is highly uncertain how quickly such an increase would occur, but research suggests that global sea level is likely to increase a meter by 2100, though melting in

Antarctica could contribute an additional meter during this period (Deconto and Pollard 2016). If sea level increases between 0.61 and 1.22 meters during the 21st century, then 1-3% of New Jersey's land would be inundated and there would be up to a twenty time increase in the frequency of coastal storms that flood low-lying areas (Cooper et al. 2008). Further, sea level rise is likely to continue for at least two thousand years (Archer 2008; Deconto and Pollard 2016; Levermann et al. 2013). Already, individuals living within coastal communities report experiencing routine floods and other severe events (Leichenko et al. 2014). Consequently, as the Anthropocene unfolds, the Jersey Shore is likely to experience more storms and higher sea levels that challenge contemporary development patterns. Gaining traction within these emerging and uncertain conditions requires grappling with the fundamentally novel operating pattern of the Earth System.

2.4—The Troubling Time and Space of the Anthropocene

The Anthropocene is a troubled and troubling time (Haraway 2016). Troubled due to the cascading urgencies of rising sea levels, changing weather patterns, increasing temperatures, species extinctions, and increasing human precarity (Connolly 2015; 2017; Hamilton 2017; Haraway 2016). The very functioning of the Earth System during the Anthropocene departs from the Holocene conditions under which human society emerged during the past 10,000-years (Lenton and Watson 2011; Steffen et al. 2011; Waters et al. 2016; Zalasiewicz et al. 2010). Troubling because many widely shared and seemingly fundamental beliefs about the world and humanity's place within it are being upturned (Aliamo 2016; Ghosh 2016; Haraway 2016; Jasanoff 2010; Povinelli 2016; Serres 1995). In other words, the Anthropocene is not only a rupture in the operation of the Earth System, it is also a rupture in human thought (Angus 2016; Chakrabarty 2009; 2014; Connolly 2017; Hamilton 2017; Haraway 2016; Latour 2017; Serres

1995; Stengers 2015). These dual ruptures amplify one another and risk creating a disorienting sense of an inexorable quagmire in which all options lead to worsening conditions (Latour 2017). As the historians Bonneuil and Fressoz (2016, p. 22) argue, "[l]iving in the Anthropocene… means inhabiting the non-linear and highly unpredictable world of the Earth system's (or Earth history's) responses to our disturbances." In short, living in the Anthropocene entails needing to respond to ongoing urgencies that existing approaches and frameworks are insufficiently capable of addressing (Hamilton 2010; Haraway 2016; Latour 2017).

However, scholars and activists are working to develop tactics for responding to the obdurate trepidations of an unlivable future by identifying and amplifying resources for composing a just and flourishing future in the face of significant and real challenges (Alaimo 2016; Bonneuil and Fressoz 2016; Haraway 2016; Povinelli 2016; Stengers 2015; Tsing 2015). Developing the capacity to respond to the urgencies of the Anthropocene demands becoming attentive and responsible to existing differences, vulnerabilities, and responsibilities (Haraway 2016). Further, the composing of a just and livable planet means giving up on searching for universal rules for justice and well-being (Alaimo 2016; Haraway 2016; Latour 2017; Povinelli 2016). As Stacy Alaimo (2016) argues, "the Anthropocene is not the time for setting things right" (p. 1) nor is it "time for transcendent, definitive mappings, transparent knowledge systems, or confident epistemologies" (p. 3). Approaching the Anthropocene requires reassessing and adjusting conceptualizations of the relations between specific people in particular places with the world at large (Alaimo 2016; Connolly 2017; Hamilton 2017; Jasanoff 2010; Latour 2017; Povinelli 2016).

The temporal and spatial scale of the Anthropocene is frequently pointed towards as a major barrier to action. The reach of ongoing planetary transformations exceeds the everyday,

embodied experiences, concerns, and hopes of people (Alaimo 2016; Haraway 2016; Heise 2008). This emerging planetary transformation requires developing approaches to research and advocacy that "are premised no longer primarily on ties to local places but on ties to territories and systems that are understood to encompass the planet as a whole" (Heise 2008, p. 10; see also Alaimo 2016; Hamiton 2017; Haraway 2016; Latour 2017; Stengers 2015). Yet, at the same time, such approaches can become successful only to the "extent that they become part of the stories that human communities tell about themselves: stories about their origins, their development, their identity, and their future horizons" (Heise 2016, p. 5). This dual challenge of needing to compose and craft stories that both collect and convey planetary processes and the myriad, variegated effects they have on particular places as well as find traction with the stories that communities tell about themselves requires careful considerations of questions of scale and spatial relations.

The extensive nature of the Anthropocene highlights (and complicates) what the spatial theorist Amin (2004, p. 32) refers to as the "variegated processes of spatial stretching and territorial perforation." With the increasing prevalence of globalized networks of capital, commodities, people, ideas, and species, local places are both stretched outwardly as they connect to distant locales as well as perforated by distant forces and processes. This has contributed to Amin and Thrift (2002) to describe contemporary "cities as sites of extension and extensive sites" (p. 31) and as "an amalgam of often disjointed processes and social heterogeneity, a place of near and far connections, a concatenation of rhythms; always edging in new directions" (p. 8). Such a notion of spatial relations fits within recent conceptualizations of the Anthropocene.

First, rapid urbanization and the Anthropocene are impossible to untangle (Bonneuil and Fressoz 2016; McNeill and Engelke 2014). Within discussions of the Great Acceleration, the rapid pace

of urbanization since the Industrial Revolution and the rapid spread and growth of cities since 1945 is frequently hailed as "one of the signal characteristics of the Anthropocene" (McNeill and Engelke 2014, p. 112). Indeed, a dominant discourse structuring discussion of human organization in the 21st century is that of the 'urban age' in which the majority of the global population now lives within urban regions and the preponderance of projected population growth will occur in cities. Some urban theorists go as far as to argue that "[d]espite pervasive sociospatial unevenness and persistent territorial inequality, the entire fabric of planetary settlement space is now being extensively and intensively urbanized" (Brenner et al. 2011, p. 226). However, such urban theorists also warn that the notion of 'the city' and 'the urban' found within the dominant narrative about globalization and global change "drastically homogenizes the variegated patterns and pathways of urbanization that have been emerging in recent decades across the world economy" (Brenner and Schmid 2015, p. 156). In contrast to this, critical urban theorists argue the past three decades has witnessed an explosion of differentiated urban configurations (Amin 2004; Amin and Thrift 2002; Brenner and Schmid 2015; Roy 2011; Ruddick et al. 2018). Consequently, careful analysis of the spatial relationality of the process of urbanization during the Great Acceleration can help elucidate the specificity and particularity of how urban spaces emerged. In doing so, it is possible to trace how urban spaces both contributed to and have been conditioned by the emergence of the Anthropocene. As will be detailed more in Chapter Three, the New Jersey shore region provides a useful example because it has gone from a remote, sparsely populated area to a densely developed residential and tourist landscape in less than two centuries. The contemporary New Jersey shore contains various urban forms—including small, dense cities and large, sprawling suburbs. This makes the region a useful case study of both the general and unique characteristics of urbanization, as significant portions of the

world's urban growth is occurring within medium- and small-cities rather than mega-cities (Ziervogel et al. 2016).

Second, the Anthropocene entails a planet in which space is becoming increasingly stretched temporally and geographically as well as perforated by distant forces. The intensifying intermingling and juxtaposition of disparate and distant forces mark Anthropocene space (Chakrabarty 2009; 2014; Connolly 2015; 2017; Haraway 2016; Latour 2017). The doings of a few actors in corporate boardrooms or legislative buildings contribute to the long-term viability of existing modes of coastal living (Latour 2004), as recent research has shown the choices made in the next handful of decades regarding greenhouse gas emission levels will likely determine ocean levels two thousand years in the future (Levermann et al. 2013). Further, the quotidian daily choices of people across the globe will have small effects that could last millennia. As the climate scientist David Archer (2008) points out, roughly twenty-five percent of carbon dioxide released today will effectively remain in the atmosphere in perpetuity. In short, actions taken in one place and at a particular time radiate outward and impact places distant in both time and space. Once more, the New Jersey shore region offers a rich case study for understanding this stretching and perforation of space. Two major cities—New York and Philadelphia—have greatly influenced the development of the New Jersey shore region since its inception. As sea level and temperatures rise, the vastness of forces impacting the shore region is increasing—choices made in capitals both close, such as Trenton and Washington DC, and distant, such as New Delhi, Beijing, Brussels, and in boardrooms of multinational corporations will all partially determine the future shape of the New Jersey coastline.

Geographic theory is well suited to explicate these dynamics. This coming together of disparate trajectories exemplifies what Doreen Massey (2005) calls the 'throwntogetherness' of space. For

Massey (2005) a given place is best thought of as an event or the intersection of various trajectories all with their own temporalities and directions:

> "'Here' is where spatial narratives meet up or form configurations, conjunctures of trajectories which have their own temporalities (so 'now' is as problematical as 'here'). But where the successions of meetings, the accumulation of weavings and encounters build up a history. It's the returns…and the very differentiation of temporalities that lend continuity. But the returns are always to a place that has moved on, the layers of our meeting intersection and affecting each other; weaving a process of space-time. Layers as accretions of meetings. Thus, something which might be called there and then is implicated in the here and now" (Massey 2005, p. 139).

These rich layers of meaning form the stories of places—indeed, Massey (2005, p. 130) goes as far to call space the "simultaneity of stories-so-far" and places as "collection of those stories." Similarly, Amin and Thrift (2002, p. 30) frame places as "best thought of as not so much enduring sites, but as *moments of* encounter, not so much as 'presents', fixed in space and time, but as variable events; twists and flexes of interrelations." This openness of space, both materially and culturally, contributes to a notion of spatial politics that reimagines and reinvigorates the local as a site for addressing and challenging globally extensive forces and processes (Amin 2004; Amin and Thrift 2002; Massey 2004; 2005; Woodward et al. 2012). Such a politics hinges upon the notion that if the global is produced and maintained through spatially interconnected local practices and institutions, then it is possible to alter global processes by changing the conditions of local places and regions (Amin 2004; Massey 2005; Woodward et al. 2012). However, it is crucial to recognize that the openness of space does not entail "unlimited ebb and flow" but rather an openness conditioned through "institutionalized practice" (Amin and Thrift 2002, p. 26). That is to say, the governance and management of spaces—particularly urban ones—entails inventing sociotechnical practices and infrastructures that attenuate uncertainty and complexity (Amin and Thrift 2002; Jassanoff 2016; Massey 2005; Simone 2019). Such

practices and infrastructures both support and condition social life as well as narrow and open up possibilities for change (Jassanoff 2016; Simone 2019).

Theorizations of the Anthropocene both resonate within and challenge aspects of spatial theory. In particular, if returns are what lends places continuity, then the Anthropocene and the discontinuities it brings creates dissonances within expectations of place. Spatial narratives are, increasingly, becoming out of synch as the timings of migrations, weather, temperature, and seasons shift. At the same time, if places are collections and intersections of stories-so-far, then those stories can also be seeds for reconfiguring spatial relations. For, as Haraway (2016, p. 101) contends, to make the Anthropocene livable "we need stories (and theories) that are just big enough to gather up the complexities and keep the edges open and greedy for surprising new and old connections." Stories that "reach into rich pasts to sustain thick presents to keep the story going for those who come after" (Haraway 2016, p. 125). At same time, the Anthropocene makes clear "the story *must* change" (Haraway 2016, p. 45). In other words, as Massey and Haraway make clear, telling stories that articulate how the precarious spaces of the Anthropocene have been composed and given consistency through the intersection and intermingling of disparate trajectories and forces can provide the fertile ground for a politics that seeks to transform those dynamics. However, one weakness within the foundations of contemporary spatial theory is its 'sociocentrism' (see: Connolly 2017) that privileges human actors and often overlooks the doings of non-human actors. This challenge of telling stories that change the story in the urgent times of the Anthropocene will be returned to in the conclusion.

2.5—Composing the History of the New Jersey Shore: Anthropocene, Capitalocene, Plantationocene

In configuring the history of the New Jersey shore landscape, I work to critically interrogate who is caught up in and what is left out of the *Anthropos* of the Anthropocene as well as how the story of the Anthropocene is told (Haraway 2016). In particular, the emergence of the Anthropocene can be connected to the actions of a small proportion of global humanity, as Earth System scientists make clear (Steffen et al. 2015). It has predominately been the inhabitants of wealthy countries like the United States, the United Kingdom, Germany, Australia, and Japan that have disrupted the climate system. Moreover, in such countries, responsibility is unequal—with a few being responsible for the majority of greenhouse gas emissions. For this reason, some (i.e. Malm 2016; Moore 2014) argue that the name 'Capitalocene' better reflects the uneven patterns of responsibility and precarity of contemporary times. As Malm (2016, p. 391) contends: "This is the geology not of mankind, but of capital accumulation." Yet, as Haraway (2016, p. 56 warns, the narrative of the Capitalocene risks creating another 'too big' story of planetary change that contributes to "cynicism, defeatism, and self-certain and self-fulfilling predictions, like the 'game over, too late' discourse." Another alternative, which Haraway coined in conversation with other scholars, is the 'Plantationocene', which focuses in on slave-labor, colonialism, and "the historical relocations of the substances of living and dying around the Earth as a necessary prerequisite to their extraction" as the critical transitions in transforming the Earth System (Haraway et al. 2016, p. 557). The Plantationocene brings to the fore "the devastating transformation of diverse kinds of human-tended farms, pastures, and forests into extractive and enclosed plantations, relying on slave labor and other forms of exploited, alienated, and usually spatially transported labor" (Haraway 2015, p. 162). Another option presented by Haraway (2016, p. 55) is the 'Chthulucene', which seeks to forefront the multispecies, more-than-human achievement of ongoing global environmental changes and the still possible vibrant futures: "the

Chthulucene is made up of ongoing multispecies stories and practices of becoming-with in times that remain at stake, in precarious times, in which the world is not finished and the sky has not fallen."

Thus, while this and the next chapter centers on the term 'Anthropocene', I also highlight how the history of the New Jersey shore region also fits within the narratives of the Plantationocene and Capitalocene. In particular, I focus on how race and racism are fundamental components of the emergence of the Anthropocene space of the region. As Pulido (2018, p. 117) states: "the Anthropocene must be seen as a racial process." Meaning that, while race is not the sole driver of the emergence of the Anthropocene, it is a crucial aspect. By documenting the history of marginalization and discrimination in the development of the shore region, I aim to problematize claims about how entering the Anthropocene means leaving behind the stable Holocene that allowed "complex civilizations to develop and thrive" (Steffen et al. 2011). Bringing the stories of the Anthropocene, Capitalocene, and Plantationocene allows me to trace how the intimately and tightly connected forces of technology, racism, and capitalism shaped the physical and cultural landscape of the contemporary shore region. Consequently, a key objective of the following chapter is to untangle how race, democracy, capitalism, and technology combined over two centuries to configure development in the shore region as well as the existing sociotechnical imaginary found there.

A second key objective, however, is to document the contingency of the development of the shore and highlight moments in which alternatives could have emerged. Throughout the history of the region, there were many points in which a different landscape and imaginary could have been nurtured and spread. In other words, the shore of today is just one of many potential configurations that could have been. By highlighting the contingency of the region, I also strive

to elucidate that alternatives also exist for the future. If the past was not inevitable, then neither is the future. Therefore, I work to locate potential sociocultural, material, and political resources in the past for achieving a more desirable future.

Chapter 3—Infrastructures of the Anthropocene: Tracing the Emergence of the Jersey Shore from 1800 to present

3.1—Introduction and methods

In this chapter, I provide an overview of the emergence and expansion of the prevailing sociotechnical imaginary found along the New Jersey shoreline. I begin with the emergence of the resort industry during the beginning of the 19th century and trace how industry, race, and technology all intersected to transform the remote and desolate shore region into one of the world's premier destinations in about a century's time. During this period, the space of the New Jersey shore became 'perforated' and 'stretched' (see: Amin and Thrift 2002) by emerging railroads, steam ships, and mass media. I follow this with an examination of how, during the first half of the 21st century, the New Jersey shore became a key crucible for the creation of a vision of democracy based upon the consumer habits of the white-middle-class. Enacting this vision entailed both the implementation of Jim Crow policies and the creation of state- and federal-level coastal erosion management. At first glance, these two phenomena seem radically different. Yet, both projects sought the same end: protecting private business and economic growth from perceived threats. Finally, I conclude with a discussion of the dramatic increase in suburban development centered around the personal automobile that occurred during the second half of the 20th century as well as the formalization of federal- and state-coastal zone management policies. In particular, I highlight how despite both the experience of the devastating Ash Wednesday Storm of 1962 and a recognition that development in the shore region was exposed to significant risks and hazards, policies were not pursued to effectively curtail precarious development. Instead, even after more than a decade of effort, beginning in about 1970, to craft policies that would reduce coastal vulnerability, residential and business development continued to unfold in

hazardous and unsustainable ways through to the present day. Thus, by the end of the 20th century, the shore region was stretched and perforated by seemingly endless roads and other forms of transportation infrastructure facilitating rapid development and accelerating consumption.

This chapter builds upon archival research conducted between 2017 and 2018 as well as secondary sources to trace the development, spread, and entrenchment of the prevailing sociotechnical imaginary of the New Jersey shore region described in Chapter One. Archival research was conducted within the Special Collections and University Archives at Alexander Library as well as the online archives of the New Jersey State Library, Rutgers University Community Repository, and Hathi Trust. Archival research was primarily focused on governmental reports related to coastal management and development in New Jersey since 1800. Particular focus was placed on reports written by and about the New Jersey Board of Commerce and Navigation (NJBCN) and the New Jersey Department of Environmental Protection (NJDEP), as these were the departments most involved in addressing coastal issues in the state.

Historical analysis in this chapter is divided between three broad periods. First, the founding of resorts in the shore region during the time period just after the ending of the American Revolution through the American Civil War and ending with the period of momentous postwar growth during which Atlantic City was founded and became ‘America’s Playground’ and Long Branch became the summer retreat for seven presidents. Second, the coinciding emergence of the Jersey Shore as a crucible of American democracy and consolidation of concerns about ‘beach erosion’ that threatened tax revenue and economic growth during the first half of the 20th century. Finally, the dramatic transformation during the second half of the 20th century in which highways and the personal automobile allowed hundreds of thousands of people to move into the

region in the matter of a few decades. During this period, both federal and state policies were created that sought to stabilize coastlines and allow homeowners to rebuild after disasters. A core focus of this section is to document how the Great Acceleration (McNeill and Engelke 2016; Steffen et al. 2007; Steffen et al. 2015) and the emergence of the Anthropocene—or, perhaps, more accurately the Capitalocene (Moore 2014) or Plantationocene (Haraway et al. 2016)—depended on various political, social, and infrastructural projects that stretch back hundreds of years.

3.2—The emergence of the resort economy from 1800 to 1900

This section examines the period of time when the shore region began to transition from a quiet, resource-based region with few people to a bustling resort-based economy. Initial resorts were spartan at best. By the end of the century, though, luxury hotels and world-class entertainment were common. Famous and powerful visitors spent their summers at the New Jersey shore—including seven presidents. At the same time, the region was also full of discrimination and racism. During most of the 19th century, Black communities struggled for freedom and equality within the shore region. Thus, transformation of the shore region into a renowned resort destination occurred, in large part, alongside the exploitation and marginalization of Black laborers.

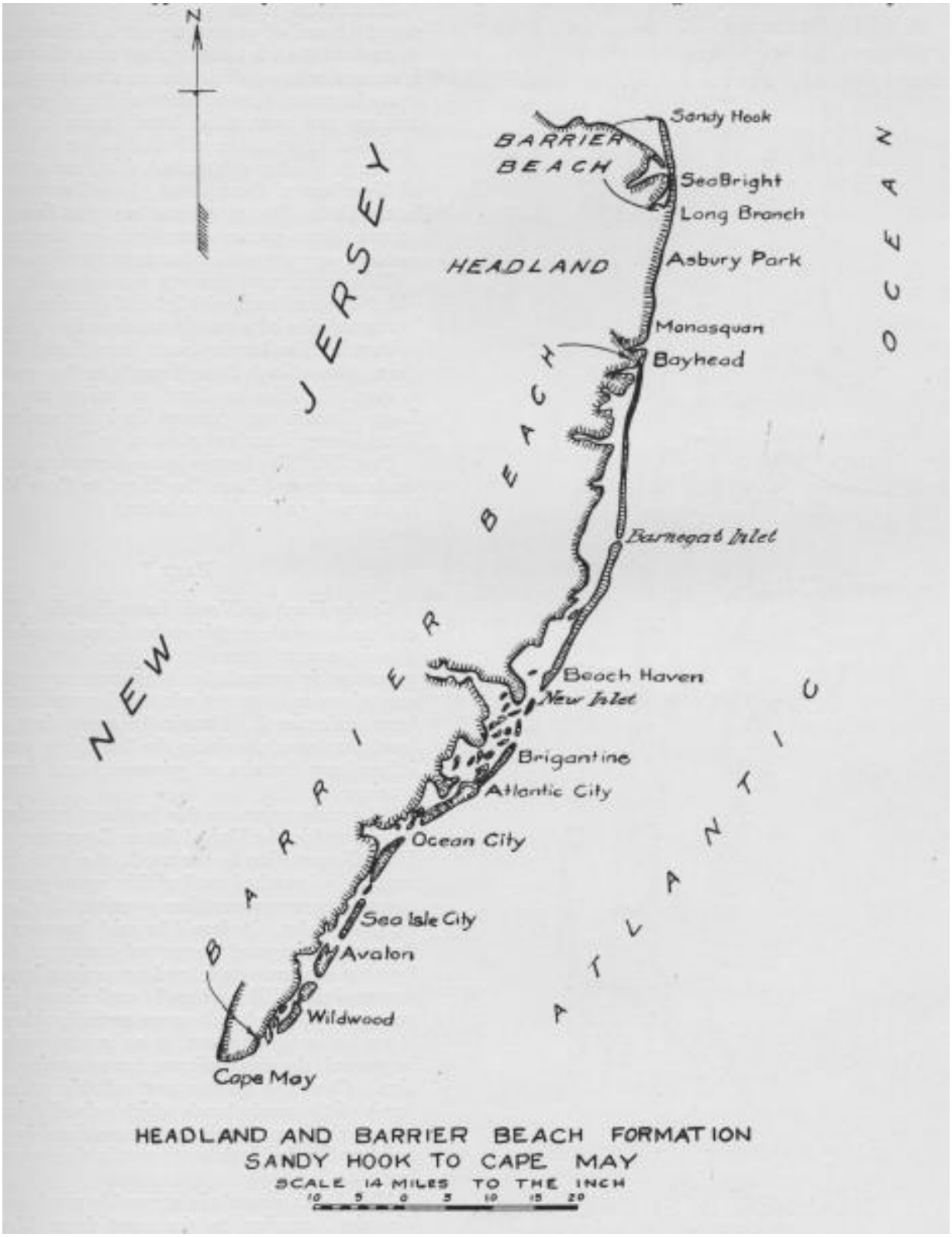

Figure 2. Map of Major Resorts, from NJBCN 1924

3.2.1—The beginnings of the resort industry: Industry, slavery, and health

During the final decades of the 18th century, coastal New Jersey was a sparsely populated region where residents largely eked out a living through some combination of farming, cattle ranching, salt mining, whaling, and oyster harvesting (Mazzagetti 2018; Wilson 1964). Indigenous populations had long utilized what is now considered the New Jersey shore region as a place to gather oysters and fish during the summer months (Mazzagetti 2018; Wilson 1964). However, after the American Revolution most Native American communities were driven from New Jersey (Mazzagetti 2018). This early displacement of indigenous populations allowed white settlers to move into the newly empty region.

Thus, at the beginning of the 19th century, only Cape May, Long Branch, Somers Point, Toms River, and a few other small bayshore developments existed as year-round communities (Stansfield 1998). Early development within the coastal region of New Jersey was shaped and constrained by natural forces. Storms and waves constantly reworked the shoreline—sometimes with economically disastrous results. The maritime-oriented economy of Toms River, for instance, was devastated when a storm permanently closed Cranberry Inlet—the town's primary access point to the Atlantic Ocean (Wilson 1964). Little permanent settlement existed on the barrier islands that stretched from the Jersey Cape in the south to the northern end of Barnegat Bay. The only exception being the occasional whaling village. The first permanent communities were founded along either the northern mainland shoreline or the back bays of the central and southern shore region. Transporting products from shore communities to the urban centers of New York and Philadelphia required a long and difficult journey by horse-drawn wagon through the swampy pine barrens of central New Jersey.

3.2.2—Agricultural Beginnings: Slavery in the Shore Region

Agricultural holdings in the shore region tended to be small-scale and frequently relied upon enslaved labor (Gigantino 2014; Hodges 1997; 2018). Slavery was prevalent within the earliest European settlement in coastal New Jersey (Hodges 1997; 2018). In 1790, of the 155 Black individuals living in Cape May, 141 were enslaved—many of whom labored in the whaling industry (Hodges 2018). Slavery remained commonplace throughout the New Jersey Shore region until the beginning of the 19th century and persisted through the Civil War—particularly in Monmouth County (Dorwart 1992; Hodges 1997; 2018 Gigantino 2014). The New Jersey legislature passed some of the most draconian laws among northern states regulating the movement of both enslaved and free Blacks (Gigantino 2014; Hodges 1997). Under the justification that free Black citizens could place a financial burden on the state, a number of laws were enacted in New Jersey to make manumission difficult. For instance, only enslaved Blacks between the age twenty-one and forty could be freed under the racist logic that both young and old free Black people would be unable to provide for themselves (Giganitino 2014). Up until the year 1786, manumission required a 200-pound bond being paid to the state—once more under the rationale of covering potential costs to the state of freed Black residents relying on public services (Giganitino 2014; Hodges 1997). This relationship is explored throughout this chapter.

Slavery was not just found in the agricultural sector of the New Jersey shore region. The Tinton Falls Iron Works was established in 1673—making it most likely the state's earliest iron works (Stansfield 1998). Located near the Shrewsbury River on the outer coastal plain of the northern shore region, the industrial facility was also the first enslaved community in Monmouth County (Hodges 1997). When founded, the iron works relied on forty enslaved men and women—a number that grew to sixty-seven by 1691 (Hodges 1997). This history not only highlights the

importance of slavery within New Jersey but also how, as recent historical scholarship on slavery documents, the centrality of enslaved labor within the emergence of the North's industrial economy (see: Beckert and Rockman 2016).

The New Jersey shore region was also the location of Black resistance to the institution of slavery. For instance, during the Revolutionary War, hundreds of enslaved individuals escaped bondage to fight for the British army in return for their promised freedom (Gigantino 2014; Hodges 1997; 2018). After the war, British Commander General Guy Carleton secured the freedom of Black soldiers that fought for the British and transported them to other parts of the British Empire. Among the three thousand Black soldiers to leave the newly formed United States were twenty-four from Monmouth County (Hodges 1997). Moreover, enslaved Blacks continued to escape bondage after the Revolutionary War (Gigantino 2014; Hodges 1997). In the mid-19th century, Harriet Tubman arrived at Cape May where she first became involved with the Underground Railroad and used her knowledge of the Maryland landscape to help ferry Black fugitives escaping slavery across the Delaware Bay (Hodges 2018). Thus, while the New Jersey shore region was a landscape of repression and bondage, it was also a site of resistance and escape.

In the beginning of the 19th century, the New Jersey government passed a law that began the gradual emancipation of enslaved Blacks in the states—making it the last northern state to pass legislation to end slavery (Gigantino 2014). After July 4th 1804, anyone born to enslaved parents would no longer be considered a slave (Gigantino 2014; Hodges 2018). Yet, anyone born before that date remained enslaved for life. The law did not free any enslaved person. Moreover, any man born after that date would remain in service to the slave owner until they turned twenty-eight and any woman until they turned twenty-one (Gigatino 2014; Hodges 2018). Two thousand

Black people remained enslaved in New Jersey in 1830—mostly in the eastern half of the state where there was less influence from anti-slavery Quakers and Methodists (Gigantino 2014; Hodges 2018). Even in 1850, just a decade before the American Civil War, two-hundred and thirty-six Black individuals remained enslaved in New Jersey. Thus, the slow decline of slavery in the shore region and the rise of the coastal resort industry coincided.

3.2.3—The First Resorts: Cape May and Long Branch

The claim to being the first coastal resort community is disputed. Boosters of Cape May and Long Branch both contend each to be first ocean resort in the United States. Regardless of which town first began advertising themselves to the urban dwellers of Philadelphia and New York, the last decade of the 18th century saw the emergence of an inchoate coastal tourism economy in the United States (Mazzagetti 2018). Boosters in Cape May and Long Branch presented the shore as a healthful retreat for wealthy individuals from the increasingly polluted industrial cities of Philadelphia and New York. Thus, the emergence of the coastal resort industry also coincided with the emergence of Philadelphia and New York as industrial centers. The wealth accumulated by industrialists and the pollution generated by industry created the economic means of spending summers away from the city as well as the environmental hazards that pushed the wealthy to escape the urban haze and heat (Mazzagetti 2018).

Within the emerging industrial economy of the North, free Black workers faced significant discrimination in New York City, Philadelphia, Newark, and Trenton and had difficulties finding employment. As Hodges (2018, p. 60) states: “Enslavement of blacks had supported the state’s agricultural economy but New Jersey African Americans did not share in the state’s new capitalist economy.” This included most labor unions refusing membership to Black workers. Many freed Black individuals and families left the state in pursuit of better economic

opportunities (Hodges 2018). Some, however, found work in the emerging tourism industry of Cape May, albeit with low pay (Goldberg 2017; Hodges 2018). This pattern in which resort communities offered some economic opportunity for Black workers in New Jersey while also exploiting discrimination to increase profits would become a crucial characteristic of the shore region in which predominately white vacationers were served by Black labor (Goldberg 2017; Simon 2004). Nevertheless, while Black workers still faced significant discrimination in the resort industry, job prospects were still frequently better than in other regions (Goldberg 2017).

Moreover, much of the wealth of industrialists and bankers living within the urban centers comprising the tourism base of early resorts in New Jersey can be connected directly to enslaved labor and the slave trade. As Beckert and Rockman (2016, p. 15) contend: "Access to slave-grown cotton, not simply coal reserves, provided the basis for the so-called Great Divergence" between the 'West' and Asia during the Industrial Revolution. At the start of the 18th century, cotton—the key resource of the early industrial revolution—production rapidly increased within the United States. Growing tenfold from eight million pounds in 1795 to eighty million pounds in 1806—largely due to punitive and violent disciplinary tactics (Baptist 2016). By 1818, the United States was exporting ninety-two million pounds of cotton—kicking off a banking boom centered in New York City (Schoen 2009). Northern financial institutions created insurance policies for enslaved laborers as a risk management technique for southern slaveowners as well as provided loans in which enslaved individuals acted as collateral (Beckert and Rockman 2016). These loans were frequently used to purchase additional slaves. Further, by the 1850s, the largest slaving ships operating in the Gulf of Mexico were owned by New York City investors (Beckert and Rockman 2016). In short, the booming cotton trade fully reliant on enslaved labor was a fundamental factor in the formation and rise of the industrial North (Baptist 2016; Beckert and

Rockman 2016; Schoen 2009); thus, the development of the early tourism economy of the New Jersey shore was also influenced by the rapid territorial expansion of slavery and cotton-production that occurred during the first half of the 19th century.

3.2.4—Traveling to the Shore: Painful Trips to Uncomfortable Rooms

For early vacationers, traveling to the shore was arduous, stressful, and long (Dorwart 1992; Mazzagetti 2018; Roberts and Youmans 1994; Wilson 1964). Those wishing to visit either Cape May or Long Branch needed to ride within uncomfortable horse-drawn wagons—typically referred to as Jersey Wagons—along routes through the mosquito- and green fly-ridden pine barrens of New Jersey. Frequently, the same wagons were also used to transport oysters and fish from the shore back to urban centers, which contributed to a lingering, unpleasant odor (Mazzagetti 2018). The journey took multiple days with little to no shelter from the elements (Mazzagetti 2018; Wilson 1964). Once vacationers arrived at the shore, they found lodgings that could be described as, at best, spartan (Mazzagetti 2018; Wilson 1964). Most rooms for rent were repurposed farm rooms with minimal renovations and few amenities (Mazzagetti 2018; Roberts and Youmans 1994; Wilson 1964). Many early visitors reported needing a few days to recuperate before beginning to enjoy their vacation (Wilson 1964). The difficulty of traveling to the shore, therefore, acted as a crucial barrier to widespread vacationing even for the growing urban elites of Philadelphia and New York.

In the 1820s, the spread of the steamboat began to provide faster access to Cape May and Long Branch (Mazzagetti 2018; Roberts and Youmans 1994; Wilson 1964). Steamboats ferried people from New York to Long Branch and from Philadelphia to Cape May. Additionally, Cape May began to attract visitors from Virginia and Maryland who crossed the Delaware Bay by boat (Dorwart 1994). However, steamboat travel entailed new technical challenges for resort

communities. Initially, ships dropped passengers off a few miles outside of resorts and passengers still needed to take wagon rides to their final destination (Roberts and Youmans 1994; Wilson 1964). Later, piers were constructed that allowed passengers to disembark directly to resorts (Wilson 1964; Roberts and Youmans 1994). Piers were vulnerable to fires and coastal storms, and they frequently needed to be rebuilt. For instance, a pier was first built in Long Branch in 1828 for landing vessels traveling from New York City. The pier was destroyed soon after and no new pier was constructed until 1878 when one with benches and refreshments was erected; this pier washed away during a storm in 1881 (Wilson 1964). Thus, even though steam opened up new and faster routes to the shore, transportation was still vulnerable to natural hazards and required expensive construction and maintenance.

3.2.5—Early Technological Transformations and the Anthropocene

The emergence of resorts during the first half of the 19th century coincided with two broad social and technological transformations: the ending of slavery and the industrial revolution. These changes fit within narratives of the 'Capitalocene' and the 'Plantationocene'. The Industrial Revolution made industrialists living in Philadelphia and New York exceedingly wealthy. With that wealth came the ability for families to spend weeks—if not months—vacationing. Moreover, the building and operating of factories in urban centers led to both environmental degradation and crowding. Especially during the hot, humid summer months, these urban conditions gave wealthy families all the more reason to seek shelter along the New Jersey coastline. The slow decline of slavery in New Jersey also unfolded alongside the emergence of resorts. While the links between the ending of slavery and the growth of a tourism-based economy are less clear, a few important connections are evident. First, the small-scale agriculture and whaling industry that had existed in the 18th century was reliant on enslaved-Black-labor. Thus, at the same time

slavery was declining, farmers, whalers, and fishermen began transitioning towards a more resort-oriented livelihood. Second, Black workers struggled to find employment in the burgeoning industrial economies of Philadelphia and New York at the same time that many Black individuals and families were both becoming free in New Jersey or migrating northward to seek freedom. The new resort communities in Cape May and Long Branch offered potential employment opportunities working as maids, cooks, and servers. Black workers were paid less than white ones, but the resort communities typically paid better than other nearby urban centers (Goldberg 2016). Finally, the overall economy of the United States was reliant upon enslaved labor. Enslaved Black labor produced the vast majority of cotton that fueled much of American and global industry. Moreover, at the time of American Civil War, "the capital stored in slaves exceeded the combined value of all the nation's railroads and factories" (Beckert and Rockman 2016, p. 1). Thus, the enslaved labor was crucial to initial development of the coastal region both because of the gradual emancipation that occurred in New Jersey as well as the territorial expansion of slavery in other parts of the United States. While the New Jersey shore region may have emerged as a resort destination without slavery existing, the form that development took there cannot be separated from slavery. One, because cheap Black labor was fundamental to the growth of early resorts. Two, because the fact that much of the wealth in the industrialized North was gained through the cotton and slave trade.

3.3—Atlantic City and the Making of the World-Class Resort: Trains, Jim Crow, and Private Property

The desire to escape the polluted industrial cities of the northeast inspired Dr. Jonathan Pitney to begin planning in 1851 and officially found in 1854, Atlantic City. Pitney had first envisioned a bustling resort on the nearly empty Absecon Island decades earlier. Few others shared his vision

(Mazzagetti 2018; Roberts and Youmans 1994; Wilson 1964). Instead, the island was widely seen as little more than a "a succession of barren sand hills and unproductive swamps" (Wilson 1964, p. 44). However, the island was large enough to support a significant population as well as located only about sixty miles from Philadelphia. Pitney argued around 1850 that "only a railroad is needed to make the island blossom as the rose" (quoted in Roberts and Youmans 1994, p. 41). Before any construction began, Pitney already had ambitiously named his resort 'Atlantic City' and drafted a charter for a railroad connecting it to Camden just outside of Philadelphia (Mazzagetti 2018; Roberts and Youmans 1994).

The Camden and Amboy Rail Road could have easily petitioned for the state to deny the request but the project was viewed as a boondoggle and Pitney's proposal as "a railroad to nowhere" (Roberts and Youmans 1994, p. 41). This initial derision proved crucial to Pitney's success, as it contributed to the Camden and Amboy Railroad waiving its exclusive rights to constructing rail lines in the region (Dorwart 1992; Roberts and Youmans 1994; Wilson 1964). Skeptics were initially proven correct, as within three years the railroad to Atlantic City went bankrupt and had to be restructured (Mazzagetti 2018; Wilson 1964). For the first decade and a half of its existence, there was little interest in Atlantic City and the resort languished (Roberts and Youmans 1994).

Partially, this was because traveling by train was initially neither luxurious nor comfortable (Mazzagetti 2018; Roberts and Youmans 1994). Trains were powered by burning wood and cars were not enclosed—meaning passengers were exposed to smoke and soot the entire trip (Mazzagetti 2018). Moreover, early facilities in Atlantic City were lacking comfort as well (Mazzagetti 2018). Tunnell (1983, p. 11) described the experience of an early vacationer in the following manner:

> "When he arrived, the visitor discovered that the 'city' was still a village. High tides occasionally flooded the streets, and until 1864 cattle were allowed to run at large. And the mosquitos! Greenhead flies were bad every year, and in 1858 they appeared in such swarms that the complaints reverberated all the way to Philadelphia. The island abounded with hundreds of wet places where flies could breed."

Moreover, hotels were located a safe distance from the shore, which meant vacationers walked long distances to the beach. Bathhouses were located at the beach so visitors could get changed. However, as Wilson (1964, p. 60) described:

> "These buildings were rough, unsightly structures so constructed that they could be put on a wagon every autumn and hauled away from the high winter wavers. Long rows of bathhouses dumped along Pacific and other Avenues were a common winter sight; not a building was left on the beach after the close of the season. A few weeks before the summer season opened, the beachfront presented an animated picture as busy laborers restored the bathhouses and removed accumulated debris."

During the 1870s, the Camden and Atlantic Railroad began to offer group promotions to religious and civic organizations, which suddenly increased the number of vacationers to the resort (Roberts and Youmans 1994). In 1870, 300,000 people visited Atlantic City in part due to such promotions as well as faster, more comfortable trains (Mazzagetti 2018). Indeed, ridership of the line began to increase so rapidly that by 1880 two new rail lines serving Atlantic City were formed (Roberts and Youmans 1994; Wilson 1964). One new line constructed in 1877 was completed in just ninety days (Mazzagetti 2018). With technical improvements, traveling to Atlantic City from Camden took only a few hours—meaning that Philadelphians could travel-to-and-from the shore in a single day. The term 'shoebies' was coined to describe this new kind of visitors based upon their tendency to carry their lunch in a shoe box (Mazzagetti 2018). By 1900, more than 700,000 visitors traveled to Atlantic City (Mazzagetti 2018). Pitney, though, never

saw Atlantic City thrive, as he had died in 1869 while the resort still struggled (Mazzagetti 2018).

Rail did not just make it easy for vacationers to visit at the shore. It also opened it up for residential development. Approaching the close of the nineteenth century, Gustav Kobbe described Atlantic City as "virtually a seaside suburb of Philadelphia" (Kobbe 1889, p. 71). The year-round population of Atlantic City in 1900 reached 28,000 people (Cunningham 1958). A significant portion of this population were the Black workers who filled many of the new service positions needed in resorts. By 1900, ninety-five percent of hotel staff was Black (Hodges 2018). Initially, Black residents of Atlantic City did not experience significant segregation in housing or in recreational opportunities (Goldberg 2017; Hodges 2018). Indeed, most neighborhoods were integrated through the 1870s to 1890s (Hodges 2018).

This reflects a broader national trend after the Civil War to move towards more racial integration during the Reconstruction Era (Foner 1990). The state of New Jersey had only been a reluctant supporter of the Union cause—and was the only state to remain in the Union to vote against Abraham Lincoln twice in presidential elections (Salmore and Salmore 2013). After the Civil War ended, few white New Jersey residents became leaders in the fight for civil rights, but many Black ones did (Hodges 2018). Beyond the initially integrated neighborhoods of Atlantic City, a few other examples of the possibility for a more racially integrated shore region can be found. For instance, James Bradley developed Asbury Park as a place where both white and Black vacationers "could peacefully seek refuge together" (quoted in Goldberg 2017, p. 22). However, as will be explored later, as white politicians in both the North and South began to sabotage the gains of Reconstruction and the federal court system overturned critical civil rights legislation,

Jim Crow and racial discrimination became the norm in the shore region by the end of the 19th century (Goldberg 2017; Hodges 2018).

3.3.1—The Boardwalk and Keeping Sand in Place

As Atlantic City became more popular, luxury hotels were built to serve the growing stream of tourists arriving in the resort. Early hotel proprietors experienced a novel problem along the shore. Vacationers returning from beach carried sand into hotels—destroying their furniture and carpet (Roberts and Youmans 1994). Business owners banded together to solve the sand problem through funding the construction of the first boardwalk. By directing visitors to promenade down the wooden blanks of the boardwalk, sand was prevented from being carried into hotels and businesses. In this regard, the Atlantic City Boardwalk was, perhaps, the first infrastructural project in the New Jersey shore region designed with the aim of keeping sand in its socially designated rightful place.

The first boardwalks in Atlantic City were little more than wood boards laid out on the beach (Roberts and Youmans 1994). The initial municipal resolution of 1870 approving the construction of the boardwalk also prohibited any buildings within thirty feet of it (Roberts and Youmans 1994). During the first decades of its existence, the boardwalk was taken apart and stored during the winter months (Mazzagetti 2018; Roberts and Youmans 1994). The boardwalk was an immediate success and quickly became one of the most popular attractions in Atlantic City (Simon 2004; Roberts and Youmans 1994). In 1880, a new, wider boardwalk was built—this time with businesses being allowed to be built up to ten feet from the walkway, though not on the ocean side (Roberts and Youmans 1994). Three years later, nearly one hundred businesses were near the boardwalk (Roberts and Youmans 1994). A third version of the boardwalk was constructed in 1884—this time designed to be a year-round structure in which businesses could

be on both sides (Roberts and Youmans 1994). This version of the boardwalk was devastated from a powerful hurricane in 1889. In response to this event, a fourth boardwalk was constructed in 1890 that once more banned building on the ocean side (Roberts and Youmans 1994). A fifth, a final version, of the boardwalk was built—this time constructed with steel girders on steel pilings (Roberts and Youmans 1994). With this version, the boardwalk became 'the Boardwalk' (Simon 2004; Roberts and Youmans 1994). No longer simply a wooden walkway over the sand, the Boardwalk was a proper place and a key spot for being seen (Simon 2004). The boardwalk experience would soon become replicated throughout the New Jersey shore region, though only Atlantic City's Boardwalk would earn an uppercase 'B'.

3.3.2—The Coast Grows Close and the Elites Flock: The Impacts of Rail

After the first train reached Atlantic City, rail lines proliferated throughout the Jersey Shore region. Along with the proliferation of rail lines came an assortment of new resorts (see figure 3). Some of the new lines connected to existing resorts like Long Branch (Dorwart 1994; Roberts and Youmans 1994). In other cases, rail lines produced newer resort destinations, such as Wildwood and Sea Isle City near Cape May (Dorwart 1994) and Asbury Park and Ocean Grove near Long Branch (Mazzagetti 2018). By the early 1880s, as many as 100 trains carrying up to 8,000 people total arrived weekly at Asbury Park during the summer (Brail and Markstedt 1982). Moreover, with the advent of widespread train travel, the four coastal counties of New Jersey grew from a population of 55,700 in 1850 to 111,000 in 1885 (Roberts and Youmans 1994).

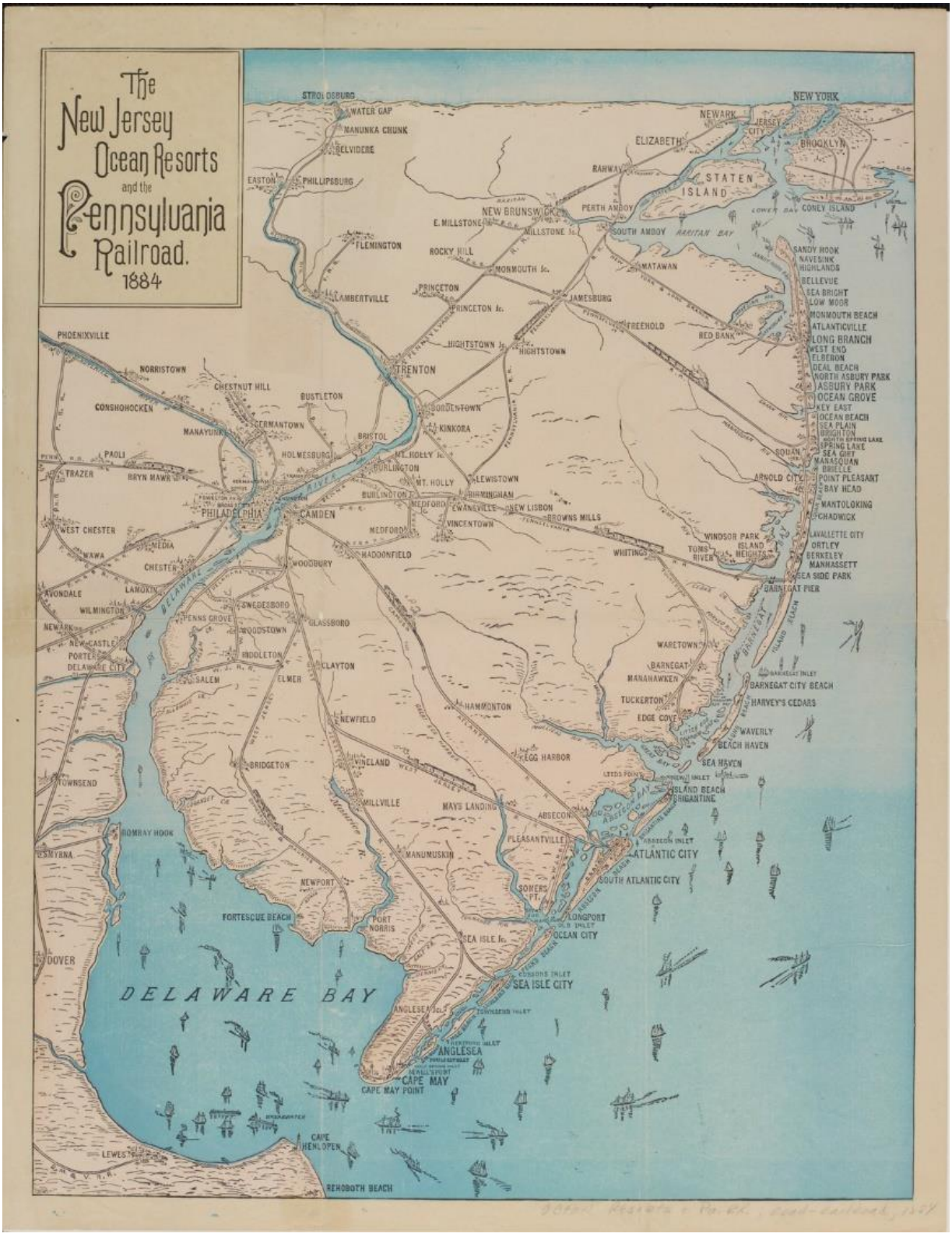

Figure 3. New Jersey Ocean Resorts and the Pennsylvania Railroad, 1884.
Image courtesy of the Rutgers University Libraries Special Collections

The decreasing travel times to shore resorts increased the popularity of the Jersey Shore. Economic and political elites began vacationing more frequently along the coast. Moreover, the growth of office workers and other professional positions created a new middle class that wanted to spend weekends at the shore (Mazzagetti 2018). Long Branch became particularly fashionable for powerful individuals to visit after the end of the Civil War. Ulysses S. Grant was the first president to vacation there in 1869 and six more presidents would later spend time in the resort during their terms of office (Roberts and Youmans 1994). Mary Todd Lincoln, who spent time in Long Branch after the assassination of President Lincoln, had recommended the resort to President Grant—who, in turn, enjoyed his stay so much that he spent each summer of his presidency there (Roberts and Youmans 1994). Beyond political elites, Long Branch also attracted well known figures such as Oscar Wilde, Annie Oakley, Buffalo Bill, and Horace Greely (Roberts and Youmans 1994). Grant's decision to summer at Long Branch inspired presidents Rutherford Hayes, James Garfield, Chester Arthur, Benjamin Harrison, William McKinley, and Woodrow Wilson to all leave the heat and humidity of Washington DC for the resort—leading it earning the nickname the 'Summer Capital' (Mazzagetti 2018). While social elites flocked to Long Branch, Atlantic City attracted more middle-class vacationers (Tunnell 1983). Visitors to Ocean Grove and Ocean City journeyed to the shore for religious reasons, as both were founded as Methodist retreats (Roberts and Youmans 1994). James Bradley was an early visitor to Ocean Grove and had founded Asbury Park to the north in order to prevent sinful behavior—such as consuming alcohol—from infiltrating the strictly regulated community (Roberts and Youmans 1994).

3.3.3—The Rise of Jim Crow

Black workers staffed many of the hotels, restaurants, and service positions within the Jersey Shore (Goldberg 2017; Simon 2004; Tunnell 1983). For many Black Americans, the Jersey Shore offered relatively lucrative work opportunities difficult to find in other northern cities (Goldberg 2017). For instance, Black workers in Atlantic City and Asbury Park filled positions such as headwaiters and managers—positions that would not have been available to them in places like Philadelphia and New York City (Goldberg 2017). By 1885, 15% of Atlantic City's population was Black—a percentage that increased to 23.5% in 1905 (Tunnell 1983), which made it the highest concentration of Black residents in any New Jersey city (Hodges 2018).

Despite initial visions of an integrated shore open to Black and white vacationers, as the memory of the Civil War began to fade and the Reconstruction project was undermined by whites in the North and South, racial discrimination became the norm in most resort communities. In fact, the marginality of Blackness was central to the design and operation of the Jersey Shore imaginary (Goldberg 2017; Simon 2004). White vacationers traveled to the Jersey Shore during the post-Civil War period not only to escape from the increasingly poor environmental conditions of cities, but also "from the contentious racial politics and class stigmas attached to older northern vacation spots" (Goldberg 2017, p. 21). In other words, white vacationers traveled to the shore, in part, to be served by Black staff in a cultural environment that reinforced a political economy of white social mobility and Black servitude. However, when Black tourists and workers sought to relax on the same beaches and boardwalks or in the same theaters as whites, "the idyllic fantasies that white tourists had fashioned for summer vacation spaces" were threatened (Goldberg 2017, p. 26).

Indeed, during the last few decades of the 19th century, discrimination became more pronounced in the shore region as Reconstruction was undermined by white politicians and judges in both the South and North (Foner 1990). More and more Jim Crow rules spread throughout the coastal resorts of New Jersey (Goldberg 2017; Hodges 2018). In many cases, the protecting of the value of private property was the justification for the implementation of segregation in resort communities (Goldberg 2017). Goldberg (2017, p. 8) documents how business owners and political elites in the New Jersey shore region worked to replace the 'free labor ideology' that dominated the post-Civil War Reconstruction-era with a vision of economic growth based upon mass consumption and private property: "Jersey shore segregationists argued that Jim Crow boundaries were permissible in a service economy because they protected the property rights of business owners and defended public welfare against disruptive consumer protesters who threatened to undermine the economic prosperity and social preferences of others." In other words, segregation was justified as acceptable not because Black patrons were inherently undesirable in the minds of business owners, though this might have been true, but because accepting Black patrons could hurt business revenue and economic growth.

3.3.4—Placing Narratives of the Anthropocene, Capitalocene, Plantationocene in the Early Shore

During the second half of the 19th century, the Jersey Shore emerged as the site of the premier beach resorts in the United States. Multiple intersecting trajectories facilitated the transformation of coastal New Jersey from a largely agrarian landscape of farmers, fishermen, and salt miners to a landscape of mass pleasure and consumption. With the ending of the Civil War, the Northern economy boomed. This contributed to both the growth of the pool of potential vacationers but also to increasingly poor environmental conditions in urban centers. Thus, industrialization both

gave some individuals the financial means to travel as well as the reasons to leave the city whenever possible. Thus, once more, the growing consumption and material changes unfolding in the shore region connects directly to many themes of the Capitalocene narrative.

Narratives of the Plantationocene are also supported during the second half of the century. The conclusion of the Civil War did bring the institution of slavery to an ending. But it did not end racist social and economic systems in the nation or New Jersey. Newly freed Black workers struggled to find employment opportunities in both the South and the North. The resorts of New Jersey were a place where Black workers could find decent employment, though in positions that still paid them less than white workers. Moreover, in the immediate aftermath of the Civil War, there were visions of the shore region being a place where visitors of all races could enjoy themselves. Yet, as the Reconstruction Era was sabotaged, this vision quickly faded and was replaced with a consumerist and private property rights imaginary that argued that segregation was justified not necessarily due to white supremacy but because integration was harmful to businesses and consumers in general.

3.3.5: The Intersecting Stories of the Early Shore—Health, Leisure, and Race

The spatial narratives that intersected to configure the early New Jersey shore frequently originated from outside the region. Industrialization in New York and Philadelphia were crucial for the transformation of the region from a ‘vast wasteland’ to a bustling tourist destination and burgeoning suburbs. In turn, the economic value extracted from enslaved Black labor was a fundamental component of the concentration of wealth within the hands of Northern industrialists. Boosters in the shore region crafted their own narratives about the healthfulness of ocean air compared to the polluted urban centers as well as the promise of freedom and leisure

outside of the confines of city life. Some resort communities also told stories of religious idealism, such as the Methodist resorts of Ocean Grove and Ocean City.

Race was always there to complicate and problematize such narratives. For the first half of the century, slavery and tourism had coexisted in the shore region. After the Civil War, there was a brief moment in which some—though certainly not all—resort boosters imagined places in which all vacationers would be welcomed. But, as politicians and elites in both the North and South began to sabotage Reconstruction, Jim Crow rules began to spread. By the end of the century, spatial segregation had increasingly becoming the norm, though most large resorts still relied on Black labor. Thus, there were now Black and white communities—and investments were made much more into the latter.

3.4—The New Jersey Shore and the Making of the White Middle Class from 1900 to 1950: Precarious Consumption and Property Along the Coast

The tensions between, on the one hand, the idealized, environmentally healthful and spiritually nourishing shore resorts and, on the other hand, racial discrimination and exploitation deepened during the early 20th century. As the following sections explore, spatial segregation and anti-Black policies became key features of the New Jersey shore region. Being catered to by Black laborers became an important way for immigrants from Ireland, Italy, and Eastern Europe to perform their 'whiteness' and claim their place in the emerging white working class. For this reason, many commentators of the time, the New Jersey shore—and in particular Atlantic City—was a valuable site for not only leisure but also achieving a fuller democracy. That this excluded Black citizens was explicit to both white visitors and Black residents.

At the same time that the shore region was becoming economically and culturally invaluable, erosion was increasingly threatening coastal development. By 1920, it was clear to resort

boosters and the state government that something had to done to protect the growing tax revenue being generated by coastal development. As will be detailed later in the section, the state government responded to this through a series of innovative and seminal studies on erosion along the entire coastline of New Jersey. Ultimately, these studies not only got the state directly involved in managing coastal erosion, but, eventually and after significant resistance, brought the federal government and the Army Corps of Engineers into the fold.

3.4.1: American Democracy—Citizenship, discrimination, consumption, and property

If the 19th century was a period in which the Jersey Shore shifted from a remote wilderness to an easily accessible place of relaxation, then the first half of the 20th century is when the region became a space of freedom, fantasy, and contradiction. In many ways, the Atlantic City of the early 20th century possessed the 'dense networks of interaction' that for Massey (1999) and other urban spatial theorists (i.e. Amin and Thrift 2002) characterize urban life. Hundreds of thousands of vacationers journeyed to Atlantic City each summer—crowding the Boardwalk, theaters, and restaurants (Simon 2004). Many of these visitors were Irish, Italian, Polish, and Jewish immigrants who traveled to Atlantic City to not only escape the crowded urban centers for the clean, refreshing ocean air but also to make a claim for their place as full American citizens (Simon 2004). The 'networks of interaction' and 'moments of encounter' (Amin and Thrift 2004) found along the Boardwalk were critical not only for giving identity to Atlantic City but also to the emerging American middle-class (Simon 2004). Teddy Roosevelt once stated that: "A man would not be a good American citizen if he did not know of Atlantic City" (quoted in Simon 2004, p. 7).

After a century of technological and social transformation in the shore region, by the turn of the century, the experience of the Jersey Shore was increasingly both a social and technical fantasy.

Socially, the Jersey Shore emerged as a space of democratic ideals and deep racial discrimination. Technologically, development crowded the shore and techniques to stabilize the inherently unstable coastline were pioneered by communities, the state government, and federal agencies. Atlantic City was the exemplifier of a fantastical space. The historian Simon Simon (2004) described Atlantic City as:

> "both real and fake, a big city and a small town, a world of soaring skyscrapers and ocean breezes. From the very start, it was conceived as a make-believe place. But this deceit wasn't disguised. No one mistook Atlantic City for his hometown. This knowledge, this participation in such an easy-to-see masquerade, liberated many" (p. 7).

The central fantasy of Atlantic City was one in which both working-class and wealthy Americans could move in the same spaces as peers; indeed, for many immigrants from Ireland and Eastern Europe, visiting Atlantic City was a way of claiming and demonstrating one's equality as a citizen (Simon 2004; Tunnell 1983). Indeed, Atlantic City quickly became a public space in which the emerging white middle class's place within American democracy was forged. Playing the part, though, required following the proper script: "Guests were expected to dress properly and behave correctly" (Simon 2004, p. 35). In this regard, Atlantic City differed from other resorts of the time, such as Coney Island or Las Vegas, in that people "came to the Jersey shore to make a claim of respectability" rather than to simply cut loose (Simon 2004, p. 36).

Displaying and performing white equality entailed marginalizing and excluding Blackness. Segregation was the rule on the beach, the boardwalk, and the city (Goldberg 2016; Simon 2004; Tunnell 1983). The position of Black workers and entertainers was central to the fantasy of Atlantic City. Being pushed down the boardwalk in a 'rolling chair' by a Black man while purchasing frivolous things performed one's place in the emerging consumerist middle class that

was central to American democracy (Simon 2004, p 19-21). Even the Black neighborhoods of Atlantic City served a place for white visitors to perform their privilege. Black performers entertained white audiences in nightclubs located within mostly Black neighborhoods (Simon 2004). These nightclubs frequently forbid Black patrons (Simon 2004).

The Black citizens of Atlantic City increasingly found themselves living in segregated neighborhoods with poor health conditions. According to Hodges (2018):

> By 1915 only 20 percent of blacks had white neighbors. Housing restrictions jacked up rents and forced more blacks to take in boarders and increased the likelihood of childhood infectious diseases. By 1910, nearly a quarter of black children died before the age of one compared to about 8 percent of whites" (112-3).

Segregation did not stop in housing, though. Instead, every amenity of Atlantic City felt the influence of segregation (Hodges 2018; Simon 2004). During the 1920s, Black vacationers were barred from swimming with whites (Hodges 2018). Black patrons were also excluded from theaters and restaurants on the Boardwalk (Simon 2004).

The segregation of the beach was not limited to Atlantic City. Asbury Park excluded Black residents from fully accessing the town's beaches decades before Atlantic City (Goldberg 2017). Despite James Bradley's founding vision of both white and Black vacationers enjoying his resorts, he was quick to acquiesce to white demands for segregation. Because Bradley owned Asbury Park's beaches—along with nearly everything else in the town—he was able limit Black residents and tourists to small sections of the shoreline (Goldberg 2017; Hodges 2018). Some white leaders in Cape May went as far as to attempt the complete removal of Black residents from the city in the early 20th century (Dorwart 1994).

The contradiction between segregation and democracy within the resort communities of the Jersey Shore can be found within writing at the time. For instance, in a book entitled *In Vacation America* published in 1915, Harrison Garfield Rhodes wrote that: “The Jersey coast is, on the whole, the most popular part of the American seashore, the most characteristic, the most democratic, the most intensely American (Rhodes 1915, p. 7). Rhodes praises the acceptance and openness of beach resorts to both male and female swimmers as well as bathers of many ethnicities. Yet, he also acknowledges that the beaches are not completely open to all, though he remains ambivalent at this fact: “Here in the waves democracy comes into its own. There is but one kind of exclusiveness (and this is an exclusiveness which from another point of view is a great generosity): both Atlantic City and Asbury Park provide ‘Jim Crow’ sections of the beach” (Rhodes 1915, p. 10-11). Consequently, to the extent that the waves of the Atlantic Ocean acted as a place that produced ideal American citizens fully capable of participating in democratic society, it did so by excluding Black Americans from the privileges democracy brought with it.

Black residents, workers, and tourists, though, did not simply accept segregation along the Jersey Shore (Goldberg 2017; Hodges 2018). Indeed, Black citizens also sought to deploy the emerging consumerist logic of citizenship to their advantage, arguing that “the right of consumers to make unregulated choices was a basic civil right” (Goldman 2017, p. 52). Black workers in the resort industry did have some advantages in fighting for their rights because so many businesses relied on their labor (Goldberg 2017; Hodges 2018). Thus, Black residents of resort communities in New Jersey were frequently more successful in achieving their political goals of a more democratic form of market capitalism (Goldberg 2017, p. 55)

3.4.2—Erosion, development, and property taxes

As resorts multiplied and flourished along the coast, the value of property along the shore also skyrocketed. At the same time, the increasing density of development along the shore put more and more capital at risk of coastal storms and changes in the shape of the coastline. In other words, as property values rose in the Jersey Shore so did the vulnerability of property. In the early years of the Atlantic City Boardwalk, rebuilding the walkway every few years after it was destroyed by a storm was a small financial burden (Roberts and Youmans 1994); yet, in the early 20th century, the Boardwalk had been lined with amusements, hotels, and businesses that made it too valuable to allow storms to destroy it (Roberts and Youmans 1994; Simon 2004). Instead, the Boardwalk and other property had to be protected from coastal forces. Beyond powerful storms, resort communities began to notice that in many places the beaches were eroding (Cunningham 1958; Pilkey and Dixon 1996; NJBOCN 1922). As fixed structures tightly packed the shoreline, the flux of beaches became a threat to the long-term viability of resorts. In particular, Long Branch had lost much of its beaches by the early 20th century (Cunningham 1958).

Consequently, individual resort communities began attempting to address the emerging problem of coastal erosion by constructing a hodgepodge of coastal defense structures along the shoreline (Cunningham 1958; NJBCN 1992; Pilkey and Dixon 1996; Quinn 1977). Groins or jetties, as they are frequently referred to as in New Jersey, became common fixtures along the coast of New Jersey by the start of the 20th century. Jetties disrupt the process of littoral drift, which carries sand parallel to the shore, and builds beaches down drift from the structure (Pilkey and Cooper 2016; Psulty and Ofiara 2000). This interception of sand drifting along the coast, however, often causes loss of sand in beaches up drift from jetties (Pilkey and Cooper 2016; Psulty and Ofiara 2000). Because resort communities in New Jersey were concerned about their own beaches, little attention was given within early jetty construction to the potential to

accelerate erosion in other nearby beaches. Indeed, towns along the Jersey Shore frequently built particularly long jetties at the end of their beaches to capture as much sand as possible before it drifted to the next community. Such jetties came to be called ‘spite groins’ (Pilkey and Dixon 1996). The downsides of the proliferation of jetties along the New Jersey coast was understood during the early decades of the 20th century, but no programs or agencies existed to coordinate state wide erosion control (Cunningham 1958; NJBCE 1922).

In 1915, the state government formed the New Jersey Board of Commerce and Navigation. It immediately took an interest in the problem of coastal erosion. By 1918, the Board called for increased state involvement in addressing coastal erosion. In its annual report, the Board argued in a section entitled ‘coast protection’ that “it is high time some action was taken by the State looking toward the protection of the coast against erosion” (NJBOCN 1918, p. 6). To start this process, the Board called for a formal study of coastal change and existing efforts to prevent erosion, which could then be used to create a general plan for coastal protection. Two years later, the Board used its annual report to again make a case for state involvement in coastal protection—this time in the more powerfully named section of ‘protection of the beaches against attack by the ocean’ (NJBOCN 1920, p. 14). While the authors of the report acknowledged that coastlines are constantly in flux, they contended that well designed technical solutions could manage coastal processes. In this report, the Board highlighted the continuous assault of winter storms on beaches as well as importance of beaches to the state in drawing vacationers and providing property taxes. This language of warfare would proliferate throughout erosion control efforts in coming decades. The Board further argued that the piecemeal and disorganized approach to address coastal erosion by local governments was potentially making matters worse and only a regional approach could stem the assault of ocean forces (NJBOCN 1920). Once

more, the Board argued the state had to take “broad measures to study and plan a defense against the ceaseless attack of the ocean” (NJBOCN 1920, p. 15). Later in 1920, the New Jersey legislature acquiesced to this request and funded a study on the extent of coastal erosion in New Jersey as well as potential solutions to the problem. Crucially, the state legislature also approved appropriating funds to address coastal erosion with the provision that local municipalities also pay for half the cost of any project (NJBOCN 1922).

Thus, the Board of Commerce and Navigation had an opportunity to make coastal erosion a ‘matter of concern’ that moved actors into action (see Latour 2004). To do so, the Board had to prove that coastal erosion was actually a problem, that feasible technical solutions to erosion existed, and that the state government of New Jersey had an incentive and responsibility to combat coastal erosion. At the time, no state government in the United States was involved in coastal management and the federal government resisted getting involved in addressing coastal erosion (Pilkey and Dixon 1996; Quinn 1977). Indeed, the study conducted by the Board is the beginning of coastal management in the United States and would lead to the eventual involvement of the US Corp of Engineers and federal government in managing the coast (Pilkey and Dixon 1996; Quinn 1977). In other words, the Board was operating in uncharted terrain and needed to create a new technoscientific object: beach erosion control.

The Board of Commerce and Navigation understood the importance of building alliances with powerful interests. Before setting out to compile evidence of the problem of erosion, the Board enrolled influential politicians and experts within their project. The Board convinced both the U.S. Department of Commerce and U.S. War Department to cooperate with their study of the New Jersey coastline. Part of this cooperation was the participation of two engineers from the U.S. Army Corps of Engineers, who acted in an advisory capacity (Quinn 1977).

After building alliances with existing political and technical authorities, the Board needed to prove that coastal erosion was a problem along the Jersey Shore. The members of the study brought to bear a range of sources and forms of information to accomplish this. They examined maps of the New Jersey shoreline dating back to 1835, conducted an on-the-ground survey of the entire coast, and interviewed workers at lighthouses and lifesaving stations (NJBOCN 1923). The thoroughness of the report was hailed more than forty-years-later as a seminal moment in the professionalization of coastal erosion management (Quinn 1977). By combining historical and contemporary data with the lived experience of those manning lighthouses and lifesaving stations, the Board determined the ocean had "encroached and robbed New Jersey of some 2,200 acres of its beach front" (NJBOCN 1922, p. 11). In highlighting the general pattern of erosion in New Jersey, the Board made three important arguments. First, they pointed out that the ocean did not differentiate its attack on the coast, and economically valuable beaches were just as likely to erode as unutilized ones. Second, the Board stressed that uncertainty about where and when erosion might occur acted as a barrier to further development in the coastal region. Thus, without addressing erosion, future economic resources were imperiled. Finally, and crucially, the Board contended that while there had been a decades long trend of erosion along the New Jersey coastline, there was not evidence that this trend was permanent. Thus, the Board answered the question of where there "have been changes in the conditions that are trending to erode the coast either along its length or locally?" by stating:

> "In so far as can be seen we have no evidence of such changes if we consider the word change to mean a definite and permanent transition from one state to another state to another, traceable to some clearly defined cause. We do have ample evidence of what may be called fluctuations, that is, changes in the rate of progress of erosion or accretion, erosion going on at some point for a greater or less time and then seeming to be followed by accretion,

> changes in the rate of inlet movements, etc. These fluctuations, however, should be attributed to variations in the attacking forces and to the resistance encountered at the point of contact rather than to any permanent change in the conditions producing erosion" (NJBOCN 1922, p. 14).

Thus, the Board of Commerce and Navigation deployed three arguments about uncertainty in order to make the case for increased state involvement in erosion management along the New Jersey coast. First, there was uncertainty in where and when erosion could happen and that "unfortunately the ocean does not always select the least valuable points for her attack" (NJBOCN 1922, p. 5). Second, uncertainty about coastal erosion would reduce development along the New Jersey coast because private actors would not want to invest in projects that could be washed away by the ocean. Third, uncertain 'fluctuations' between erosion and accretion meant that it was feasible that erosion was not a permanent trend; rather, it was possibly part of a long-term cycle between erosion and accretion—even if there was little evidence of accretion ever being widespread in the human history of the New Jersey coast.

Arguably, without these three uncertainties, the Board would have had more difficulties in convincing the state government to become involved in erosion management. If it was possible to predict where erosion was to occur, then it would also be possible to prioritize development in areas less prone to erosion. If private development were not hindered by uncertainties about erosion, then the state did not need to worry about lost tax revenue. If erosion was a permanent trend and not part of uncertain fluctuations between erosion and accretion, then the state government might be skeptical about the long-term viability of addressing problems of erosion. In other words, the Board made the argument that uncertainty made erosion a real problem, but also that uncertainty meant that it might not be a permanent problem.

The burgeoning value of coastal property justified the state taking action to mitigate erosion along the coast. In transmitting the report to the New Jersey legislature, Robert F. Engle (NJBOCN 1922) began with an economic argument. He pointed out that from 1899 to 1922 that total assessed value of property along of coastal property grew from fifty-five million dollars to more than three hundred million dollars. This increase of 425% exceeded the state's total rise of property value, which stood at 310%. Ultimately, the powerful and destructive force of the ocean threatened "invested capital in seashore property" and, therefore, it was "of prime importance to protect this valuable contribution to the State's growth" (NJBOCN 1922, p. 5).

Two years later, the NJBOCN (1944) provided a more detailed breakdown of the economic importance of coastal development to the state by creating a municipality-by-municipality description of erosion alongside the total taxable valuation of property in each location. Table 4 provides a summary of the report's findings regarding the population of each municipality, the valuation of taxable assets, and relevant quotes. Notably, while the NJBOCN estimated that there were $372,367,868 in taxable assets along the coast, the four municipalities on Absecon Island account for $225,593,253 of that sum—with Atlantic City being home to just under two hundred million of that valuation. Moreover, nearly half of all people living in the thirty-nine different ocean-fronting municipalities lived in Atlantic City. In contrast, the two original coastal resort communities—Long Branch and, especially, Cape May City—had declined in economic importance. Long Branch remained one of the more populous municipalities, though it was beginning to be eclipsed by the recently developed nearby Asbury Park. The economic valuation of Cape May City, though, had clearly fallen behind the nearby Wildwoods. It is also interesting to observe how economically unimportant the municipalities on Long Beach Island were to the population and economic valuation of the shore region. In total, only 612 people lived on Long

Beach Island at the time—with a total net valuation of less than three million dollars. Finally, it is worth pointing out that the NJBOCN chided municipalities for destroying dunes and building too close to the ocean. For instance, in the case of Mantoloking Borough, the NJBOCN dryly states “we shall watch with interest the result of the removal of these splendid protections against the sea” (p. 43). More drastically, the NJBOCN goes as far as to state that Ocean City ought not receive assistance for potential coastal erosion in light of the municipality’s widespread levelling of dunes “since the municipality is wealthy enough to provide adequate works and has the examples of loss in other municipalities in the comparatively recent past” (p. 45). In other words, it was already clear to the state government that destroying dunes was a short-sighted decision.

Table 4 Summary of report findings

Municipality	Population	Net valuation taxable (not adjusted for inflation)	Ocean frontage (miles)	Quotes from report
Sea Bright Borough	856	$1,641,893.00	n/a	"The attacks it has received from the sea have been more severe than on any other section of the State" (p. 22)
Monmouth Beach Borough	410	$1,577,904.00	1.5	"It has a high degree of exposure and has also suffered greatly although since the beach is much wider than at Sea Bright it has not been threatened with breaching. But here, as in other ocean-front municipalities, the residents built up and improved their waterfront to the farthest possible limit, and as a result great losses occurred during the severe storms of 1913-1914" (p. 22). "In 1924 the State Legislature voted to Monmouth Beach a grant of twenty-five thousand dollars to aide in providing protection" (p. 24).
City of Long Branch	13526	$17,619,375.00	5	"The shore line has receded greatly, and apparently the process has been continuous since early times…The State in 1922 appropriated a grant of $25,000 to aid Long Branch in providing coast protection" (p. 27)
Deal Borough	420	$7,030,246.00	1.5	"Recession [of the beach] has been considerable since 1839, though of course not excessive since property owners have undertaken protection measures. Nevertheless, the tendency has been unfavorable and the State in 1924 appropriated a grant of $8,000.00" (p. 28).
Allenhurst Borough	343	$3,431,285.00	0.5	"The tendency here has been unfavorable…During the construction of the large breakwater by Asbury Park City, considerable erosion took place immediately north of the jetty, that is in Allenhurst and Loch Arbour, and to combat this condition quantities
City of Asbury Park	12400	$18,560,313.00	1	"Although considerable erosion is indicated by the maps of 1839, erosion has not been severe for at least twenty-five years along this frontage…The 1922 Legislature voted an appropriation of $25,000.00 to aid Asbury Park in protecting its beach." (29).
Neptune Township (Ocean Grove)	6470	$10,474,453.00	1	"The preservation of its beach has never been precarious so far as is known" (p. 36)

Bradley Beach	2307	$4,271,720.00	0.75	"There has been considerable recession since 1863 and the tendency, though not rapid, has continued since the riparian surveys of 1883 and 1839" (p. 36)
Avon Borough	647	$2,333,650.00	n/a	"In January 1924, the sea broke through the north jetty…This north jetty was severely damaged as a result of a storm in the middle of January 1924, a large section near the inshore end toppling outward into the channel, and endangering the new Ocean Boulevard bridge constructed by Monmouth County...The Legislature appropriated the sum estimate, $55,000.00, which became available July 1924 (p. 36).
Belmar Borough	1987	$5,403,894.00	n/a	"Erosion of the beach is causing Belmar considerable loses each year, which are caused chiefly by the undermining of the gravel surfaced shoulders of the roadway. Occasionally slabs of the concrete roadway are undermined also" (p. 39).
Spring Lake Borough	1009	$4,586,219.00	2.5	"The Legislature in 1920 appropriated a grant of $20,000.00 to aide Spring Lake in coast protection devices" (p. 39).
Sea Girt Borough	110	$1,275,068.00	1.5	"The maps indicate that considerable erosion has occurred since 1839, but comparatively little change is indicated for a considerable number of years prior to 1920" (p. 39)
Manasquan Borough	1705	$1,930,920.00	1	
Point Pleasant Beach Borough	1575	$2,071,123.00	2	"It has not been found necessary as yet to construct any coast protection works of any importance" (p. 43)
Bay Head Borough	273	$1,353,261.00	1	"A number of timber groyes have been constructed here and for years past have given good satisfaction" (p. 43).
Mantoloking Borough	37	$369,835.00	2.5	"The entire strip of beach between Bay Head and Mantoloking is very rapidly being built up. In operation, as in other places along our beaches, sand dunes are being levelled and we shall watch with interest the result of the removal of these splendid natural protections against the sea" (43).
Brick Township	273	$459,091.00	1	
Dover Township	2198	$2,713,077.00	1.75	
Lavallette Borough	117	$438,077.00	1.25	"It is in this vicinity that the old inlet known as Cranberry Inlet pierced the beach in the 1700s" (p. 43)
Seaside Heights Borough	154	$753,457.00	0.75	
Seaside Park Borough	179	$1,173,020.00	2	
Barnegat City Borough	69	$115,292.00	2	"Barnegat City, on the south point of Barnegat Inlet, is the site of the Barnegat Lighthouse, for the preservation of which this Board has made strong pleas" (p. 43-4).
Harvey Cedars Borough	65	$124,153.00	2	
Surf City Borough	43	$105,008.00	1.5	
Long Beach Township	106	$1,329,757.00	n/a	
Beach Haven Borough	329	$1,290,757.00	n/a	
Brigantine Borough	12	$916,025.00	n/a	"A company is now engaged in developing portions of this beach, their first move being the undertaking of the construction of a highway bridge from Atlantic City. This work is well advanced. Coast protection problems will therefore have more interest than has hitherto the case" (p. 44).

City of Atlantic City	50707	$196,554,799.00	3.5	"No loses from the ocean have occurred for many years in which respect Atlantic City is highly fortunate" (p. 44).
Ventnor City	2193	$21,666,760.00	1.75	"Conditions on the Ventnor ocean front are well in hand" (p. 44)
Margate City	249	$6,502,208.00	1.75	"Conditions at Margate are highly favorable" (p. 44)
Longport Borough	100	$869,486.00	2	"It is highly probable that adequate and permanent protection of Longport will require heavy works at the lower
Ocean City	2512	$22,002,119.00	7.75	"It was practically uninhabited in 1880…Real estate development has been very active for the past two years on the north point of Ocean City and this has resulted in the levelling and grading of the dunes in addition to the dredging of vast quantities of sand from Great Egg Harbor Bay for grading purposes. The question of erosion or accretion of this north point will be of greatly increased interest hereafter in view of the construction of roads and dwellings and the advance in the land values. It is hoped that the levelling of the dunes will not be accompanied by unfavorable tendencies toward erosion. There would be scant excuse for Ocean City's permitting any serious erosion should that tendency develop since the municipality is wealthy enough to provide adequate works and has the example of loss in other municipalities in the comparatively recent past" (p. 45)
Sea Isle City	564	$1,900,888.00	6	
Avalon Borough	197	$1,702,600.00	n/a	
Stone Harbor Borough	159	$1,941,665.00	3	
North Wildwood City	807	$3,888,455.00	1.5	
Wildwood City	2790	$12,025,555.00	1	
Wildwood Crest Borough	161	$2,554,619.00	2.5	"Portions of this beach have been subject to erosion in the past, but conditions for several years have been favorable" (p. 46).
Cape May City	2999	$7,409,841.00	3.5	
Total	111058	$372,367,868.00		
Total on Absecon Island	53249	$225,593,253.00		
Total on Long Beach Island	612	$2,964,967.00		
Data collected from NJBOCN 1924				

Table 4. Summary of the Board of Commerce and Navigation's survey

In response to these studies, New Jersey politicians began to take more interest in coastal engineering. In the decades after the Board of Commerce and Navigation completed its study of erosion, the state government of New Jersey began to invest more in projects aiming to combat beach erosion.

The effects of this process did not stay confined to New Jersey. In 1926, New Jersey Governor A. Harry Moore along with J. Spencer Smith, who was president of the New Jersey Board of Navigation and Commerce, and the National Research Council in Washington D.C. organized a meeting in Asbury Park of Atlantic and Gulf Coast governors (Quinn 1977). Eighty-five delegates from sixteen states participated in the meeting. The immediate outcome of this meeting was the formation of the American Shore and Beach Preservation Association (ASBPA)—an organization dedicated to catalyzing the protection of beaches (Pilkey and Dixon 1994; Quinn 1977). J. Spencer Smith, who led the New Jersey State Board of Commerce and Navigation, became the first president of ASBPA—a position he retained until his death in 1953 (Quinn 1977). Initially, the ASBPA argued that addressing beach erosion should be the responsibility of state governments; however, within a few years, it began to lobby for federal involvement (Quinn 1977).

Securing federal involvement proved significantly more difficult than convincing the state government of New Jersey to get involved in coastal management. It was not until the 1950s that the federal government—through the Army Corps of Engineers—became a full partner in designing, building, and maintaining coastal infrastructure projects (Pilkey and Dixon 1994; Quinn 1977). The main sticking point for Congress and the Army Corps of Engineers was the perception that individual property owners would be the primary beneficiaries of engineering projects seeking to arrest coastal erosion (Quinn 1997). For instance, Quinn (1977, p. 37) quotes Colonel Earl I. Brown a member of the Army Corps of Engineers' Beach Erosion Board as arguing in 1936 that:

> "He [the business owner] has deliberately placed his structure in a dangerous location near the sea, with a view to seeking the profits to be derived from the facilities which he affords to the seacoast

> visitors, that is, he deliberatively chooses a location to exploit the visitors and if he has made a bad choice, he should not expect those visitors to be taxed to save him from his dilemma."

This reflects the broader view at the time that largescale governmental projects ought to have broader societal benefits. Thus, irrigation projects in the West and flood control along the Mississippi River were seen as worthwhile because the benefits were spread more broadly throughout society; whereas interventions to address beach erosion typically benefited the property owners directly affected by erosion (Quinn 1977).

A decade later, a very different argument based upon the fairness of federal spending was made. J. Spencer Smith of the ASBPA and New Jersey Board of Navigation and Commerce remarked in 1946 that: "what's hard for me to reconcile is the fact we are willing to spend…a great deal of money on flood and soil and irrigation purposes and yet we hesitate to authorize the Congress to appropriate money for the protection of beaches" (quoted in Quinn 1977, p. 5). In response to this, Thorndike Saville—a member of the Beach Erosion Board since its creation—went even further to point out what he saw as the deep unfairness of the lack of federal spending on coastal erosion. After pointing out that the federal government had spent more than two billion over five years on irrigation and inland flood control, he stated:

> "But from the standpoint of logic it never seemed sensible to me to adopt policies reflecting enormous expenditures, running up to up to $2,500,000,000 over the next five years, when a majority of that cost, probably a pretty big majority, upwards of 70 percent I would guess, is going to be paid for by the taxes of the coastal states—New York and the other eastern coastal states, plus California…The coastal states do put up very large amounts of money for Federal construction programs in the water field, that by and large they do not benefit proportionately from these moneys, and therefore it is logical that the Government should adopt a policy which would enable such states to secure some of their tax

> money in the form of Federal structures to protect the coast line" (quoted in Quinn 1977, p. 50).

Thus, the argument regarding taxes was turned on its head. Rather than focusing primarily on who benefits from governmental spending, Saville highlighted the question of who is paying for such spending. Coastal states, in Saville's framing, logically deserved federal support in their efforts to address coastal erosion because those states were the most significant source of tax revenue.

With this newfound support from the Army Corps of Engineers, elected officials from New Jersey began to craft legislation that would provide federal funding for beach erosion control projects (Pilkey and Dixon 1994; Quinn 1977). In 1946, Congress passed Public Law 727, which authorized the federal government to fund up to one-third of the costs of erosion-control projects as long as they were on public land (Pilkey and Dixon 1994; Quinn 1997). This marked the first instance in which federal spending became available on a widespread basis for addressing coastal erosion (Pilkey and Dixon 1994).

3.5—The Great Acceleration and the Jersey Shore: The rise of the automobile and suburban sprawl post-1950

After the conclusion of World War II, a variety of forces intersected to further transform the shore region. Powerful machines developed during the war years to move vast quantities of material opened up new possibilities for altering the landscape. The growing accessibility of the personal automobile along with the creation of new limited access highways allowed for more people to visit the shore during the summer months. By the 1960s, people were increasingly making the shore region their year-round residence. These developments, though, were challenged by natural forces. Powerful storms and coastal erosion once more threatened the

newly built residences and infrastructure. Yet, as will be documented, both the federal and state government were now fully committed to protecting coastal development.

3.5.1—The Parkway and the Suburbs

Once more, investment in transportation infrastructure fundamentally changed life in the New Jersey shore region. In the mid-twentieth century, the state government began to plan and fund massive highway projects. The Garden State Parkway was imagined in the early 1940s as facilitating tourist travel from northern New Jersey and the New York City metro region to shore resorts (Mazzagetti 2018; Spies 2004). Construction began in 1947 in Union County, however only twenty-two miles were constructed by 1950 largely due to a lack of funds (Spies 2004). To facilitate the completion of the Parkway—as well as the New Jersey Turnpike that would connect the Philadelphia and New York City areas (Gillespie 2004)—the state legislature created in 1952 the New Jersey Highway Authority (Spies 2004). By creating highway bonds that would be paid off through future toll revenue, the New Jersey Highway Authority was able to complete both the Parkway and Turnpike—and later the Atlantic City Expressway—with no tax-payer funding (Gillespie 2004; Spies 2004). The final twenty-seven miles of the one-hundred seventy-three-mile-long Parkway was completed in 1953.

The impact was immediate. Dorwart (1992, p. 235) explains that for the formerly struggling resort communities of Cape May County, the opening of the Parkway "brought hundreds of thousands of newcomers, many from northern New Jersey and New York, into the county for vacations. The county felt the impact at once as the weekend of July 4th 1955 brought all-time record crowds to the Jersey Cape resort. Every barrier island street was filled with bumper-to-bumper traffic. A mile-long bottleneck developed at the end of the parkway as tourists waited to cross the narrow bridge over the canal to Cape May City." The dramatic increase in summer

tourists was not limited to Cape May County; every shore county saw a significant rise in visitors once the Parkway reached them (Mazzagetti 2018; Simon 2004). In Asbury Park, every parking spot was occupied the day after the Parkway connected to the resort (Wolff 2005). According to Mazzagetti (2018, p. 263) the "tax ratables in towns along the Parkway (including the northern counties) jumped $300 million within twelve months of its completion and retail sales in all the shore counties boomed."

The Parkway contributed to two unexpected outcomes. First, the decline of Atlantic City, Asbury Park, and Long Branch as popular resort destinations. Second, the rapid suburbanization of the region. In some ways, these changes are interrelated. Atlantic City, Asbury Park, and Long Branch represented the most densely populated areas in the shore region and had the greatest concentration of Black residents (Hodges 2018; Simon 2004; Wolff 2006). A number of reasons have been suggested for why resorts like Atlantic City began to decline in the late 1950s—including air travel, backyard swimming pools, and air conditioning—but, as Simon (2004) points out, none of those developments explain why other New Jersey shore resorts thrived while Atlantic City struggled. Instead, Simon (2004, p. 112) argues that the "flight from Atlantic City was, more accurately, part of another flight pattern, the one that swept the white middle class from the cities to the suburbs, from the downtown movie palaces to the drive-ins, and from urban amusement parks to the tightly controlled worlds of Disneyland and its imitators." Once more, technology and racism combined to alter the social and material fabric of the New Jersey shore region.

Residential development was swift and largely unchecked. According to Mazzagetti (2018) between 1950 and 1960, thirty-five of thirty-eight oceanfront municipalities increased their year-round population. In Cape May County, every municipality with the exception of Wildwood and

North Wildwood grew by at least 25% (Mazzagetti 2018, p. 263). Further supporting Wilson's argument that white flight and not technological change contributed to the decline of Atlantic City, each of the neighboring municipalities grew in population as it shrank: "Margate doubled, Brigantine more than doubled, and Longport's population grew by 74 percent" (Mazzagetti 2018, p. 264). Thus, a strong desire existed to live on Absecon Island—just not in the more racially diverse Atlantic City.

After 1960, residential development continued to accelerate and transform the region. Between 1950 and 1970, Ocean County was the fastest growing county in New Jersey—with the total population increasing from 56,622 to 208,470. By the mid-1970s, the most densely developed land areas in Ocean County were barrier islands (New Jersey Department of Community Affairs 1977).

The population growth in the shore counties did cause some concerns for governmental agencies and planners. For instance, the New Jersey Department of Community Affairs (NJDCA) warned in 1977 of the lack of employment opportunities in Ocean County for residents moving there, which was leading to a high proportion of commuters as well as a worse than average unemployment rate (NJDCA 1977). The NJDCA (1977, p. 16) cautioned that if the commuting population continued to grow, then new highways would be needed—leading to "more air pollution and also higher levels of noise in the area" as well as turn valuable open space into roads. Moreover, they highlighted the possibility that as more roads and highways were constructed that "the area may become increasingly attractive to potential residents" and thereby create a reinforcing cycle where there are more commuters and the need to create more roadways (NJDCA 1977, p. 16). Thus, for the NJDCA, it was important to support the creation of local, year-round economic opportunities in Ocean County.

At the same time, the New Jersey Department of Environmental Protection (NJDEP) warned of the ongoing loss of cultural resources in the shore region. In a 1976 report, the NJDEP point out that suburbanization had "resulted in a new breed of resident, the commuter"—few of which who "earn[ed] their livelihood from the traditional trades of the shore, fishing, boatbuilding, and the multifaceted resort industry" (NJDEP 1976, p. 14). The DEP (1976) lamented the rise of "filleted, frozen fish in supermarkets" (p. 15), "mass produced fiberglass boats" (p. 16), and "mass transportation" that replaced travel by boat, which had given travelers "a maritime awareness" (p. 18). To preserve cultural resources, the NJDEP suggested placing sites in the New Jersey Register of Historical Places as well as acquiring historic areas through the Green Acres Program.

Concerns about job growth and coastal heritage emerged in large part due to the unplanned nature of development in the shore region. The Parkway had been envisioned as largely carrying vacationers to shore resorts—not opening it up to residential development (Cunningham 1958). This unexpected consequence contributed to another outcome, which had national repercussions: increasing the involvement of the federal government in coastal management. As more and more residents flocked to the New Jersey shore region, more important tax revenue was placed in hazardous areas. The first significant consequence of this occurred less than a decade after the Parkway opened.

3.5.2—The Ash Wednesday Storm of 1962 and the Entrenchment of Coastal Development

The Ash Wednesday Storm of 1962 caused significant damage from northern Florida to southern Massachusetts (Pilkey and Dixon 1994; Quinn 1977). The 1962 storm was a nor'easter that brought high wind, powerful waves, and significant ice and snow to the Atlantic Coast (Mazzagetti 2018). What contributed most to the storm's destructive results was a high-pressure

system from the north that hindered its course, which both slowed its movement and elongated its shape (Quinn 1977). Because of this, the storm lasted through four tidal cycles during which five high tides occurred—including a perigee springtide (Quinn 1977). While six states were declared disaster zones after the storm, New Jersey stood out as being particularly devastated (Pilkey and Dixon 1994). Forty-five thousand residences along with two thousand businesses sustained damage during the storm in New Jersey with an estimated one-hundred and three million dollars (in 1962 dollars) of damages (Pilkey et al. 1986) and thirty-two fatalities (Mazzagetti 2018). In the mid-1980s, Pilkey and colleagues estimated that if a storm of similar magnitude would occur again it would cause more than a billion dollars in damage (Pilkey et al. 1986, p. 43). In response to the damage along the Atlantic coast in general and to New Jersey in particular, the United States Congress authorized the Army Corps of Engineers to begin beach nourishment projects (Pilkey and Dixon 1994).

Beach nourishment or beach replenishment emerged as a new strategy for maintaining shorelines after World War II (Pilkey and Dixon 1994; Psulty and Ofiara 2004; Quinn 1977) and involves the periodic placement of sand onto an eroding beach (Pilkey and Dixon 1994). As an alternative to structural solutions, beach nourishment is frequently referred to as a soft solution that takes advantage of beaches' natural ability to dissipate the force of waves (Psulty and Ofiara 2004; Quinn 1977). The idea of beach nourishment as an alternative technique for addressing erosion first emerged in the early 20th century, but it was only after technological advancements made during World War II created machines capable of moving vast amounts of material to alter landscapes that it became a viable management technique (Quinn 1977). Once the technical hurdle was overcome, there was still a regulatory one preventing beach nourishment—it was considered a form of 'maintenance' rather than 'construction' and therefore ineligible for federal

funding (Quinn 1977). This changed in 1956 with the passing of Public Law 727, which authorized the federal government to pay for up to one-third of beach nourishment projects (Quinn 1977).

Immediately after the storm subsided, residents along the New Jersey coast began rebuilding. Even on the devastated Long Beach Island—where a sixty feet wide and twenty feet deep breach was opened up that connected the ocean to the bay—recovery efforts stated as soon as the storm ended. Residents of the island began work to close the breach by pumping sand into it and by the first Saturday after the storm, the Army Corps of Engineers arrived to finish the job (Mazzagetti 2018). Indeed, a major consequence of the Ash Wednesday Storm was that the federal government became more involved in coastal engineering (Pilkey and Dixon 1994; Quinn 1977). The Army Corps of Engineers began a widespread beach nourishment effort along nearly the entirety of the Atlantic Coast (Quinn 1977). In New Jersey alone, more than twelve million cubic feet of sand was pumped onto beaches in just two years (Mazzagetti 2018; Psulty and Ofiara 2004).

Soon after the Ash Wednesday Storm, the United States Congress passed another law altering the relationship between the federal government and coastal management. Public Law 874 was passed in August of 1962 and increased the proportion of costs the federal government would pay on the construction costs of projects to up to fifty percent on private property and seventy percent on public property (Quinn 1977). However, the law also sought to discourage the construction of housing and other development near the coastline by requiring any funded project on public property to include a buffer zone that would protect natural resources and reduce damage from storms and floods—as approved by the Army Corps of Engineers (Quinn 1977).

The Ash Wednesday Storm of 1962 occurred at the confluence of multiple developments. The Garden State Parkway and the prevalence of affordable automobiles opened up the shore region to rapid suburban development—especially on barrier islands. After decades of cajoling from New Jersey politicians, the federal government and the U.S. Army Corps of Engineers were active players in coastal engineering. New technologies developed during World War II allowed for the movement of vast amounts of material. With more people living in the coastal zone, a federal government now willing to be a full partner in coastal management, and new technology that allowed for rapid and extensive response to disaster, the storm of 1962 occurred at a point in which cultural, political, and technology change created the possibility for widespread and well-coordinated recovery. Indeed, one of the key qualities of the storm is how quickly it faded from public consciousness. Two decades later, the NJDEP (1981, p. 41) wrote that: "Unfortunately, the devastation of the March 1962 storm was soon forgotten, and population and development have continued to increase in shore areas, more of it within actual overwash zones of the storm. Since present population and development levels of the State's barrier islands exceed pre-1962 levels, future severe storms will undoubtably result in far heavier tolls in lives, injuries, and property damage."

The 1962 storm was also a seminal event in the academic study of hazards. In the aftermath of the storm, the human geographers Robert Kates and Ian Burton—who had both recently completed their doctoral studies at the University of Chicago under the tutelage of Gilbert White—along with the physical geographer Rodman Snead conducted surveys of impacted communities along with analysis of aerial pre- and post-storm coastlines (Burton et al. 1969). As they highlight, before their study there had been no real analysis of coastal hazards; instead, focus had been placed upon inland floodplains. Moreover, they wrote that Kates and Burton had

"been involved in these flood-plain studies and were already engaged in armchair speculations about an extension to other natural hazards when the storm of March 1962 gave the necessary impetus for action" (Burton et al. 1969, p. 5). Not only, then, did the Ash Wednesday Storm act as a catalyst of increased federal involvement in addressing coastal erosion, it also marked the beginnings of the academic analysis of coastal hazards in the United States.

In light of the federal government's increasing role in coastal management as well as continuing development along the nation's coasts, Congress passed the Coastal Zone Management Act (CZMA) in 1972 (Psulty and Ofiara 2004). The CZMA created a set of incentives to facilitate state- and local-level management of coastal erosion and hazards along with better coordination with federal authorities (Psulty and Ofiara 2004). As a voluntary initiative, the federal government offered various grants and assistance to states that designed and implemented their own coastal zone management plan. So, while states had to meet particular conditions to receive support, the law did not mandate any particular actions be taken. It was up to individual states whether or not to participate. In other words, the CZMA departed from other significant federal environmental legislation passed during the same period—such as the Clean Air Act, Clean Water Act, and Endangered Species Act—that mandated particular actions and results and included penalties for failing to comply.

3.5.3—The Institutionalization of Coastal Zone Management in New Jersey: Innovation and Inertia

Around the same time that the CZMA was passed, the New Jersey state government began to also institutionalize environmental management. On the first Earth Day in 1970, the New Jersey legislature formed the Department of Environmental Protection (NJDEP)—becoming only the third state to create a unified agency to address environmental issues (Belton 2010). The NJDEP

also predates the federal Environmental Protection Agency, which was created during the fall of 1970. Further, in 1970, the state passed the Wetlands Act, which both authorized an inventory and mapping of tidal wetlands and gave the NJDEP jurisdiction over all activities that occur on regulated wetlands (NJDEP 1977). With the passage of this law, the practice of filling in and building on coastal wetlands in the state was ended.

In 1973, the New Jersey legislature passed the Coastal Facilities Review Act (CAFRA). CAFRA gave the recently created NJDEP significant regulatory power over large-scale development in the state's coastal areas—which consist of 1,376 square miles or nearly 20% of the state's area. CAFRA required developers to receive a permit from the NJDEP before constructing industrial facilities (such as power plants, chemical production, mineral processing, and waste incinerators), any housing or public facility with more than twenty-five units, roads and sewerage lines of more than 1,200 linear feet, or commercial facilities with 100-or-more parking spots (NJDEP 1976). To receive a permit, not only did a project need to meet all environmental standards with regards to air and water pollution but also minimally impact ecological processes, not endanger human life or property, create minimal practicable degradation of unique landforms and/or historical sites, and not deplete aquifers (NJDEP 1976). Moreover, even if a development met all of those conditions, the act gave the NJDEP director the authority to deny any proposal if they came to conclusion that it violated the intent of CAFRA (NJDEP 1976).

One of the first major actions taken as part of the implementation of CAFRA was an inventory of the entire coastal area of New Jersey. The NJDEP received funding through the CZMA to conduct this study because the inventory also had the purpose of informing the creation of a broader coastal zone management plan that would allow the state to cooperate with, and receive additional funding from, the federal government (NJDEP 1975). The inventory found that around

seven hundred thousand people lived in the areas regulated by CAFRA—which represented almost 10% of the state's population (NJDEP 1975). Moreover, the inventory also found that year-round population was increasing rapidly. More than half of all residential construction in the early 1970s occurred there (NJDEP 1975). Thus, the inventory occurred at a time in which the areas regulated by CAFRA had a lower population density than the state as a whole but development trends pointed towards that pattern changing. Indeed, the inventory documented the ongoing environmental degradation of the region, such as a quarter of estuarine waters suitable for shellfish harvesting being restricted or condemned due to high bacteria counts, a quarter of tidal wetlands having already been destroyed in the 1950s and 1960s before the Wetlands Act, half of the state's dunes needing to be repaired, and a significant problem of saltwater intrusion in drinking water (NJDEP 1975). In short, the NJDEP found that the cumulative impacts of development were beginning to cause significant environmental damage.

In light of these challenges of accelerating growth and environmental degradation, the NJDEP (1975, p. 16) stressed that CAFRA charged it "with striking a sensitive balance between environmental protection and economic development." This framing of 'striking a balance' configures environmental integrity and economic growth as being, at least partially, in opposition to one another. Thus, early in the instantiation of state-level coastal management, a sociotechnical imaginary can be found that situates the role of regulation and technical interventions as dealing with trade-offs between economic goals and ecological vibrancy. Rather than seek to craft economic models that do not lead to ecological degradation, the NJDEP followed a vision in which economic growth unavoidably entailed ecological decline and environmental protection meant economic costs. Managing these imagined trade-offs became the mission of coastal management. Indeed, in his letter of transmission of the report to Governor

Byrne, NJDEP Commissioner framed this task with language that foreshadows later discourses of sustainable development: “the New Jersey coast must meet the diverse needs of the present, but the irreplaceable qualities of the coastal environment must also be protected for future generations” (NJDEP 1975, p. ii).

As the next step towards fully participating in the CZMA’s voluntary Coastal Management Program, the NJDEP (1978) created a report entitled *The New Jersey Coastal Management Program—Bay and Ocean Shore Segment* for the National Oceanic and Atmospheric Administration (NOAA). The report laid out the state’s vision for the coastal zone; important challenges facing effective coastal management; and policy and regulatory tools for managing coastal issues (NJDEP 1978). To participate in the CZMA, NOAA needed to approve the vision and strategy laid out in the report. The vision the report described for the future of the shore region was one in which new housing and industry was concentrated in areas that had already experienced development:

> “New developments will be heavily concentrated in, or immediately adjacent to, existing development areas. Recreation and tourism will continue to be the largest industry in the coastal zone, and will perhaps expand as a result of development in Atlantic City. Other urban areas in the coastal zone may be revitalized as well, as a result of efforts to concentrate new construction, to develop urban waterfronts, and to encourage expansion of recreational activities in urban areas…The ocean waterfront from Sandy Hook to Cape May will be devoted almost exclusively to recreation and commercial fishing…Inland areas of the coastal zone nearest the ocean will continue to provide housing and commercial services for seasonal and year round residents…As this program is implemented and this vision becomes reality, some positive results will be immediately and directly visible, such as the halt in the indiscriminate high-rise construction along the Atlantic Ocean shoreline” (NJDEP 1978, p. 21).

To achieve this vision, the NJDEP (1978, p. 12-13) laid out three basic elements of its management program. The first was the boundary defining the spatial scope of the program, which was based largely upon the landward extent of tidal waters. The second element was the collection of policies, standards, and regulations that determine the actions that take place within the boundary. The final element included the decision-making processes and management systems that were used to evaluate and enforce standards and policies in the boundary zone. The report compared these three basic elements as a tripod in which "all three legs, or elements, must be firmly in place for the Program to stand and work" (NJDEP 1978, p. 12-13).

The report presented four "basic policies" to be used within state-level management the coastal zone (NJDEP 1978, p. 25-26). First, it would be the state's policy to protect coastal ecosystems under the argument that such natural features were fundamental to the region being a desirable place to live and visit as well as provided economically important benefits for commercial fisheries and agriculture. Second, the state aimed to concentrate new development into areas that already had residential, industrial, commercial, and resort development. As part of this policy, the state sought to preserve open space. Third, the state would develop and employ a new decision-making framework that took in consideration both the advantages and disadvantages different locations offered for new development. In particular, the report stated that it would seek to consider factors such as a site being near existing roads and infrastructure, which would contribute to less environmental disturbance. Finally, it would be the policy of the state to protect human health, safety, and welfare of the people that lived, worked, and visited the coastal zone.

To implement these policies and make concrete decisions, the report highlighted both the previously described CAFRA and the Wetlands Act as well as the state's Shore Protection Program, which was created in 1977 to provide funding for coastal erosion projects, as being the

core of the state's decision-making process (NJDEP 1978, p. 170). Additionally, the NJDEP stressed the importance of municipal and county governments, which would have significant control over zoning and land-use regulations at the local level (NJDEP 1978, p. 176).

Ultimately, NOAA did approve *The New Jersey Coastal Management Program—Bay and Ocean Shore Segment*, which allowed the state government to begin working on a final coastal management plan. However, it did raise concerns that CAFRA did not regulate small-scale development (NJDEP 1981a). NOAA was not alone in voicing this concern. Organizations as diverse as the Sierra Club, Monmouth County Planning Board, Cape May County Planning Board, New Jersey Department of Community Affairs, the U.S. Department of the Interior, and the U.S. Environmental Protection Agency all raised the issue of the cumulative impacts of small development in the New Jersey coastal area (NJDEP 1981a). The NJDEP (1981a, p. 2) found that between 1972 and 1978 "an increasing number of residential projects in the Bay and Ocean Shore area have been built below the CAFRA statutory threshold of 25 dwelling units. In addition, significant non-residential development, particularly small-scale commercial development, has taken place in the CAFRA area that is not subject to direct state coastal regulation." In many cases, developers decided to either simply scale down development projects—often to be just under the regulator threshold—or even use the threat of downscaling to get approval. For instance, the NJDEP (1981a, p. 4) acknowledged that in one case it had denied a developer a permit for a project, but then approved a slightly revised application "due in part to the developer's threat to revise the site plan to build less than 25 units"—which "would have truly marred the landscape." The problem of cumulative impacts from small scale development was exacerbated in large part because municipal government interests were oriented towards

increasing property tax rates—a priority that the NJDEP (1981a, p. 4) argued "can produce strong pressure at the local level to act contrary to regional or long-term interests."

When the state finalized its *Shore Protection Master Plan* in 1981, the NJDEP still noted that CAFRA and other state regulations "do not regulate the construction of most homes" but that that problem had "been the subject of several proposed pieces of legislation in the last two years" (NJDEP 1981b, p. 2). Without such legislative changes, the NJDEP would continue to be unable to regulate the increasingly prevalent small-scale development occurring in the shore region. Thus, in setting out the goal of the Master Plan, the NJDEP (1981b, p. 1) stated it was "intended to represent a more cohesive and comprehensive approach to the problem of shore protection use by the State, and hopefully other levels of government as well." With almost four decades of hindsight, it is difficult to not focus on the word 'hopefully' in that sentence.

The long-identified flaw of CAFRA was never fully addressed and small-scale development continued with minimal state review. An investigation in the early 1990s found that only four hundred sixty-seven out of nearly thirty-five hundred dwelling units constructed in Cape May County from 1984 to 1991 had been reviewed under CAFRA (Dorwart 1992). The rest—nearly three thousand units—had been too small meet the threshold for review. Such a pattern can be found along the entirety of the coast (Bates 2016). Thus, in the years immediately following the approval and implementation of the *New Jersey Shore Protection Master Plan*, few changes in development patterns occurred.

That is not to say that nothing changed. State and federal funding for beach nourishment projects has dramatically increased in the past three decades (Nordstrom 2003; Pilkey and Cooper 2016; Psuty and Ofiara 2004). While most—about eighty percent—of the New Jersey coastline does have stabilization structures (Psulty and Ofiara 2004, p. 159), beach nourishment became a

constant process along the coast during the 1980s and 1990s (Psulty and Ofiara 2004, p. 178). Frequently, these efforts fall short of expectations. For instance, in 1982 five million dollars was spent in Ocean City on a beach nourishment project that completely washed away in less than three months (Pilkey and Dixon 1994). While this is an extreme example, most nourishment projects typically last less than five years (Pilkey and Dixon 1994; Psulty and Ofiara 2004). Recent analysis by the Coastal Research Center at Stockton University estimates that more than a billion dollars has been spent in New Jersey on beach nourishment projects since 1986.

One reason for the prevalence of beach nourishment is that the federal government covers sixty-five percent of the costs of such projects (Psulty and Ofiara 2004). However, by the early 1990s, even with the federal government covering the nearly two-thirds of the cost of beach nourishment projects, local governments began struggling to pay the ongoing costs of maintaining beaches. To remedy this, the state created in 1991 a 'Shore Protection Fund' that initially provided fifteen million dollars a year to fund beach protection—a sum that was later increased to twenty-five million dollars (Psulty and Ofiara 2004). Thus, while municipal governments do need to compete for funding, they generally do not need cover much of the costs of beach nourishment projects.

Sea Bright is home to perhaps the most ambitious beach nourishment project. Located at the very northern end of the coastline, Sea Bright is located on a narrow sand spit bordered by the Atlantic Ocean and the Navesink River (see figure 4). In 1905, a railroad company built a seawall along the Sea Bright coast to protect tracks that ran to the military base on Sandy Hook. By the middle of the century, the sea wall had caused the beach to almost completely erode (Nordstrom et al. 1986). In the mid-1990s, the Army Corps of Engineers began a major beach nourishment project along the thirty-three mile stretch of shore from Sea Bright to Asbury Park.

The total cost of this project was initially estimated as costing two hundred and ten million dollars along with more than ten million dollars in yearly maintenance (Psulty and Ofiara 2004). Because of this project and ongoing beach nourishment, Sea Bright today has a beach. However, without continuous future maintenance, the beach will disappear.

This reliance on beach nourishment reflects a reality that since the finalization of the state's beach protection master plan, there has been no move to decrease development along the coast. Homes, businesses, attractions, and infrastructure continue to hug the majority of the coast. The beaches of New Jersey continue to erode, yet fixed structures remain in the same place. Without constantly adding sand each year to the coastline, beaches and barrier islands would migrate landward. Thus, the same fundamental problem persists today that existed more than a century ago: development occurring in vulnerable areas.

Figure 4 Sea Bright's wall. A) A view of the northern portion of Sea Bright. B) View along the wall facing south. C) Rebuilding in Sea Bright after Sandy.

3.6: The Once and Future Shore: Staying with the Trouble to Compose a Desirable Future

A central insight from narratives regarding the Anthropocene is that, now more than ever before, the future does not follow from the past. The very functioning of the Earth System in the Anthropocene is distinct from the Holocene past. For this reason, the Anthropocene is framed as a rupture (Chakrabarty 2012). At the same time, though, cultural and institutional inertia persists in the face of the cascading environmental and climatic changes found within the Anthropocene. In this sense, the sociotechnical imaginaries, infrastructures, and institutions that, in part, configure the shore region are, as Clive Hamilton argues, "anachronistic"—literally belonging to a different era.

Moreover, as documented above, the cultural, economic, and political imaginaries, infrastructures, and institutions were never truly capable of achieving socially just and ecologically vibrant outcomes. This highlights the reality that in the Holocene only some modes of living were allowed to thrive and others were subjugated and exploited—sometimes violently so. That some people thrived in the New Jersey shore region cannot be separated from the history of racist institutions—from slavery to Jim Crow to white flight. This legacy is sedimented into the spatial relations of the region. The most economically disadvantaged parts of the shore region are, by and large, located in historically Black neighborhoods that experienced disinvestment once white residents moved to newly developed suburban neighborhoods.

Additionally, those that thrived did so through a reliance on technological solutions with ecologically destructive results. The proliferation of hard structures along the New Jersey coast contributed to accelerated beach erosion and the destruction of coastal ecosystems—including dunes and marshes. Stabilizing the coastline of New Jersey gave investors and developers confidence to build more and more structures closer and closer to the shore. However, by destroying coastal ecosystems and causing additional beach erosion, these hard structures

worsened flooding—a reality that was widely recognized by the middle of the 20th century. The knowledge that marshes and dunes could lessen the impacts of storms and floods did not significantly alter development. Instead, both the state and federal government began spending millions of dollars each year to 'replenish' beaches by bringing in sand from elsewhere.

Thus, while the Anthropocene is a troubling time, so is the past. For Haraway (2016, p. 1), in light of this troubling past and present, this demands of us to "make trouble, to stir up potent response to devastating events, as well as to settle troubled waters and rebuild quiet places." Achieving this requires not imagining a safe future in which technofixes have solved our problems or believing in 'game over' narratives in which collective action is incapable of staving off disastrous climate change and other forms of planetary change. Instead, for Haraway (2016) and many other feminist thinkers (i.e. Alaimo 2016; Gibson-Graham 2011; Heise 2016; Stengers 2015), the challenge remains how to locate material, imaginative, and political resources in the present to compose a more desirable and vibrant future. Thriving in the Anthropocene, therefore, requires choices that result in "articulating bodies to some bodies and not others, nourishing some worlds and not others, and bearing the mortal consequences" (Haraway 2008, p. 88).

Staying with the trouble of the Anthropocene—and the Capitalocene and Plantationocene—in order to compose a more just and sustainable future requires telling "stories [that] reach into rich pasts to sustain thick presents to keep the story going for those that come after" (Haraway 2016, p. 125). The history of the New Jersey shore region does present a rich array of spatial narratives that can be used to craft visions of a more desirable future. This will be explored in greater depth within the Conclusion of the dissertation. At this point, it is valuable to point out that the history of the shore is full of moments of wavering and disagreement—moments that illuminate that alternatives to the present were possible.

Struggles by Black workers and communities to have their equality recognized permeate the history of the New Jersey shore—from slavery to Jim Crow to urban disinvestment. These struggles prove that a more socially just shore region is possible. Working alongside communities still fighting for recognition can provide an important avenue for achieving sustainable transformation within the shore region. Efforts by Black residents and vacationers to secure recognition have constantly been countered by claims about the need to protect private property rights and values. Indeed, during the height of the New Jersey shore's prestige, the exclusion of Black people from public space was justified not by claims of the supposed superiority of whites but by the argument that some white vacationers would object to integrated spaces—thereby decreasing profits and property values.

Historical debates about whether or not it was the government's role to protect property built along the coast is another important resource for thinking about the future. For decades, the federal government resisted getting involved in coastal management. Even state agencies that were largely supportive of an active governmental role in coastal management sometimes criticized the form development was taking, such as the NJBOCN shaming Ocean City for destroying their dunes in the 1920s and the NJDEP warning about the problems of developing barrier islands in the 1970s. More explicit and vocal in their objections to prioritizing the protection of private property were coastal scientists, such as Orrin Pilkey, who bemoaned the 'newjerseyization' of the American shore.

Finally, another lesson from the past is that vast change is possible in a relatively brief amount of time. Indeed, this is an insight true of the Anthropocene and Great Acceleration. Two hundred years ago, the New Jersey shore was a sparsely populated region with a few, relatively unimportant resorts. One hundred years ago, the New Jersey shore was one of the most popular

destinations in the world with hundreds of luxury hotels and thousands of miles of rail lines. Now, the New Jersey shore is home to hundreds of thousands of year-round residents, countless miles of roads, and popular—though no longer world-class—resorts. The shore of a hundred years in the future will doubtlessly look very different from today. But history proves that transformative change is the norm in the coastal New Jersey. The Anthropocene heralds the arrival of new and unpredictable forces becoming part of these changes—and there are real risks that without significant foresight and planning these transformations will be undesirable.

Section Two—Adaptation in the shore region

Introduction: Interventions to support coastal adaptation

Within this section, I examine the various factors that make it difficult to implement effective adaptation policies in the New Jersey shore region as well as explore efforts to overcome those constraints. The historical processes documented within Section One continue to influence the practices and outcomes detailed in the following chapters. Events—both small and large—from the past two centuries condition and narrow the solutions space available to actors in the New Jersey shore region. Choices made to construct resorts abutting the water, privilege private property and business interest, enhance and protect property taxes, and commit the state and federal government to rebuild homes and infrastructure after disasters continue to persist within contemporary governance processes—despite decades of criticism from coastal scientists, government agencies, and environmental organizations (see Chapter Three). The sustained influence of these historical events documents both how path dependencies emerge and the difficulties in breaking out of them.

At the same time, the history of the shore region also proves that rapid changes—for better or worse—can emerge and drastically alter social, material, and ecological conditions. Indeed, the shore region itself went from a handful of isolated villages in the beginning of the 18th century to being home to world class resorts in the start of the 19th century to a sprawling suburban landscape at the start of the 20th century. For much of the past two centuries, change has been the norm along the New Jersey shore. Thus, while the past continues to influence the present, it also demonstrates that transformational change can emerge.

The section is divided into two main parts. First, I develop a novel heuristic to differentiate and connect constraints to adaptation in order to locate the factors that are at the core of slow and ineffective responses to climate change in the New Jersey shore region. Based upon in-depth interviews with municipal government elected officials and staff members, I find that the factors most constraining successful adaptation relate to the political, cultural, and economic commitments highlighted in Section 1. In other words, commitments to protecting private property rights, prioritizing economic growth, and stabilizing the coastline are at the center of ineffective policy responses that continue to place people in harm's way, contribute to ecological fragmentation and degradation, and rely on expensive maintenance and recovery efforts.

Critically, I find that such sociopolitical constraints are rarely explicitly—or even implicitly—addressed within collaborative efforts to inform and support adaptation actions. In part, this is because these factors are widely seen as deeply entrenched. While there is truth to this view, such factors are not immutable and impossible to change. Instead, path dependencies within sociopolitical commitments can be seen as form of social myth (see Chapter One and O'Brien 2018) that are amenable to transformation through carefully crafted and targeted interventions.

Next, I document how one effort to collaboratively produce usable climate information has overcome some of the identified constraints to successfully place adaptation on the policy agenda. I highlight how a well-crafted collection of boundary objects acted as a crucial resource within this effort. By providing interpretative flexibility and meeting the information needs of multiple communities of practice, boundary objects allowed municipal actors and knowledge brokers to collaborate even though consensus was lacking regarding goals and visions for the future. Moreover, boundary objects were effective throughout the entire collaborative process—from convening the program to writing a final report.

Chapter 4: Differentiating and connecting constraints to adaptation in the New Jersey Shore region

4.1—Introduction

Regardless of future mitigation efforts, some level of anthropogenic climate change is unavoidable. Cumulative greenhouse gas emissions have already permanently altered the climate system in ways that will contribute to dangerous climatic hazards for the foreseeable future. In light of this, adaptive actions are necessary in both the short- and long-term to address emerging risks (Pelling 2010; Walker et al. 2013; Wise et al. 2014). Despite a growing recognition of this reality among scientists, practitioners, policy-makers, and activists alike, the implementation of adaptive actions has been incommensurate with the pace and extent necessary to protect vulnerable communities from plausible climate impacts and hazards (Bhave et al. 2016; Dilling et al. 2015; Ekstrom and Moser 2014). Even communities and regions possessing relatively high levels of adaptive capacity, the social processes that place people, infrastructure, and ecosystems at significant risk have proven resistant to change (Eakin et al. 2014; Mortreux and Barnett 2017). In the continental United States, for instance, tens of millions of people live in coastal areas projected to be frequently flooded and/or inundated due to sea level rise during the 21st century, yet coastal development and policy pathways largely follow maladaptive and risky trajectories (Abel et al. 2011; Barnett et al. 2015; Brown et al. 2014; Moser et al. 2015; Ramm et al. 2017; Walker et al. 2013). This highlights a persistent implementation gap between, on the one hand, what is believed necessary for sustainable, safe development in the face of uncertain climate risks and, on the other hand, slow and ineffective adaptive actions at the local, regional, national, and international levels (Cornell et al. 2013; Flagg and Kirchhoff 2018; O'Brien 2012; Tribbia and Moser 2007).

In response to this, scholars have documented a wide range of social, technological, informational, and institutional factors that constrain adaptation efforts (Barnett et al. 2015; Biesbroek et al. 2013; Eisenack et al. 2014; Ekstrom and Moser 2014; Klein et al. 2015; Leichenko et al. 2015). Such constraints include, but are not limited to, a lack of funding, staff, and climate information as well as ineffective and outdated

institutions and environmental management systems. Thus, not only must people, communities, and governments develop the adaptive capacity needed to plan for climate change, but they must also address critical barriers, limits, and limitations that narrow and hinder sustainable adaptation pathways (Barnett et al. 2015; Biesbroek et al. 2013; Eriksen et al. 2015; Shackelton et al. 2015).

The terms barriers and limits are utilized within climate adaptation research to broadly distinguish between constraining factors based upon whether they can be overcome or if they are immutable and insurmountable (Biesbroek et al. 2013; Leichenko et al. 2015; Moser and Ekstrom 2010). Barriers are understood to be factors that hinder adaptation by making the design and/or implementation of effective policies difficult, but can be overcome or avoided through individual or collective action (Biesbroek et al. 2013; Eisenack et al. 2013; Klein et al. 2014; Moser and Ekstrom 2010). For instance, lacking sufficient climate knowledge represents a barrier that can be overcome through activities such as partnering with scientific authorities or knowledge brokerage efforts (Kirchhoff et al. 2013). Overcoming barriers requires allocating resources that might be scarce—time and money being most evident—so tradeoffs are likely to exist in dealing with multiple barriers. In contrast, limits to adaptation represent the threshold points at which escalating risks of climate change become intolerable and no successful adaptation action is available to maintain existing social and institutional arrangements (Adger et al. 2009; Dow et al. 2013). As an example, rapid sea level rise could pose a limit to adaptation within low-laying coastal regions. Thus, encountering a limit demands transformative change within development patterns in order to achieve desirable results (Barnett et al. 2015; Dow et al. 2013; Eisenack et al. 2013).

In many cases, successfully addressing the factors that constrain adaptation requires deep, systemic, and transformative changes aimed at the fundamental structures of governance and decision-making (Barnett et al. 2015; Colloff et al. 2017; Eriksen et al. 2011; 2015; Fazey et al. 2017; Gorddard et al. 2016; O'Brien 2012; 2017; 2018; Park et al. 2013; Pelling et al. 2015; Shackleton et al. 2015; Wise et al. 2014). This highlights aspects of what has come to be known as the 'adaptive challenge of climate change' in which basic assumptions regarding social organization and beliefs must be questioned in response to the

urgent, unprecedented, and rapidly developing transformation occurring in the climate system (O'Brien 2012; O'Brien and Selboe 2015). Switching to sustainable developmental pathways that are capable of meeting the needs of the most vulnerable and avoids environmentally destructive outcomes (see: Eriksen et al. 2011; 2015) demands careful analysis that locates the critical political, cultural, and economic factors at the heart of the persistent, durable social and political hesitancy to pursue meaningful adaptation policies (Azhoni et al. 2015; Barnett et al. 2015; Shackelton et al. 2015).

Existing scholarship on the constraints to adaptation currently struggles to differentiate the factors that play a central, causal role in hindering adaptive actions from other more superficial factors, such as a lack climate information or funding—a weakness frequently acknowledged within the adaptation literature (i.e. Azhoni et al. 2017; Barnett et al. 2015; Biesbroek et al. 2013; Cote and Nightingale 2011; Measham et al. 2011; Shackleton et al. 2015). To date, research has tended to answer the question of 'which barriers and limits have emerged' rather than exploring 'how and why such constraints came to be' and 'why do they continue to persist' (Biesbroek et al. 2013; Shackelton et al. 2015). While understanding which barriers and limits are most common is valuable, there is a crucial need for documenting the socially and spatially uneven nature of political and cultural forces and processes hindering effective and sustainable adaptation planning and policy (Cote and Nightingale 2011; Eriksen et al. 2011; 2015; Nightingale 2017; Shackleton et al. 2015). Thus, there is a need to provide more evidence of the structural, systemic, and deeply-rooted underlying factors that create the constraints hindering or preventing adaptation from occurring—including, but not limited to, racial and religious discrimination, the prioritization of short-term economic growth, and a lack of democratic accountability (Cote and Nightingale 2011; Shackelton et al. 2015).

Additionally, while there is a general recognition that individual constraints do not act in isolation, the majority of empirical research still tends to treat them as discrete entities (Biesbroek et al. 2013; Eisenack et al. 2014; Klein et al. 2014)—with a few important exceptions (i.e. Azhoni et al. 2017; Islam et al. 2014). As such, there is a shortage of analysis and guidance regarding how and why particular

constellations of barriers emerge and are sustained through time (Biesbroek et al. 2013) as well as how limits and barriers interact with one another so as to cause, amplify, and/or reinforce one another across temporal and spatial scales (Barnett et al. 2015; Shackleton et al. 2015). Thus, in sum, research on the limits and barriers to adaptation frequently results in the creation of lists of the factors constraining action without (a) differentiating the significance of different limits and barriers and (b) disentangling how barriers and limits interact to cause, entrench, and/or amplify one another or other political-economic processes. Due to these weaknesses, policy recommendations emerging from scholarly work for addressing limits and barriers to adaptation run the risk of entrenching political inequalities and power asymmetries; subsequently, increasing the risk of maladaptation and diminishing the potential for sustainable adaptation (Eriksen et al. 2011; 2015; Shackleton et al. 2015).

This paper provides a heuristic for differentiating constraints to adaptation based upon the degree to which they drive slow, ineffective, and unsustainable adaptation efforts. The heuristic allows for mapping the multiple connections between different constraints so as to better document how individual constraints reinforce, amplify, and/or cause one another. By both differentiating and drawing connections between constraining factors, the paper aims to help identify central, sociocultural constraints that frequently lie at the core of slow and ineffective climate change response. By directly addressing these sociocultural constraints, it may be possible to catalyze cascading positive changes that support sustainable adaptation—a call recently made by Shackelton and colleagues (2015). This, it will be argued, raises important questions regarding how best to design and sequence interventions aiming to navigate and overcome constraints as fundamental shifts in cultural, political, and economic structures might be necessary in the short-term before more incremental shifts are practical in the medium- and long-term.

To make this case, the paper begins with a review of the current state of research on the factors constraining the efficiency of adaptation initiatives. In particular, focus is placed on recent calls to delve more deeply into the connections between constraints and how they interact to produce and/or reinforce one another. After this, three levels of constraints are described in order to differentiate them based on

how fundamental they are in hindering successful, sustainable adaptation. These levels are informed by multiple strands of literature on the political, policy, and cultural dimensions of climate change. Following the description of these three levels of constraints, a framework for mapping the connections and relationships between constraints is laid out. This framework is then applied to the case study of local municipalities in the shore region of New Jersey. The paper concludes with a discussion of why tackling sociocultural constraints within the near future is an urgent scholarly, practical, and political issue that demands placing more focus on producing and disseminating transformative knowledge and resources.

4.2—Why Constraints Matter

People and ecosystems will be exposed to increasingly unpredictable and dangerous climatic impacts during the 21st century (Hauer et al. 2016; Neumann et al. 2015; Park et al. 2012; Wise et al. 2014). Even if total warming by 2100 is limited to 1.5° C, many regions and groups still will face significant, disruptive, and deadly climatic impacts during the coming decades (Arnell et al. 2017; Pelling et al. 2018; Solecki et al. 2018). In other words, some level of risky climate change is now unavoidable even with dramatic mitigation levels. Thus, climate change adaptation policies and plans must be a continuous and long-term endeavor in which decision-making is iterative, flexible, reflexive, and dynamic (Park et al. 2012; Pelling 2010; Walker et al. 2013; Wise et al. 2014).

However, research has documented that many factors hinder or prevent both autonomous and planned adaptations to climate change. These constraints make pursuing sustainable adaptation an even larger challenge (Colloff et al. 2017; Gorddard et al. 2016; Hermans et al. 2017; Lawrence and Haasnoot 2017; Ramm et al. 2017). Even locations and communities with relatively high levels of adaptive capacity have struggled to translate that capacity into effective adaptive actions—with some examples existing that households and communities with more adaptive capacity sometimes do not adapt as successfully as nearby ones with less adaptive capacity (Mortreux and Barnett 2017). Crucially, this highlights that possessing the capacity to adapt does not necessarily translate into actually desiring or being able to adapt (Eakin et al. 2014; Marshall et al. 2012; O'Brien et al. 2007). Stated otherwise, having sufficient levels of

adaptive capacity is not a sufficient condition for sustainable adaptation. Instead, a wide range of factors constrain and narrow the design and implementation of effective adaptation actions. Until such constraints are dealt with, sustainable adaptation will remain out of reach (Eriksen et al. 2010; 2015; Nightingale 2017).

In recent years, the seemingly clear distinction between what counts as a barrier and limit has become somewhat ambiguous and arbitrary (Barnett et al. 2015; Biesbroek et al. 2013). In an influential article, Adger et al. (2009, p. 337) argued that limits of adaptation should be thought of as "mutable, subjective, and socially constructed." That is, rather than being exogenous and immutable factors placing an absolute limit on a system's capacity to adapt, limits emerge from social relations and value systems, which, though often deeply entrenched, remain changeable (Adger et al. 2009). This means that social and cultural changes can alter where and when limits are encountered and how they are experienced. The view that the limits of adaptation have social roots is now widespread within the literature.

Currently, the concept of the limits of adaptation is generally placed within an actor-centered framework of social perceptions of risk in which an adaptation limit is linked to the perception of intolerable risks (Dow et al. 2012; Klein et al. 2014). Within this approach, a limit represents the point at which social and cultural values determine that climate risks are no longer tolerable and no adaptation option is feasible for maintaining the existing configuration of things. As social values, worldviews, and objectives play a role in determining both what is perceived as a barrier or as a limit, the existence of a diversity of social positions and perspectives renders the defining of 'intolerable' relative (Barnett et al. 2015). What comes to count as intolerable directly depends upon the social positioning of the actors involved in determining acceptable and inacceptable risks. Moreover, disagreement might exist as to whether or not something is even a constraint at all (Barnett el al. 2015).

Such differences in perspective about the degree to which something acts as a constraint (or even if it is a constraint) raises important questions about inclusion, recognition, and social justice (Barnett et al. 2015; Shackelton et al. 2015). Whose perspective is deemed as valid and important determines in large part who

has the authority to influence policy and who is excluded from decision-making (Eriksen et al. 2015; Nightingale 2017). Indeed, as Barnett et al. (2015) state, "the difference between barriers and limits to such [climatic] changes is a matter of spatiotemporal perspective: the possibility of mutable constraints seems more or less likely depending on where one sits, and on how one understands history." In other words, an important component of diagnosing constraints to adaptation is understanding the broader political, economic, and cultural dynamics that structure inclusion, recognition, and notions of justice and equality (Eriksen et al. 2015). Such dynamics frequently act as the driving forces behind not only the emergence and persistence of adaptation constraints but also the very determination of whether something constrains adaptation (Shackleton et al. 2015).

The relational and political nature of adaptation constraints illustrates the need for tracing the complex and frequently dense connections between different factors hindering sustainable adaptation (Azhoni et al. 2018; Barnett et al. 2015; Shackelton et al. 2015). In general, empirical research on barriers and limits to adaptation has been descriptive in nature. Research has focused on enumerating the most frequent constraints encountered by relevant actors and detailing when and where they typically emerge. This research has provided valuable insights in regards to the existence of a multitude of constraining factors. Nonetheless, the literature on constraints has not offered systematic explanations as to why such constraints emerge or how they interact (Azhoni et al. 2018; Barnett et al. 2015; Eisenack et al. 2014; Shackelton et al 2015). For instance, in reviewing the state of the adaptation literature, Klein et al. (2014, p. 911) found that the constraints to adaptation are "often discussed in the literature as discrete determinants" even though "they rarely act in isolation." Moreover, as Measham et al. (2011, p. 889) argue, many empirical studies of barriers tend have largely diagnosed "simplistic factors" acting as barriers, such as financial constraints and the lack of climate information, while overlooking or underemphasizing "more fundamental challenges affecting local, place-based planning," such as a lack of leadership, competing priorities, and legal and regulatory constraints originating both at the local level and arriving from higher levels of government. This focus on 'simplistic factors' stems, in part, from a

lack of engagement with the complex, intricate interactions between the various factors constraining adaptation (Cote and Nightingale 2011; Shackleton et al. 2015).

As a result, policy solutions suggested for overcoming constraints tend to treat them in isolation and, therefore, solvable in isolation—frequently through technical measures. As Cote and Nightingale (2011, p. 480) note, this mirrors a wider trend in adaptation scholarship focusing on how to get the institutional contexts and rules right while sidestepping questions about the "processes and relations that support these structures" and cause uneven and unequal results (see also: Eriksen et al. 2011; 2015; Nagoda and Nightingale 2017; Nightingale 2017). This sentiment is echoed by Shackleton et al. (2015, p. 337) who found only a few studies of barriers to adaptation conducted in sub-Saharan Africa explored the "complex interactions between…different types of barriers and their compounded impacts on adaptation." Moreover, this elision of the multiple interactions between various constraints runs the risk of reinforcing existing inequalities and, even, producing new sources of inequality (Nagoda and Nightingale 2017; Shackelton et al. 2015). Thus, there is a real risk that proposed solutions to address constraints might not only be inefficient but also maladaptive by reinforcing existing path dependencies and fostering new lock-in effects.

In recent years empirical research has begun delving more into how various constraints connect and interact. Barnett et al. (2015) utilized the concept of path dependency to illustrate how in coastal Australia disparate factors constraining adaptation that operate at multiple scales reinforce one another to lock-in maladaptive decision-contexts. In another study demonstrating the importance of examining the interrelations of barriers and limits, Islam et al. (2014) found that for Bangladeshi coastal fishing communities "local and broader factors originating from both internal and external sources interact in a complex way to combine to impede adaptation" (p. 214). For instance, they found that the barriers of power asymmetry between boat owners and fishermen as well as the lack of access to credit interacted to reinforce the barrier of unsafe fishing boats and working conditions. A lack of good access to credit meant that boat owners could not afford to invest in boat safety while also entailing that they took out

unfavorable loans with high interest rates, which contributed to boat owners coercing fishermen to work in dangerous weather events on unsafe boats (Islam et al. 2014). Azhoni et al. (2018) provided additional support for the notion that barriers are interconnected but also found that some constraining factors act as deep drivers or root causes of other social and institutional constraints. Crucially, they argue that such driving factors should be seen as potential leverage points in which cascading and, potentially, transformative change towards more desirable states could be unleashed through carefully constructed initiatives. Thus, empirical evidence documents that not only do constraints interact with one another, but some factors hindering sustainable adaptation drive other constraints.

Beyond research documenting how constraints connect, other recent scholarship provides empirical evidence that treating constraints in isolation attenuates the practical impacts of efforts to support adaptive planning through the creation of usable climate information and climate services. In a study on the effectiveness of a UK governmental project to provide municipal decision-makers with relevant and usable climate information, Porter et al. (2015) found that, even though local officials and employees reported gaining climate information suited to their needs, they had been unable to convert that understanding in concert with adaptive action. Instead, decreased funding from the central government along with a lack of guidance and coordination for adaptive planning at multiple levels of governance constrained adaptive planning and policy at the local level (Porter et al. 2015, p. 420). In other words, at the same time the central government sought to provide informational support to municipalities, decisions made at the national level also increased the barriers to adaptation by failing to provide adequate financial resources and regulatory guidance. Similarly, in a review of the literature on the provision of usable climate information, Flagg and Kirchhoff (2018) found that efforts to produce and communicate usable information is only effective in supporting effective adaptation in situations where micro-, meso-, and macro-factors align to support adaptation. When factors at just one level did not support adaptive action, targeted users struggled to utilize climate information with high degrees of fit, interplay, and usability. This finding mirrors Dilling and colleagues' caution (2015, p. 14) that "the capacity to generate

information and the ability to produce appropriate governance solutions may in itself not be sufficient to lead to effective decision support…[as] the current ability to respond to climate variability and change is still constrained in multiple ways (e.g., in the way that existing regulations function, or limitations on management options).” In other words, if current regulatory, institutional, and political arrangements at all scales do not support effective adaptation, then providing even the best information will not support sustainable adaptation (Porter et al. 2015). Taken together, this research demonstrates that treating barriers in isolation, such as the lack of usable climate information, reduces the practical impact of decision-support initiatives. Even the best targeted initiative can be blocked by other constraints. This situation brings to the fore the necessity of addressing the barriers and limits to adaptation in a more holistic fashion.

While this research has begun to provide empirical evidence that constraints do in fact interact in complex ways, there is still a relative lack of examination of the deeper political dimensions and drivers of slow and ineffective adaptation planning (Shackelton et al. 2015). Instead, the primary focus has remained on the institutional structures and arrangements that either hamper or facilitate adaptive actions. To the degree political dynamics and power asymmetries are discussed as factors constraining adaptation, better institutional design is generally seen as a solution (Cote and Nightingale 2011; Eriksen et al. 2015). Often, this is seen as entailing the creation of ‘politically neutral arenas’ in which explicitly political concerns are attempted to be excluded (Ojha et al. 2016). This is problematic because research on the politics of adaptation has proven that it is highly difficult to achieve sustainable adaptation without addressing directly the fundamental and systemic imbalances of power, recognition, and responsibility (Cameron 2012; Cote and Nightingale 2011; Eriksen et al. 2011; 2015; Nightingale 2017; Taylor 2013). In other words, getting the rules right is not sufficient to overcoming the deeper, systemic, and, frequently, hidden political constraints inhibiting sustainable adaptation. Consequently, in its current state, the literature on constraints to adaptation is frequently fails to differentiate, locate, and address the core, sociocultural constraints preventing sustainable adaptation from unfolding. In the next section, a

heuristic is outlined that can help (a) disentangle the myriad and variegated ways in which barriers and limits interact and (b) differentiate and locate the most significant limits and barriers driving resistance to just and sustainable adaptation. By doing so, it is possible to identify potential leverage points that, while likely deeply entrenched and difficult to change, can contribute to cascading change towards more just and desirable trajectories.

4.3—Building a heuristic

4.3.1—Overview

Figure 5 provides a visualization of a three-tiered heuristic for differentiating constraints based upon the degree to which they are systemic, deep drivers of lagging adaptive actions. As will be demonstrated later, barriers can be mapped onto the heuristic in order to visualize the various and variegated connections between individual factors. In understanding the differentiated connections between constraints, the relationships are broadly categorized as causal, reinforcing, and/or a feedback loop (either positive or negative). The following section provides more information on each tier—starting from the outer sphere of technical constraints and working inward to the core constraints that play a significant

causal role in slowing and attenuating adaptation. After each tier is explained, the various potential forms of connections between constraints is also explored.

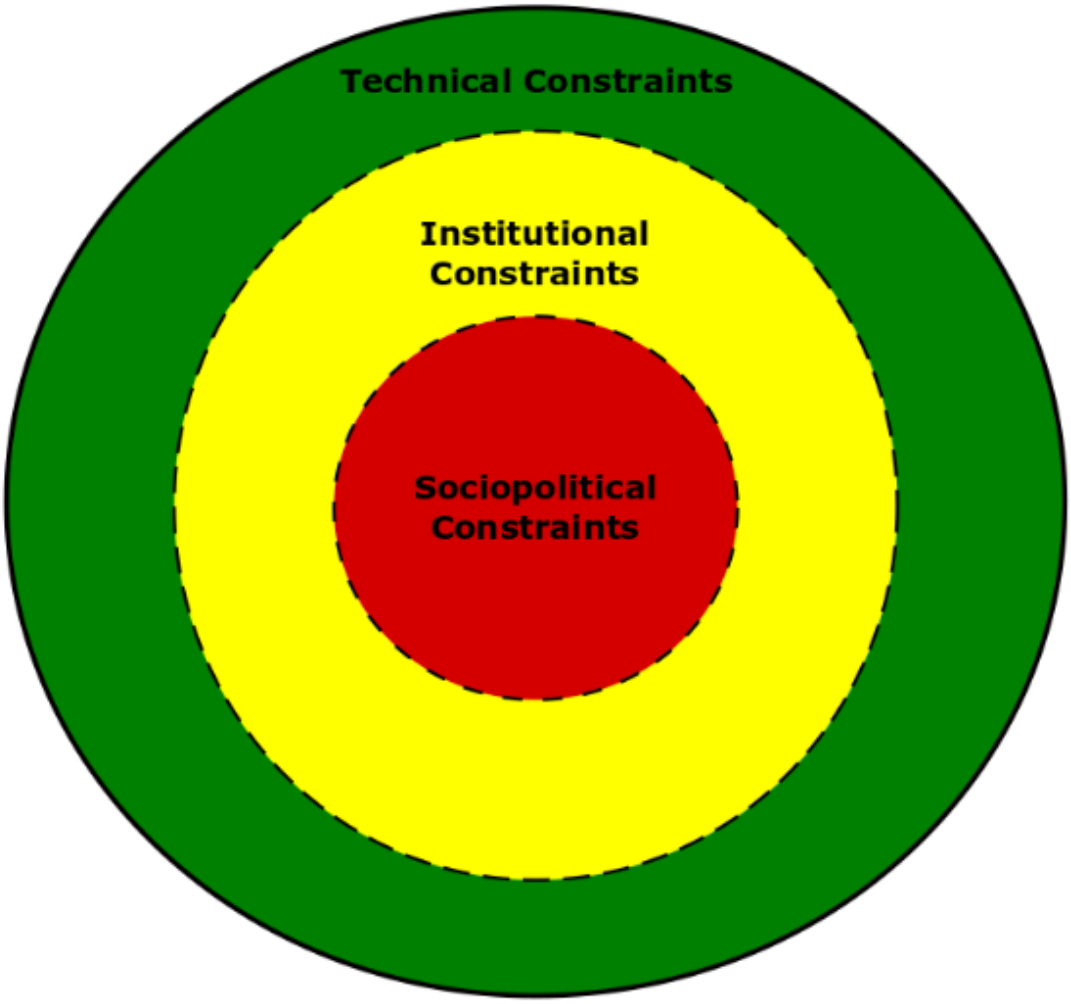

Figure 5 Three-tiered constraints heuristic

4.3.2—Technical Constraints

The difficulties associated with the actual design, implementation, monitoring, and enforcement of effective adaptation policy and planning occupy the outer sphere of the heuristic labeled as 'technical constraints'. These constraints tend to fall into the category frequently referred to in the literature as 'barriers to adaptation' because they are possible to surmount within existing decision-making contexts. The lack of usable climate information, funding, technical skills, and access to technology are all examples of technical constraints. The constraints located in this sphere are possible to rectify, though

with the important caveat that underlying institutional arrangements and core sociocultural values, worldviews, and objectives support effective action. However, addressing one specific constraint might entail trade-offs in that overcoming one factor hindering adaptation might further entrench another. For instance, the lack of relevant and trackable indicators to monitor the ongoing effectiveness of adaptation policies would be a technical constraint that addressing would likely entail forming collaborations with climate experts, which might require significant time and resources from municipal staff. Thus, this might detract attention from other constraints. This, though, does not preclude successful and sustainable adaptation if a sufficiently broad range of adaptive pathways remain plausible. It does raise questions regarding the potential trade-offs encountered when dealing with competing priorities and the need to analyze how pursuing one good option might make another option less likely.

The constraints found within the technical sphere have received the most attention within scholarship on the limits and barriers to adaptation. These constraints can occur during any stage of the adaptation policy process (Ekstrom and Moser 2014; Moser and Ekstrom 2010). Moreover, technical barriers can originate both locally and at other scales (Barnett et al. 2015; Ekstrom and Moser 2014; Klein et al. 2014). Thus, even though they can be overcome through individual and collective action, sometimes actors at the local level need to collaborate with actors operating in different locations or different policy levels (Amundsen et al. 2010; Morrison et al. 2017; Oberlack and Eisenack 2014). For instance, the provision of usable climate information depends upon collaborating with scientists that most likely reside and work in another location. In order to address such constraints, scholars have collaborated with decision-makers to design a plethora of climate services, decision-support-tools, and various other types of usable climate information that fit the needs and contexts of targeted users and interplay with the knowledge systems deployed in decision-making (Hegger et al. 2014; Lemos et al. 2012; 2014; McNie 2013; Vaughan and Dessai 2014; Webber 2017).

While technical constraints are indeed important and must be addressed if sustainable adaptation is to transpire, it is crucial to distinguish whether they can be successfully and effectively addressed within

existing institutional arrangements or they are the result of misaligned and mismatched institutions ill-suited to respond to climate change. That is to say, it is important to determine whether the easy to identify technical constraints are actually the manifestation of deeper factors at the institutional or politic-economic levels, which are harder to identify. For instance, the lack of usable climate information could be due to decision-makers not having access to necessary knowledge but it could also be because existing decision-making contexts are incapable of effectively addressing the challenges of climate changes—therefore reducing the usability of any form of climate information. It is vital, then, to not conflate the abundance of identified technical constraints with them being the main reasons for sluggish and ineffective adaptation planning. Instead, they might signal the existence of more systemic constraints that make planning for plausible climate impacts difficult.

4.3.3—Institutional Constraints

Within the middle tier of the heuristic are constraints relating to institutional structures and configurations that reduce the overall effectiveness of adaptation policies, narrow the total range of available pathways, and, in some cases, make climate change an intractable problem seemingly impossible to solve. Institutions here include both formal and informal rules and norms influencing collective behavior (Ostrom 1990) and structuring decision-contexts (Colloff et al. 2017; Gorddard et al. 2016). Thus, factors that could act as institutional constraints include things such as regulations, knowledge systems, policy frameworks, economic incentives, problems of leadership, and so forth. Generally, institutional constraints are more difficult to address than technical constraints, but can solved through targeted interventions aimed at creating governance institutions that better fit the emerging challenges associated with global environmental change (Young 2017).

Scholars of environmental governance increasingly contend that "[m]any global change problems are intractable within existing decision-making processes" (Gorddard et al. 2016, p. 60) and that "the familiar regulatory approach to governance has serious drawbacks as a means of dealing with a range of increasingly prominent problems arising in complex systems" (Young 2017, p. 17). The emerging

challenges associated with global environmental change in the 21st century require new institutional modes of managing and governing human-environmental interactions (Bai et al. 2016; Brondizio et al. 2016; Steffen et al. 2011; Young 2016). Growing evidence exists that existing governance institutional arrangements frequently are ill-suited for emerging problems of global environmental change (Gorddard et al. 2016; Park et al. 2012; Walker et al. 2013; Wise et al. 2014; Young 2016). Indeed, recent scholarship has provided compelling evidence that the complex, nonlinear, unpredictable, and emergent character of novel forms of planetary change currently unfolding has rendered many existing institutional designs and regulatory approaches ineffectual (Colloff et al. 2017; Fazey et al. 2017; Gorddard et al. 2016; Young 2017). Due to humans interfering with and altering planetary systems, such as the carbon and nitrogen cycles, the Earth System is now approaching critical thresholds that, once crossed, entail fundamental and irreversible regime shifts (Lenton 2013; Lenton et al. 2008; Werners et al. 2013). Such changes undermine existing governance systems because many of the previously essential features of socioeconomic and biophysical systems have been transformed (Young 2017). Already, climate change, species extinctions, pollution, and other drivers of global environmental change have altered some critical biophysical processes (Lenton 2013; Zalasiewicz et al. 2010; Waters et al. 2016). The persistence of governance institutions ill-suited to creating and implementing effective and sustainable adaptation pathways, therefore, is an important underlying cause of many of the commonly cited constraints found in the technical sphere (Ramm et al. 2017; Walker et al. 2013; Young 2016)

Recent research has focused on exploring the increasing mismatch between dominant coastal management regimes and the challenges of sea level rise, flooding, altered storm regimes, and ecological change (Barnett et al. 2015; Moser et al. 2012; Ramm et al. 2017). In particular, scholars have highlighted the dominance of ‘predict-then-act’ approaches that seek optimal policies based upon best projections of future conditions as a key constraint to enacting effective and sustainable adaptation pathways in coastal regions (Ramm et al. 2017; 2018; van der Voorn et al. 2017). Such approaches are ill-suited to addressing emerging coastal hazards due to the deep uncertainty associated with climate change (Hallegatte et al.

2012; Kalra et al. 2014; Kwakkel et al. 2016; Maier et al. 2016; Walker et al. 2013). The uncertainty regarding the form, extent, and timing of climate impacts within the next decades is irreducible and extensive (Walker et al. 2013). This makes decision-making frameworks that depend upon 'best guesses' about future conditions—whether that be sea level rise, coastal storm frequency and intensity, ecological conditions, or temperature—ineffective. Furthermore, the irreducible nature of uncertainty regarding climate impacts means that future research and analysis will always be inadequate in providing such projections because of the dynamic, interrelated, and complex set of factors involved (Kwakkel et al. 2016; Lawrence et al. 2019).

Beyond deep uncertainty, a number of other characteristics of climate change make existing governance institutions poorly suited for designing and implementing effective and sustainable adaptation pathways. This includes the immense and complex temporal and spatial scale of climate change as well as the need to integrate multiple forms of knowledge to effectively organize responses to a range of threats. In light of this recognition of institutional mismatch, scholars and practitioners have begun devising such approaches. This includes calls for adaptive co-management, boundary organizations, triple-loop learning, robust decision making, dynamic adaptive policy pathways, and polycentric, multi-level governance. Such strategies are theorized to be better suited to addressing the complexities and uncertainties associated with climate change and global environmental change than extant ones (Anderies et al. 2013; Haasnoot et al. 2013; Kalra et al. 2014; Leach et al. 2010; Manocha et al. 2018; Walker et al. 2013). Actual implementation of these novel approaches has been scarce, however. Indeed, implementation has proven difficult even within locations with high levels of wealth, education, and political agreement (Lawrence and Haasnoot 2017).

This points towards not only that existing institutions are ill-suited for addressing the emerging environmental challenges of the 21st century, but also that such institutions are deeply entrenched and resistant to change. Thus, institutional constraints often exhibit path dependencies that contribute to maladaptive and unsustainable outcomes (Barnett et al. 2015) as well as what Leichenko et al. (2015)

refer to as the ‘limitations’ of policy or actions taken to increase resilience that do not address fundamental drivers of vulnerability. The existence of deeply entrenched path dependencies within institutional arrangements means that switching to new decision-making contexts is often a significant challenge that entails a great deal more than just getting the rules right (Barnett et al. 2015; Eriksen et al. 2015; Shackelton et al. 2015). Instead, fundamental belief, value, and political systems that undergird institutional design and persistence must be addressed (Barnett et al. 2015; O’Brien 2018).

4.3.4—Sociopolitical Constraints

Ultimately, if the values, imaginaries, and objectives that structure decision-making do not support sustainable and just adaptation, then overcoming constraints found in the institutional or technical sphere will be unlikely to succeed. Instead, overcoming seemingly intractable path dependencies and lock-in effects to achieve meaningful institutional change requires facing historical, political, and cultural factors as well (Bhave et al. 2016; Hermans et al. 2017; Lawrence and Haasnoot 2017; van der Brugge and Roosjen 2015). As O’Brien (2018, p. 154) has argued, path dependency ought to be understood as a collective “myth” and “a depoliticized and naturalized story that justifies and guides practices based on unconscious or unquestioned beliefs.” In other words, path dependencies are produced and maintained through particular and obdurate power relations, as well as materially through the material infrastructures that have emerged over time.

As such, overcoming the path dependencies found within institutions is always plausible, though accomplishing this frequently depends on changing or transforming the deeper, systemic cultural and political dynamics that structure collective actions. Addressing such factors entails facing what has become labeled the ‘adaptive challenge of climate change’ or the “questioning of the assumptions, beliefs, values, commitments, loyalties and interests that have created the structures, systems and behaviors that contribute to anthropogenic climate change, social vulnerability and other environmental problems in the first place” (O’Brien 2012a, p. 2; see also O’Brien and Selboe 2015).

Sociopolitical constraints are the deep, systemic, difficult to identify, and often seemingly intractable factors that make addressing the adaptive challenge and root drivers of climate vulnerability a monumental, seemingly intractable challenge. They relate to the uneven political economic dynamics and processes of exclusion, marginalization, and discrimination. For instance, Shackelton et al. (2015, p. 335) found that most barriers found in sub-Saharan Africa "can be traced back to poverty, marginalization, inequity, and inequality." They note that such deep social and political barriers to adaptation can be difficult to identify and might not become more apparent until attempts are made to address more visible ones. However, they also argue that "the roles of conflicts, corruption, vested interests, and power relations in blocking adaptation, especially for the most marginalized, are…poorly studied" (Shackelton et al. 2015, p. 337). In other words, while political economic factors that narrow and/or hinder sustainable adaptation trajectories can be hard to locate, there also have not been sufficient efforts to develop strategies to do so within research into adaptation constraints.

Though the role of power asymmetries and uneven political dynamics in stymieing just and sustainable adaptation more broadly has been explored in the climate adaptation literature (i.e. Cote and Nightingale 2011; Eriksen et al. 2011; 2015; Lemos et al. 2007; O'Brien 2012; Tschakert et al. 2016), such factors have been less explored within research explicitly dealing with the barriers and limits of adaptation (Cote and Nightingale 2011; Shackleton et al. 2015). Climate adaptation research has long documented that existing power structures and uneven processes of development drive vulnerability to climate change (Cote and Nightingale 2011; Eakin and Lemos 2006; Eriksen and Lind 2009; Eriksen et al. 2011; Inderberg et al. 2015; Jones and Boyd 2011; Lemos et al. 2007; Næss et al. 2005). Moreover, evidence exists that adaptation efforts can reinforce and deepen structural inequalities and political asymmetries that constrain additional adaptation (Eriksen et al. 2011; 2015; Jones and Boyd 2011; Næss et al. 2005; Nightingale 2017). For instance, in the context of coastal flood planning in Norway, Næss et al. (2005) found that a positive feedback loop existed between existing power structures and the developmentally oriented measures taken to protect coastal property through the creation of a dike that would likely cause

decreased biodiversity and was unlikely to protect against some types of flashfloods. Similarly, Jones and Boyd (2011) document that social barriers in Nepal, such as cognitive behavior, normative behavior, and institutional structure and governance, create significant constraints on marginalized populations' ability to participate within participatory adaptation processes. As such, they warn that adaptation plans that emerge from such processes risk reinforcing and deepening political inequalities and vulnerabilities (Jones and Boyd 2011, p. 1272). More recent research in Nepal provides support for this view by empirically documenting how apparently neutral adaptation programs have contributed to deepening political, cultural, and economy inequality between already privileged and marginalized populations (i.e. Nagoda 2015; Nagoda and Nightingale 2017; Nightingale 2017; Ojha et al. 2016). Thus, there is sufficient evidence that unjust distributions of power, access, and resources significantly hinders the effectiveness of adaptation policy. It is important to distinguish sociocultural constraints from what is often referred to as the 'root causes of vulnerability' (Eriksen et al. 2015; Nagoda and Nightingale 2017; Ribot 2014), as they both relate to the values, commitments, worldviews, knowledge systems, and political economic systems that structure uneven distributions of wealth, well-being, and power. While the two concepts highlight similar problems, they differ in both material effects and analytical purpose. Simply stated, the root drivers of vulnerability are the systemic social and political factors and processes that cause and structure spatially and socially uneven exposure, sensitivity, and precarity to climate risks and hazards. In contrast, sociocultural constraints are social and political factors that make addressing such causes of vulnerability an immense challenge. In many cases, the factors comprising root drivers of vulnerability and sociocultural constraints are likely to overlap—for instance people are vulnerable because they are excluded from decision-making and the lack of democratic institutions constrains effective and sustainable adaptation. Indeed, addressing vulnerability is challenging in part because many of the reasons people are vulnerable are the same reasons reducing vulnerability is so difficult. Analytically, elucidating the root drivers of vulnerability highlights what to target through interventions, while explicating sociocultural constraints illustrates the barriers that interventions need to overcome to achieve desirable outcomes.

4.3.5—Connections between constraints

To understand how constraints persist, it is crucial to examine how they connect. Connections between constraints can reinforce and amplify the factors hindering effective adaptation. In isolation, it can appear that an individual constraint is easy to overcome. When understood to be part of a broader network of constraining factors that interact, though, it becomes clearer that addressing barriers and limits one at a time can be ineffective. Moreover, tracing the connections between constraints can help illuminate critical clusters of constraints that, if addressed, could lead to cascading positive change.

Connections between various constraints can take a variety of forms. One constraining factor could reinforce or deepen another. For instance, institutional arrangements that are mismatched to the problems associated with climate change can reinforce challenges associated with gathering usable climate information. In such a situation, mismatched and misaligned institutions structure decision-contexts that are difficult to fit effective climate information. Similarly, two constraints could also exist within a feedback loop. A lack of both public concern and political leadership, for example, can create a reinforcing loop in which the general public does not push for adaptation policy and elected officials do not make the case for planning for the impacts of climate change. Additionally, some constraints can cause others to exist. For instance, deeply held belief systems structuring unsustainable development patterns can cause the design of institutions that are maladaptive. As an example, privileging private property rights above protecting coastal ecosystems has caused the design of coastal management institutions that have contributed to accelerated beach erosion (Cooper and Pilkey 2014; Leatherman 2018; Summers et al. 2018). Though it is likely that other types of connections exist between constraints, these three forms (reinforcing, feedback loop, and causal) offer a beginning for analyzing how various factors hindering sustainable adaptation interact and intersect.

4.4—Adaptation constraints along the Jersey Shore

4.4.1—Overview of the region

The New Jersey shore region stretches one hundred twenty-six miles along the Atlantic Coast from Sandy Hook in the north to Cape May in the south. In total, the region contains 664.5 miles of tidal coastline, which includes mainland beaches, peninsulas, barrier islands, and back bay areas. The vast majority of the region consists of densely developed suburbs with a few small cities, such as Atlantic City, Long Branch, Asbury Park, and Cape May City. The most populous municipalities are large suburban communities, such as Toms River Township (pop. 93,017), Brick Township (pop. 75,061), and Middle Township (pop. 65,603). However, like most of New Jersey, municipal governments in the shore region tend to be geographically small. Because of this, most barrier islands are comprised of multiple municipal governments. For instance, Atlantic City, Ventnor, Margate, and Long Port are all located on Abescon Island, while Barnegat Light, Beach Haven, Harvey Cedars, Long Beach Township, Ship Bottom and Surf City are all located on Long Beach Island. Thus, most municipal governments only control small portions of coastline and management of the coastline(Bates 2016)

The shore region is exposed to a number of plausible climate change hazards and risks, such as sea level rise, coastal flooding, storm events, increased temperatures, and ecological change. A recent report by the state's Coastal Management Program (NJDEP 2016) found that of New Jersey's miles of shoreline 67% is currently either at high or very high risk to coastal erosion while 60% of the coastline is at high or very high risk to sea level rise that has already occurred during the past century. Both of those proportions are likely to increase due to the accelerating pace of sea level rise as well as to subsidence due to groundwater extraction and land compaction. Indeed, New Jersey is considered a 'hot spot' for sea level rise (Cooper et al. 2008).

The aforementioned sprawling development patterns have placed numerous people and critical infrastructures in harm's way (Bates 2016; Leichenko et al. 2014; 2015; O'Neill and van Abs 2016). Recent analysis suggests that New Jersey is among the states with the greatest number of people and economic activity at risk due to sea level rise and land inundation (Haer et al. 2013). Already coastal hazards are becoming a frequent occurrence in the region. Superstorm Sandy caused $30 billion in

damages and twelve deaths in the state of New Jersey in 2012 (New Jersey Office of Emergency Management 2014). A year earlier, Tropical Storm Irene caused $1 billion in damages and seven deaths. By midcentury, if sea level rises by 1.2 feet, there is a 50% chance of unprecedented floods in Atlantic City and a nearly 100% likelihood in Cape May (Strauss et al. 2014). Beyond such severe impacts, the increasing prevalence of nuisance flooding already regularly causes road closures throughout the shore region. A report by the Union of Concerned Scientists projects that by 2050 about 62,000 homes in New Jersey will be at risk of routine flooding—of which Ocean City, NJ accounts for more than 7,200 properties (Union of Concerned Scientists 2018, p. 5). Yet, since 2009, homes have been built in areas at a high risk of coastal flooding at a pace three times greater than in areas less flood prone (Climate Central and Zillow 2018).

Numerous studies by nonprofits (i.e., New Jersey Future 2015; Regional Plan Association [RPA] 2017; Urban Coast Institute [UCI] 2016), state agencies (i.e., New Jersey Office of Coastal and Land Use Planning 2015), and scholars (i.e., Bates 2016; O'Neill and van Abs 2016) have found that actions taken by local governments in New Jersey to address climate change risks to be severely lacking. As billions of dollars in disaster aid entered the region, the focus of most local and state governmental actors was to quickly 'restore the shore' with little to no focus on systemically addressing the drivers of coastal vulnerability (Bates 2016; O'Neill and van Abs 2016). The state's general lack of adaptation planning and management earned it a D- grade for coastal flooding preparedness in Climate Central's 'States at Risk: America's Preparedness Report Card', which assesses both climate threats and the level of action states have taken to prepare for them (States at Risk 2019). The grade compares unfavorably to the nearby states that are exposed to similar coastal flooding hazards, such as Delaware (B+), Maryland (A-), and New York (B).

Unsurprisingly, then, a plethora of constraints to sustainable and effective adaptation have been documented within the New Jersey shore region. For instance, Leichenko et al. (2015) identified a number of constraints reducing the effectiveness of policies to improve coastal resilience in the Barnegat

Bay region. In particular, their research highlighted that many stakeholders in the area believed there was a need for new, more systemic and regional approaches for coastal planning that contribute to transformative outcomes. To accomplish this, they argue for collaborative initiatives between scientists, stakeholders, and policy-makers that seek to explicate the limitations of current policies, barriers to implementing more effective ones, and possible alternative pathways towards more resilient and desirable futures (Leichenko et al. 2015).

Other research further documents the need for, yet lack of, transformative change in the New Jersey shore region—with both deficits within public concern and political leadership being highlighted. For instance, Bates (2016, p. 120), in explaining the rush to 'restore the shore' after Superstorm Sandy, points towards "a widespread belief that social problems—especially environmental problems—have technical solutions. Rather than questioning the fundamental, underlying patterns of social organization, people increasing turn to engineers for solutions. Public policy reflects this preference." That is, public belief in technical fixes to problems such as sea level rise, coastal flooding, and storm events contributes to elected officials putting forward such solutions. Alternatively, Van Abs and O'Neill (2016) argue that Sandy was not a transformative event because "there has been little leadership in government and other major institutions to frame it as a transformational event" and that "[w]ithout support from large-scale institutions for lending, planning, and regulating, even the people who became concerned because of Sandy will have difficulty finding the ideas, tools, encouragement, and policy frameworks to take action." In other words, in this analysis a central driver behind 'restoring the shore' was that no transformative responses were articulated and no transformative resources and knowledge were produced and disseminated. Thus, these two analyses suggest a feedback loop between public trust in technical solutions to environmental hazards as well as a lack of leadership for transformative approaches. The public does not demand transformative change, while leaders do not make the case for systemic change.

However, research has yet to document how such constraints emerge, connect, and persist within the New Jersey shore region. In the remainder of this section, I employ the heuristic developed above to highlight

the systemic, causal social, cultural, and political factors at the heart of ineffective adaptation planning. By doing so, a case is made that incremental change in the short-term is unlikely to be able to address constraints to sustainable and just adaptation and, therefore, transformative change is needed. Findings are based upon semi-structured interviews, participant observation during workshops and conferences relating to coastal sustainability and adaptation, and textual analysis of documents examining coastal vulnerability and resiliency in the region. Semi-structured interviews were conducted from summer 2016 to fall 2017 with thirty-five municipal government staff members and elected officials in eight localities as well as with ten staff members working for eight different environmental organizations that work on coastal issues in New Jersey.

The municipalities where interviews were conducted included a range of social and physical characteristics—including communities with populations of more than 75,000 and less than 1,500 as well as ones completely on barrier islands and ones with significant mainland regions outside of flood prone areas. The studied communities were also geographically distributed across the New Jersey shore region—spanning from the Raritan Bay in the north to the Delaware Bay in the South. Despite this diversity of social, physical, and geographical characteristics, all communities contained valuable waterfront development at risk to plausible climate hazards. Further, all studied municipalities experienced some level of damage from Superstorm Sandy. Qualitative analysis is used rather than quantitative in order to avoid conflating the most frequently mentioned constraints with the most crucial constraints hindering sustainable adaptation. Analysis focuses on highlighting the constraining factors at the heart of slow and ineffective adaptation by tracing the critical connections between various constraints mentioned. By doing so, the aim is to elucidate the more fundamental sociopolitical constraints that most likely need to be addressed if sustainable adaptation is to be achieved.

4.4.2—Technical constraints

Invariably, interviewees within municipal governments highlighted a lack of funding for resiliency and adaptation projects. This challenge of funding manifested both in hindering the design and

implementation of policies as well as not having sufficient staff to allocate the necessary bandwidth to potential climate risks and hazards. Additionally, interviewees highlighted the challenge of allocating time to apply to grants to try to secure funding for adaptation actions. Thus, a time and money crunch were seen as hindering effective adaptation actions.

Additionally, interviewees within both municipal governments and environmental organizations frequently contended crucial decision-makers within local governments lacked sufficient knowledge about climate change. Thus, while planners, engineers, and other staff members tended to believe they possessed sufficient knowledge, they pointed towards deficits in knowledge among mayors, council members, and commissioners. For instance, the leader of an environmental organization focused on coastal issues stated a major obstacle to addressing coastal vulnerability was that "the people that sit on the planning board or the zoning board, they're not necessarily experts on—or even really aware of—the many sea level rise and resiliency-related issues. And I feel for them. They are, you know, moms and dads and they have got to work for a living. They are balancing a whole lot of other things." This connects to the aforementioned fragmentation of the shore, as the majority of coastal municipalities are too small to have significant full-time staff.

While funding was the most frequent constraint mentioned and lack of knowledge second, interviews demonstrated that lacking such resources were not the most important factors hindering resilient coastal governance. Indeed, within most interviews, actors expressed their belief that they knew enough about climate change hazards to create better plans and policies. Generally, interviewees also tended to believe that elected officials knew that, in general, climate change was a serious issue that would dramatically alter life in the shore region—especially after experiencing the effects of Superstorm Sandy and participating in various initiatives to provide municipal governments with tailored and usable climate information. The success of one of these initiatives is examined in detail in Chapter Five. Thus, sustainable adaptation policy is not currently significantly hindered primarily by technical constraints.

Rather, as the rest of this section will document, institutional and sociopolitical constraints act as the main barriers to sustainable adaptation.

4.4.3—Institutional constraints

Municipal actors often pointed towards regulatory mandates as key barriers to pursuing long-term adaptation and resilience projects. Interviews were conducted at a time in which federal and state funding was flowing into the region as part of Superstorm Sandy recovery programs. However, as municipal officials pointed out, the recovery funds came with significant conditions and constraints. As one city councilmember stated that "Congress essentially gave municipalities money to replace what was there, which is a huge problem. If you get damaged by a storm, there should be money to do better. You gotta make it better, but they [municipalities] just get to build it back." Thus, municipal governments' ability to pursue alternative management regimes with recovery funds was curtailed by the design of federal and state programs.

Moreover, FEMA flood zone maps made long-term planning post-Sandy difficult for two reasons. First, FEMA can only use historical data to designate flood zones. While local municipalities can create stricter zoning requirements, local decision-makers typically argued that it was politically untenable to implement stricter requirements than required. Within interviews with floodplain managers and zoning officers, the primacy of FEMA maps in long-term planning was frequently highlighted, even though such individuals typically understood that future floods would not reflect the maps. Second, the maps available post-Superstorm Sandy were only provisional. In the aftermath of Superstorm Sandy, FEMA produced provisional maps ahead of official revised maps, which were expected to increase the size of flood zones. The provisional maps were aimed at helping municipalities avoid rebuilding in ways that would not meet the standards of the forthcoming flood zone maps. However, the provisional nature of the maps created a great deal of confusion and controversy, as homeowners argued the maps were too restrictive and not official. This created strain between some municipal governments and community members.

Another constraint in the region is that coastal management institutions follow a 'predict-then-act' framework. When asked what forms of climate information that wished they had access to, municipal staff often responded that they would like information that fits within benefit cost analyses. As described earlier, such institutional arrangements are ill-suited for addressing problems associated with climate change due to the deep uncertainties regarding the form, magnitude, and timing of climate impacts. Rather, as documented within Chapter One, research suggests that robust decision-making institutional arrangements that prioritize flexibility and acceptable performance across a wide array of plausible climate futures better fit the problems associated with climate change. However, information that provided an overview of the range of plausible climate impacts was frequently deemed to not be particularly useful within existing decision-making frameworks. This suggests that institutional change is necessary for effectively addressing the challenges associated with climate change.

Interviewees also frequently brought up difficulties gaining permitting approval from the New Jersey Department of Environmental Protection (DEP) for replacing hard coastal infrastructure with nature-based solutions, such as dune and marsh restoration projects. While interviewees did acknowledge that the state had improved the permitting process in recent years, they still often found it much easier and faster to get approval for constructing seawalls, reventments, and jetties. Beyond regulatory challenges, municipal engineers also had significant more experience working on hard solutions rather than nature-based ones. Moreover, it was stated that building dunes and restoring marshes can have more upfront costs than hard engineering projects. For instance, during an interview with staff members of an organization advocating for nature-based solutions, it was stated that the two biggest hurdles for doing a living shoreline project is securing funding and getting state permitting approval. In particular, they stated that marsh restoration is challenging because it entails discussions with state and federal agencies regarding habitat tradeoffs and making sure that such projects do more good than harm, which is not always straight forward in determining. While the staff members made it clear that these constraints could be overcome with discussion and collaboration, they do hinder the spread of nature-based solutions.

Furthermore, the spread of new, more resilient policies was constrained by the fragmentary nature of coastal zone management in New Jersey. For many staff members of environmental organizations, the lack of a regional approach was seen as a crucial factor slowing down the spread of climate change adaptation policies and plans. Indeed, non-profit advocacy organizations often frame their work as setting the ground work for a regional approach to coastal management. For instance, in one interview with staff at a prominent environmental organization it was stated: "Ideally, we are going to get beyond sort of the project by project approach and do some more regional or state-wide planning…Ideally, we get to the point where you are looking at the vision of the coast beyond one project or community. That's a huge challenge. So, we're just sort of viewing our work as the stepping stones and just laying the groundwork for bigger conversations that are going to have to happen." This notion that non-governmental organizations could only achieve so much without coordinated regional efforts that brought together state, county, and municipal governments was expressed both within interviews as well as at conferences and in reports, such as The Fourth Regional Plan by the Regional Plan Association and Sustainable and Resilient Coastal Communities by New Jersey Future.

Related to the issue of the fragmentary nature of coastal management are debates around the concept of 'home rule' in New Jersey. The concept of home rule entails that municipal governments have significant autonomy in creating and implementing regulations. Importantly, while municipal government officials in New Jersey frequently argue for home rule, there is no constitutional requirement for home rule in the state (Salmore and Salmore 2013). Thus, though home rule is often treated as a regulatory barrier to regional management of climate change impacts, it is more a political and cultural barrier than a regulatory. As one individual with decades of experience working in New Jersey on coastal environmental issues explained about home rule: "It is actually a recent thing. The home rule stuff is a political construct, and it's only under the Christie administration that it has gotten a lot of focus. I mean, municipalities always claim home rule, but when you start talking about resources or issues that are larger than local in nature, then the state steps in and regulates them or creates regional bodies to deal with them.

But it [bringing up home rule] is a dodge, because if you agree that the mayor is the ultimate decision-maker, then you'll never be able to address any of these issues." Thus, as was further explored in Chapter Three, the fact that the state has minimal regulatory oversight in regards to small-scale development in the New Jersey shore region is a result of political choices to not do so.

Institutional and policy inertia at the state-level also has contributed to municipal decision-makers generally maintaining the policy status quo. For instance, a municipal administrator stated: "My joke is always that the state of New Jersey just built a sixty-million-dollar bridge from the mainland out to Long Beach Island. So, who am I to argue [for coastal retreat] in this little town if the state and the county are doing these major projects?" In other words, at the level of the state government, investment continues to be made in infrastructure that both is vulnerable to climate change impacts and encourages additional development in areas that are exposed to climate hazards. In light of this signal that state investment will persist, municipal governments continue following existing development patterns.

Interviewees also repeatedly mentioned the existence of competing local policy objectives that took priority over addressing climate change risks and hazards. These priorities tended to focus on the need to restore, maintain, and grow the local economy. For instance, in the immediate aftermath of Superstorm Sandy, many local governments along the shore focused on making sure summer tourist attractions were ready by Memorial Day weekend. The same official that pointed out the requirements attached to recovery funds largely build back what previously existed also stated that even if municipalities had more control, many would have still rebuilt largely to pre-storm conditions because "they were just concerned about being open by Memorial Day." Indeed, Governor Christie made numerous public statements about the importance of resorts being opened by Memorial Day—including a promise to be in the resort community Belmar on Memorial Day to open the boardwalk (see: Bonamo 2012). A director of a large coastal conservation nonprofit stated that "the governor made a decision after the hurricane to build it back right away, and the arrogance of his viewpoint that we are going to be stronger than the storm" contributed to vulnerable coastal development that relied on hard engineering solutions. Similarly, many

interviewees working in municipal government stressed the need to rebuild quickly so as to maintain property tax revenue. Indeed, in many interviews, recovery from Superstorm Sandy was defined in terms of current property values compared to pre-storm levels. One municipal administrator stated that after Superstorm Sandy "I thought, this is all going to turn into marshland, but it is all about how fast you can turn it around and get the tax base back." This sentiment of needing to recover as fast as possible was captured in the ubiquitous slogan to 'Restore the Shore' found on bumper stickers and in governmental documents.

Beyond recovering the local property tax base, the desire to maintain the pre-storm tax base over the long-term also constrained adaptation. In one case, a borough administrator explained their struggles with the concept of coastal resiliency because it suggests that "maybe we shouldn't be building on the bay shore—because it is just going to flood again and again. Well, I don't want to present that [to the public] because people would be like 'well, I'm not rebuilding' and then I'm going to lose tax payer money. So that is where the balance is. Yes, resilience [as a concept] is very helpful, but I don't want to scare the residents that the whole town would be under water." That administrator further stated they had recently approved four million dollars of water and sewer lines in areas that would likely be repeatedly flooded in the next few decades. Such a situation is typical in the shore region, where the most valuable property—and therefore most significant source of property taxes—is frequently the closest to the water and most prone to flooding. As one individual with decades of experience advocating for more environmentally sensitive development in New Jersey argued, "the most powerful driver [of not addressing coastal hazards] is the property tax system of funding municipal services—particularly education." Thus, beyond wanting to restore infrastructure and buildings as quickly as possible, municipalities generally were hesitant to take actions that might reduce long-term property values or decrease overall tax revenue. Similarly, in an interview with staff members at an organization working on implementing nature-based solutions to coastal flooding, a situation was described in which a municipal government was willing to pursue a living shorelines project because it was aesthetically pleasing; yet, at the same time, would only do so as

long as it did not attract endangered species. The reasoning by decision-makers in the municipality was that a living shoreline could increase property values but attracting endangered species would create regulatory burdens, decrease tax revenue, and increase costs.

Municipal officials are also hesitant to pursue new coastal policies if doing so would entail raising tax rates. For instance, in one small municipality, municipal officials reported that they did not participate in FEMA's Community Rating System (CRS) because doing so would require hiring a staff member to handle those duties. Even though participating in the CRS would contribute to lower flood insurance rates for residents, the municipal government worried that property owners would balk at needing to raise property rates to hire a staff member to oversee the program. This concern over the possibility that addressing climate hazards would require instituting higher property tax rates is particularly keen in New Jersey, where property taxes are already high.

Worries about raising taxes rates reflects another constraint: a general lack of public demand for climate change action in the region. Municipal staff and officials rarely felt that local residents prioritized addressing medium- and long-term climate change risks. This is not to say that residents of the region deny climate change is a real threat. One municipal planner stated that: "They believe in it, but they don't think it is going to affect them. They feel like they pay flood insurance, so even if it does flood, they'll be fine." The planner continued with an anecdote of an active member of a local environmental organization telling her that the municipality ought to force people to move out of flood zones; yet that same individual owned a property immediately on the shores of Barnegat Bay. A different staff member also brought up the organization and pointed out that even though the organization is concerned about sea level rise "most of them live on the bay and most of them rebuilt their homes after Sandy and didn't take the opportunity to donate their homes to Blue Acres or anything." In a different community, a chair of an environmental commission stated that: "if I asked people what are you concerned about, [they'd respond that] it's the bread-and-butter issues: taxes, traffic concerns, and so forth. I don't think people are so focused on [sea

level rise]—they should be." Thus, municipal actors did not perceive pressure from the public to address medium- and long-term climate hazards.

Public pressure did exist to quickly rebuild after Superstorm Sandy. One zoning officer stated that "no one is worrying about what is going to happen in fifty years when they are still waiting to have their flood insurance claim processed. And all we had was a lot of local screaming and yelling" about the need to rebuild. Similarly, a planner in a large municipality explained that "I could tell you countless stories of people coming to the front counter after the storm with plans to rebuild their house and our building code official rejecting their plans because they weren't to the basic floodplain elevation. And them complaining that we're adding costs to their redevelopment." In other words, while municipal actors did not feel much pressure from the public to pursue medium- and long-term adaptation actions, they did recognize significant pressure to immediately and quickly rebuild after Superstorm Sandy.

Lack of leadership on addressing climate hazards at the state and municipal level both exacerbate and are exacerbated by the lack of public demands for systemically addressing sea level rise, coastal flooding, and potentially devastating storm events. Without elected officials making the case for addressing climate risks and hazards, the public is not given concrete reasons to care about potential future threats. For instance, the zoning officer of the small back bay municipality that pointed towards public pressure to rebuild argued that the time to make the case for systemic change was "before Sandy." Once the storm hit, it was too late to rethink planning and policy. However, municipal actors also report that elected officials are afraid of getting ahead of the public on developing strategies to address climate hazards. Even in cases where mayors and council members believe sea level rise presents a serious threat, interviewees often stated that key decision-makers hold a 'NIMTOO' mindset—meaning: 'not in my term of office'. That is to say, in some cases elected officials worry that pursuing policies capable of effectively responding to projected coastal hazards will result in them being voted out of office. For instance, a township administrator of a small back bay community stated that if you are an elected official "you don't want to go out and say to someone, hey you are going to be underwater in 2050; as a

politician, you are going to get voted out." In a different interview, a staff member of an environmental organization argued that "intellectually, they recognize these issues, but elected officials also recognize they are working under political constraints and if they get too far out in front of their constituents on things like property buyouts, then they will not get reelected." Thus, for many elected officials, the incentives to not act often outweighed the incentives to address climate hazards.

In some municipalities, this reluctance of elected officials to implement long-term adaptation plans created tension with staff. One engineer explained that in their experience of working in local government that "your engineers, your people that work here [in municipal government departments], are supposed to think about the next fifty years; whereas, the elected officials—except in the situation of mayors that want to be the mayor of a small town forever—they think about the next two to six years, because that is the electoral cycle." The engineer continued to express their struggles gaining support on thinking about the need for managed retreat from flood prone areas—a position also supported by the township's municipal planner. They went on to state that: "You can arm your policy makers and your decision-makers with all the information, but it is all about the next election." Similarly, a floodplain manager in small coastal community stated that "you need to remember that, for the most part, these are elected officials that need to make these decisions. They're going to run around every three to four years. We are talking about a fifty-year-run here" in regards to climate change hazards. Thus, in some cases, it was not that municipalities lacked staff to work on issues of coastal adaptation; rather, they were constrained by a lack of support by elected officials.

Moreover, in some interviews, it was stated that elected officials and high-ranking staff members were concerned about publicizing information about projected climate impacts. For instance, one planner stated that the municipal business administrator objected to making sea level rise maps easily available because they were concerned that "the people won't come back." In a different location, a consultant that had worked with a municipal government to assess coastal vulnerability stated that there was political resistance to publicizing sea level rise maps because local officials "didn't want to get people concerned

about it." Indeed, one township administrator stated that they were concerned about releasing information about projected sea level rise to residents living near the coast "because that is a huge tax portion of our revenue in our town. The people down there, they want to be on the water and I don't want them claiming tax appeals" because of what the municipalities publicizes about sea level rise. Therefore, they stated "we had to be bureaucratese about it." Thus, the overriding concern about maintaining and growing the municipal property tax base not only contributed to elected officials pursuing maladaptive policies but also led to wariness about informing local communities about their personal vulnerability.

The lack of political leadership at multiple scales is an important factor constraining adaptation because support from key policy-makers frequently is needed to overcome other barriers. For instance, one engineering consultant described how financial and regulatory constraints were navigated to construct a sea wall along the northern shore of Atlantic City, a municipality with significant financial constraints. In this situation, the engineer began by saying "if you don't have that political push, whether it is through a law firm or an elected official, it's hard to get something done—even when it is the right thing to do." They continued by explaining that:

> "The seawall here in Atlantic City was planned twenty-five years ago. It's the whole North End of the city. That area has been ravaged by storms in the 40s and 60s and then Sandy. But you could never redevelop it. The Army Corps always had a 50-year plan to build a seawall. They don't like to build sea walls, but in this case because of the wave action that could do anything less--it couldn't be a living shoreline, it couldn't be anything soft. When I started here, I asked: "okay, why can't we get it done, what is the issue?" We couldn't get a permit. So, we worked with Deputy Commissioner at the time who understood. She understood the importance of Atlantic City and the importance of that area. After a number of meetings, she told her staff, we are doing this. We got a permit. That's it. After twenty years of people saying you can't get a permit. And now it's built and it changes the whole city. It changes people's quality of life. It's changing the demographics of the area. It's changing the economics of the area. But somebody had to make a decision. So there than are the kind of things that shouldn't take 20 years. The money—fifty million dollars—money was the easy part. DEP Coastal Engineering got involved. DOT gave us money. DCA [Department of Community Affairs] gave us money. FEMA gave us money. There were six different pots of money being used there. The city bonded ten million dollars--a city that is broke--ten million

> dollars. Because it was the right thing to do. Now it's done, because it was the right thing to do. That takes real leadership."

As this quote demonstrates, many constraints can be overcome—whether they be a lack of financial resources or regulatory obstacles. However, while it might be the case that in Atlantic City a seawall was the most effective solution to coastal erosion and flooding, it is also true that building a hard, engineered solution to such problems fits within the broad contours of development and management strategies that have dominated the region for more than a century—as documented in Chapter Two and Chapter Three. Indeed, the same engineering consultant that relayed the above anecdote acknowledged as much. Immediately after explaining how the seawall was funded and built, they stated that: "Most of the administrations in New Jersey since I've worked here—and I've worked here for thirty-five years—have been Democratic and pro-environment. But they still haven't gotten it done. Because there is a bigger world out there that you don't change. They [developers and engineers] all friends of mine; I went to school with them. It's just a mindset that you can't be flexible. It's just not right." This points towards a deeper driver of maladaptive and vulnerable development in the New Jersey shore region that relates to fundamental beliefs and values regarding what is possible, desirable, and important within governing and managing the coastline. These political, cultural, and economic forces make up the sociopolitical constraints to sustainable adaptation in the region.

4.4.4—Sociopolitical Constraints

As a longtime leader of an environmental organization focusing on coastal issues explained: "There's just a build-in mentality that is inherent in New Jersey's approach to coastal development. There's a lot of money to be made. All those folks influence the policy development and therefore make it very hard to change things…So, you know, the system is rigged against resiliency and it's very, very difficult to change the policies that are in place or at any kind of wide scale—even in the aftermath of a hurricane." Similarly, though from a very different perspective, a long-term municipal planner argued that, while information about sea level rise is "fascinating from an intellectual point of view", "it's much more

difficult to come up with rational reasons to restrict development or overly restrict development." They later stated that: "Just the idea of trying to phase out development potential over time is extraordinarily difficult. How do you do that? You can't. You can't stop development for no reasonable reason." Instead, this municipal planner argued that: "My view on that is that property will be on the shore as long as it has value. If it gets flooded during a full moon, it's not going to have a lot of value anymore." In other words, they believed that, ultimately, market forces should determine whether or not coastal development persists. This belief that as long as coastal property has market value there was no justification for curtailing existing or new development was a common refrain in many interviews.

Indeed, municipal officials typically framed their actions as meeting consumer demand for coastal property. For instance, a municipal administrator stated that "people live on the water because people want to live on the water. Even after Sandy, that is a commodity. It is gold and silver, it is down in price right now. But they are never cutting another lagoon. That price will come back and that price is almost back to pre-sandy land values—not quite there." Even when municipal actors seemed skeptical about the ability to maintain infrastructure in the long-term, they typically saw demand for coastal property persisting. For instance, a floodplain manager stated that regardless of future climate change, "people will still want to be on the shore. It will still flood. We will have many more flooding events...We will have many more worse storms... Basically, things will be the same. People aren't going to learn lessons. Politicians aren't going to spend money. Engineers and eggheads aren't going to spend money. And the people that do the construction aren't going to get the money. Therefore, the concrete improvements aren't going to get done."

As documented in Chapter Two and Chapter Three, a belief in the capacity of technological innovation and engineered solutions has long been wide spread in the region and has persisted despite frequent hazards. In particular, municipal actors often highlighted elevating homes and infrastructure as crucial strategies for making the region more resilient. One planner argued that because of recently constructed revetments, barrier island properties "are protected forever." An ongoing study by the Army Corps of

Engineers examining strategies to mitigate flooding within back bay regions of the shore was often mentioned by municipal actors as a potential source of solutions for dealing with climate change, though interviewees tended only to have a general, vague sense of what was occurring.

As an extreme example of trust in technical solutions, municipal actors located on a barrier island reported that in response to sea level rise, they could raise the elevation of the entire island: "I mean, not only are homes being built at higher elevations, but we're encouraging people to elevate the land—the dirt—as well. And so, you know, bring in a few loads of fill…Then, when properties are elevated, the next time we pave that street we have the opportunity to elevate the street. Everything in the neighborhood is elevated…You know, that happens throughout a whole generation of properties being torn down, reconstructed, whatever has to be repaired." Thus, within this barrier island community, not only did they envision raising up homes, but they also planned to raise the entire island. Notably, this strategy only works if homes continue to be destroyed by storms. Every time a strong coastal storm destroyed properties would become an opportunity to raise the elevation of the island and stay ahead of sea level rise.

Beyond framing potential climate change impacts as technical challenges, municipal officials also stressed the need to get better at post-storm rescue and recovery. As one municipal administrator pointed out, "we can't elevate all the roads. We can make the houses go up ten feet. The roads—the most I can add is six or eight inches on a repave. There's still going to be flooding...Understanding the complexities of trying to get down there to save someone when there is four and a half feet of water. The house might be ok, but now someone has had a heart attack." Thus, while acknowledging that disasters would occur in the future, municipal officials argued that future responses to extreme events would be more efficient and recovery efforts more effective.

Overall, feelings amongst municipal actors regarding the desirability of these types of futures was mixed. One floodplain manager expressed melancholy about the visual effect of becoming more resilient to

flooding impacts. When asked what they hoped the future would entail for the community they worked within, they stated:

> "The majority of houses are lifting now. And so, you walk down, and instead of seeing everyone's porches, you are seeing garage doors. It's really got kind of ugly. So personally, from an aesthetic standpoint, it hasn't been a positive change to get flooding resilient. You can see for yourself you can find a little house it hasn't been lifted yet and two houses next door that have been lifted, and that's the way it used to be but now it's all concrete and garage doors. It's less of an impact up north where the homes are big and many the new homes were lifted anyway, and people wanted to see over the seawall anyhow, so they lifted up anyhow, but it's more the downtown community, I think it's not been a positive impact. It's almost like a hanging on scenario, like we want to live here, we want to stay here, this is the only way were going to be able to do it. It may be becoming more flood resistant. I don't know that it's changing the town for the better. Says that it's something that has to be done if you're going to live here. So, in the future, I don't know, I guess this is going to continue that way. And that's the way it will be. Everything is going to be up in the air."

This discontent with, and sometimes almost elegiac view of, 'hanging on' in the face of growing climate hazards frequently permeated discussions of the future of the shore region. In some cases, this unease with this status quo translated into a desire to more fundamentally depart from existing development and management models. However, how this could be achieved remained vague and to be figured out in the future. For instance, a planner working within a large coastal municipality stated that:

> "I personally, my personal belief, is that we should be considering long-term changes at the same time as our short-term changes. And I am a 'retreatist'. So, I do believe, that I should be preparing our elected officials-slowly but surely—to adopt the concept of retreat. At the same time, recognizing that the local economy and the public will is not there yet. It is a tightrope walk, but I'm lucky in that we have professionals that have shared visions here and we are just laying the groundwork. Ultimately, at some point, we are going to have to talk about it. So, I'm sort of trying to work in a bifurcated, parallel universe."

This sense of living in a 'parallel universe' points towards the feeling that most other individuals either in government or, more broadly, living and working in the region do not support managed retreat. This supports the notion that a sociopolitical constraint within the region is a general trust in technical solutions to allow existing development trajectories to persist. However, it also demonstrates while that

view might be the dominant perspective, it is not the only perspective. Rather, some individuals—including some working as planners and engineers—do believe in the need for managed retreat.

The developmental, market-based imaginary found in the New Jersey shore region was also highlighted by employees of environmental organizations as being central to resistance to transitions towards more systemic and transformative approaches to coastal planning. Ultimately, interviewees working within such organizations tended to project a declining coastal region as long as market forces continued to dominate. One employee of an environmental organization stated that:

> "Barnegat Bay is dying, but the state and counties—particularly the counties—refuse to take the steps to limit development because it still provides utility. They are less concerned about the ecological condition of it than they are about their ability to use it as a commodity. So, they can still boat on it; they can still water ski on it; it's becoming harder and harder to swim in it though. But with sea level rise—we got a big bump of federal money after the hurricane to rebuild all these beaches—the money is not going to be there in the future."

Such a view that, unless the values and prioritizes that structure coastal development in New Jersey are transformed, the dominant drive to maximize economic utility would contribute to the ecological and, eventual, social demise of the region was prevalent within environmental organizations.

However, few professional environmental actors were able to articulate an alternative, hopeful vision of the future. For instance, an employee of a different environmental organization at first was surprised by the question of what they hoped the shore region would be like in the year 2050. Eventually, they stated that:

> There will be a lot less beach front. I guess the hope would be that there is much more ability for the wetlands to be given a chance to grow. I think that would be the most hopeful. If we were able to convince the water's edge—not necessarily to retreat from all areas—but to give back the ten feet to nature so that it survives. That we remove the bulkheads and allow nature to grow some of the wetland areas that are getting inundated. So that we have habitat for the 75% of the fish populations that rely on coastal ecosystems to survive.

As one director of a coastal conservation organization stated, efforts to provide information to municipalities have largely focused presenting overviews of plausible threats, but:

> "No one taken the next step to say, here's the vision. Because then you're taking a position. Because obviously not everything is going to get protected. So nobody wants to say well, you know, maybe Mystic Island should be bought out. Maybe Beach Haven West should be bought out. Particularly these places because of the places that were built on salt marshes the other fill communities. Ortley Beach which sits on top of a historic breach, right? It's going to breach again at some point. Nobody wants to take responsibility for that."

Indeed, the efforts of environmental organizations interviewed within this project overwhelmingly took the form of incremental adaptations seeking to work within existing governance and management structures. Environmental organizations tended to position municipal governments as their constituency. This contributed to organizations not wanting to make too strong an argument for transformative approaches to climate change adaptation. For instance, many of the organizations promoting dune and saltmarsh restoration as part of living shorelines projects typically frame such projects as coastal stabilization efforts. In other words, they are framed as 'nature-based' solutions to coastal erosion that would be more effective at protecting infrastructure and property. However, a few interviewees pointed towards the flaw of this framing: saltmarshes, dunes, and other coastal ecosystems are only able to mitigate the risks of rising sea levels if they are able to migrate inland as water levels increase. That is, a restored marsh might be able to reduce coastal flooding in the short-term while staying in the same place, but as sea level rises the marsh will be inundated by water and die out. Thus, living shoreline projects are not a long-term solution to protecting coastal property. Eventually, property needs to be moved or coastal ecosystems will die.

Indeed, as employees of a major environmental organization working to implement living shoreline projects explained: "a living shoreline is about the marsh edge at the water and the room to move is about the open space behind the marsh. So, they're complimentary, but they're not linked, per-se. If you are looking at climate adaptation in general, then open space to allow marshes to move is an additional tool. Living shorelines is one tool and open space protection is another tool." As this suggests, the pursuit of nature-based solutions to coastal hazards is not framed as necessarily a long-term adaptation strategy. In fact, this organization specifically de-links living shorelines from creating the open space necessary for

salt marshes to adapt to sea level rise. Living shorelines, therefore, are framed as a short-term risk mitigation strategy that has the potential to be linked, at some point in the future, to adaptation through the creation of open space. This is important because living shorelines do not, therefore, necessarily challenge existing development patterns. Indeed, the organization typically strives to "work within the existing framework" of coastal management rather than attempting to transform it—at least in the short-term.

While incrementalism is the dominant strategy pursued by environmental organization, few interviewees truly believed incrementalism was sufficient to address the challenges of climate change in the region. For instance, one interviewee explained:

> "Incrementalism, I really don't think it's really going to get us to where we need to be. So that's bad, because our work is a very incremental approach. But what I can only hope is, and I have some hope, that culture matters. And so, by sort of, you know working in the schools and having green teams we can have people take the environment more serious and be receptive to more radical changes that have to come down the pike. So, there's that sort of hope that this sort of you know, incremental steps like raise enough awareness that people are more, you know open to a more educated about more receptive to the radical things that will probably be required."

This laying the groundwork approach that seeks to meet the existing needs of decision-makers prevailed within environmental organizations in the region. A crucial exception was the Surfrider Foundation's 'Rethink the Shore' campaign in the immediate aftermath of Superstorm Sandy. However, this campaign had limited impacts—as acknowledged by the organization itself. One reason frequently given for this was the perception that, under Governor Christie, the state government was not going to support efforts to systemically address long-term coastal hazards. Thus, environmental organizations sought to provide information and resources that would be usable for municipal governments to begin addressing climate hazards. A crucial result of this view, though, was little production of transformative knowledge and resources that foster holistic change towards more sustainable development pathways.

4.5—Differentiating and Connecting Constraints in the New Jersey shore

Figure 6 differentiates the various technical, institutional, and sociopolitical constraints identified above.

The rest of this section highlights three critical clusters of constraints that

Figure 6 Differentiating constraints

interact to hinder imagining, designing, and implementing sustainable coastal adaptations in New Jersey. Taken together, these three clusters demonstrate that without addressing sociopolitical constraints, policy support initiatives are unlikely to catalyze sustainable adaptation actions.

The first crucial cluster of constraints lies at the center of slow and ineffective coastal adaptation. These include political, economic, and cultural commitments to maintaining the existing developmental status quo as well as the dearth of transformative knowledge and resources. Thus, sociopolitical constraints to adaptation include factors on both sides of the science-policy interface. Municipal level policy-makers and staff generally see few—if any—alternatives to continuing to follow existing forms of governance and management. Existing developmentally oriented models of governance and management that prioritized private property rights, economic growth, and engineered solutions tended to be seen as not only the status quo but as the only real option. However, the challenge of imagining and articulating alternatives was also found within interviews with leaders working in environmental organizations. Such organizations tend to position municipal governments as their constituency and seek to provide information and resources that work within existing decision-making contexts. Thus, because municipal decision-makers desired information that fits within existing management and governance systems, the resources provided by environmental organizations was tailored to existing institutional and political contexts. This contributes to an incrementalist approach to coastal adaptation. At the same time, interviewees who worked within environmental organizations also expressed the view that holistic and transformative change was needed in the shore region. How such a switch from incremental to transformative change would occur remained vague. Interviewees tended to explain their hope that something would create a tipping point that catalyzed rapid and extensive change at some point in the future. Ultimately, these two dynamics reinforce one another. Municipal actors continue to perceive that there is no real alternative to the status quo, and therefore do not demand the tools and information necessary to design and implement transformative change. Because there is a lack of demand for such information, environmental organizations that see their role as meeting the needs of municipal governments do not produce such resources. Figure 7 shows in more depth how this feedback loop operates.

The second critical cluster of constraints relates to municipal governments' reliance on property taxes to fund local services. For many elected officials, addressing climate change hazards is seen as politically fraught for two important reasons. First, funding expensive adaptation projects would likely entail either increasing taxes or cutting other services, which elected officials worry could create backlash from voters. Second, adapting to climate change could reduce the property tax base by lowering property values or decreasing the total number of taxable properties through coastal retreat policies. Not only would this reduced property values and coastal retreat also risk voter backlash, but this would also reduce municipal tax revenue. These concerns about property tax revenue also leads to some municipal actors being worried about informing residents about plausible climate hazards, as such knowledge could cause

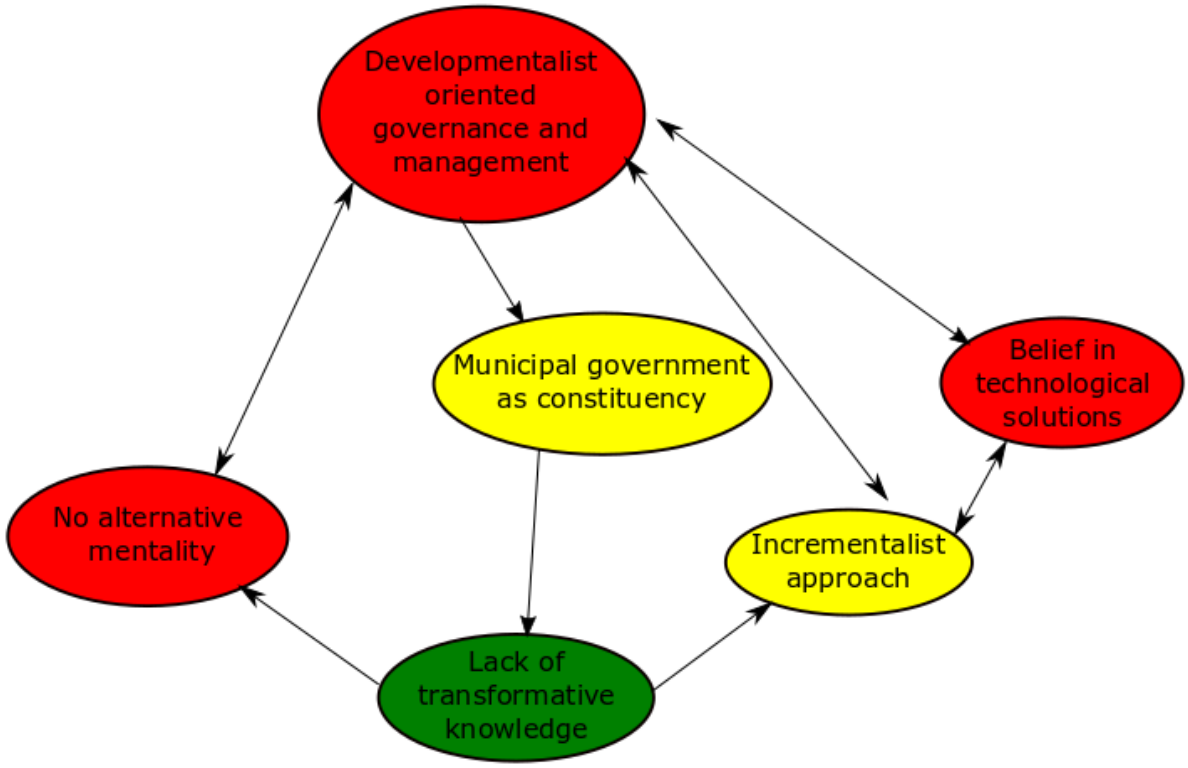

Figure 7 Lack of transformative capacity feedback

property values to also decrease. This worry belies municipal actors' justification that maintaining the status quo as a product of public demand to live on and near the water's edge. Frequently, municipal officials both point toward market demand for coastal properties as grounds for maintaining the status quo, but also worry that providing information to the public would decrease demand for coastal properties. This raises the possibility that one key reason for the lack of public demand for long-term adaptation policies in the shore region is that there are few frank conversations about what climate change entails for them. Figure 8 traces how this feedback loop between a reliance on property taxes, lack of leadership, and little public demand for adaption unfolds.

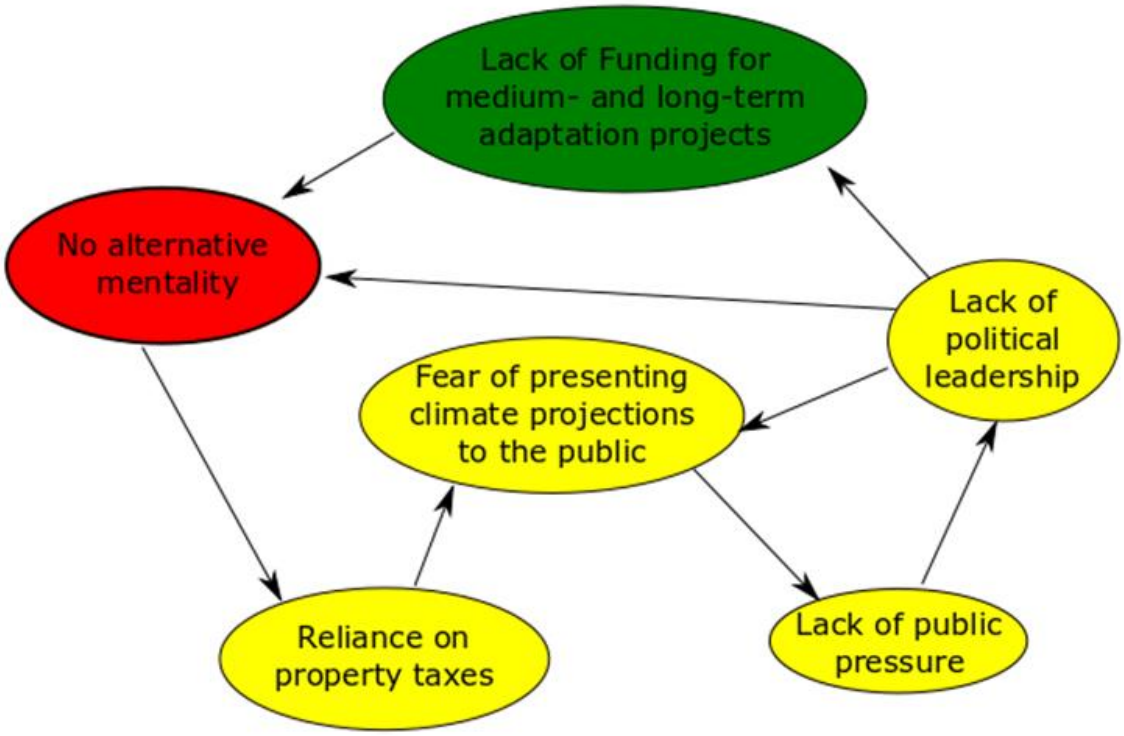

Figure 8 Reliance on property tax feedback loop

The third cluster of constraints relates to challenges associated with producing, disseminating usable climate information within policy-making. While in the short-term, it is possible to produce information that fits within existing decision-contexts and interplays with current knowledge systems, it is highly likely that eventually climate hazards and stresses will become intractable within extant institutional and

governance arrangements. Indeed, it is plausible that the New Jersey shore region—and many other coastal landscapes—exist within maladaptive space (see: Wise et al. 2014). Because climate change creates problems that existing institutions are ill-suited to manage, it is extremely difficult to translate knowledge about climate change hazards into forms usable to municipal decision-makers. Within the shore region, most management and governance institutions follow a predict-than-act framework that seeks to maximize economic benefits. This model has been shown to be poorly suited to coastal governance (Haasnoot et al. 2013; van der Voorn et al. 2017). For instance, municipal actors often stated they wished they had climate information that would allow them to conduct benefit-cost-analysis on long-term adaptation policies—including managed retreat. However, because of deep uncertainty within the form, timing, and intensity of climate impacts, such analysis would be unlikely to be useful even with the best climate information. For this reason, robust decision-making models are suggested as being better suited to addressing climate hazards (Haasnoot et al. 2013; van der Voorn et al. 2017). In the New Jersey shore region, though, deeply entrenched developmental imaginaries that prioritize economic growth and protecting private property rights makes switching to robust decision-making frameworks difficult. Robust decision-making must sacrifice some degree of performance in order to achieve a sufficient performance across a wide range of plausible futures. Existing commitments to maximizing economic growth and preserving private property rights can therefore be seen as the sociopolitical constraint to the production and integration of usable climate information. Until such commitments change, coastal management and governance institutions will be poorly suited to use even the best tailored information.

Figure 9 demonstrates how such imaginaries drives the challenge of producing usable climate information.

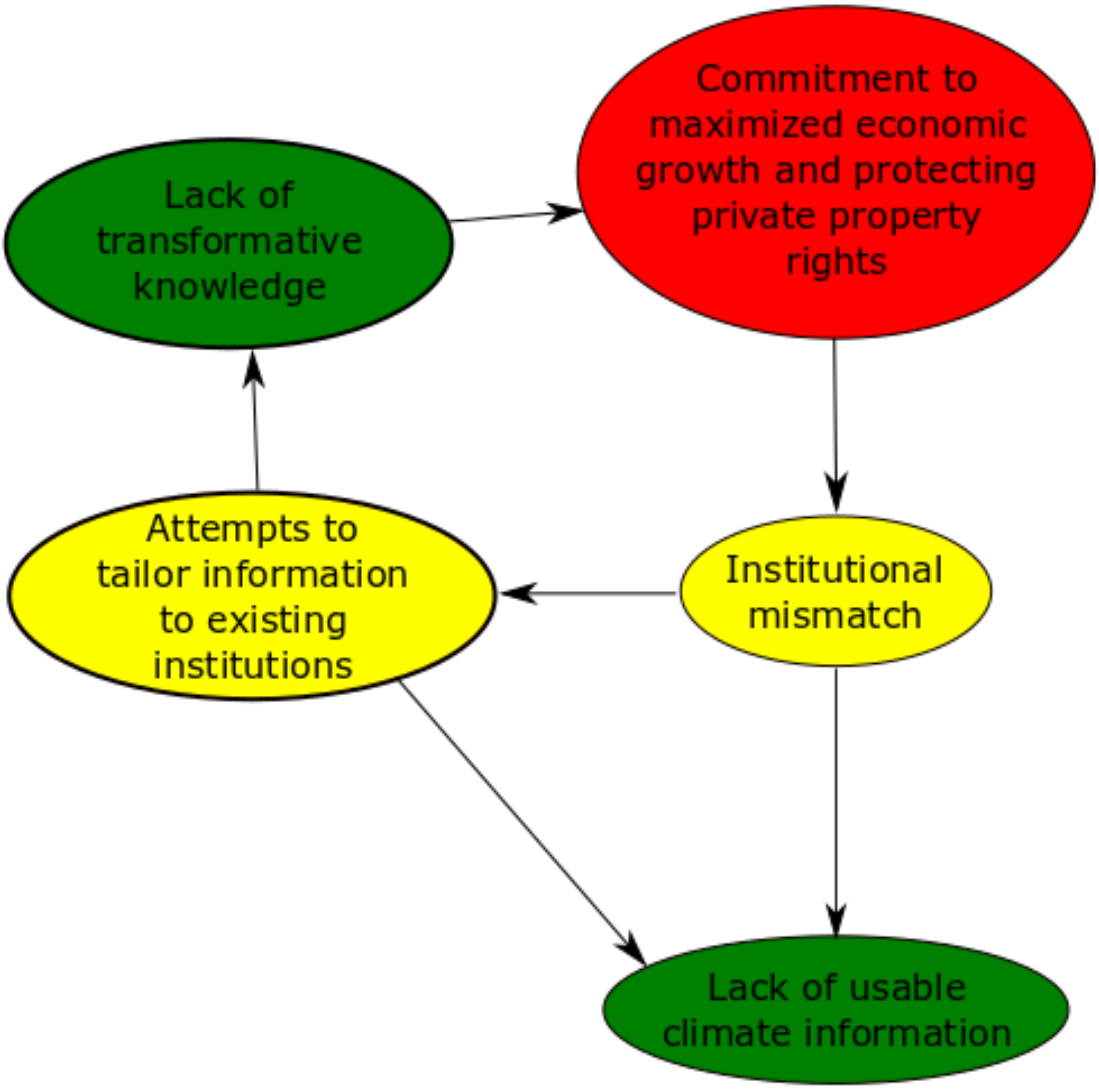

Figure 9 Development commitments driving lack of usable information

4.6—Conclusion: Moving Sociopolitical Constraints to the Fore

In the New Jersey shore region, efforts to help municipalities create and implement climate change adaptation policies have focused predominately on addressing technical constraints. Initiatives have been designed to provide municipalities with usable climate information that fits existing decision-contexts and meets the current needs of decision-makers. Further, grants and funding opportunities have been created to help fund adaptation and resiliency projects. By providing more information and funding, the hope is that municipalities will be able to plan for plausible climate impacts. However, even with more information and funding, deeper constraints hinder effective and sustainable adaptation. While some attention has been placed on institutional change in the form of calls for regional coastal planning, few organized efforts exist to address the institutional constraints found in the shore region. Further, there was little evidence of organized efforts to address the sociopolitical constraints found in the region. This strategy of starting with addressing the outer technical constraints and working inward towards sociopolitical constraints is not unique to New Jersey. Indeed, substantial time and resources have been directed at addressing deficits of usable climate information and available financial resources for adaptation projects across the globe; while significantly less time and resources have been spent on addressing the crucial political, economic, and cultural constraints that hinder sustainable adaptation.

Policy-support initiatives tend to begin with the question of why is it difficult to implement sustainable adaptation policies. The answer to such a query is often that municipal governments lack the funding, staffing, and knowledge to implement such projects and programs. Thus, technical constraints more to the fore. However, another question is why is it hard to design sustainable adaptation policies. Asking this question raises issues of competing priorities, little political support and leaders, public indifference, institutional mismatch, and perverse incentives. In other words, institutional constraints come into focus when questioning the difficulties in designing effective and sustainable adaptation programs. Even more fundamentally, it is possible to ask why it difficult to even imagine sustainable adaptation pathways. Seeking answers to this question requires examining the political, cultural, and economic commitments

that structure governance and management. These sociopolitical constraints not only make imagining sustainable adaptation seem impossible but also reinforce and entrench problems of design and implementation. Thus, without addressing sociopolitical constraints, decision-support initiatives are likely to be ineffective.

Not only does this focus on more periphery constraints run the risk of being an inefficient allocation of resources, but it also has the potential of further entrenching and calcifying sociopolitical constraints. For example, as more and more climate information is produced to fit existing, frequently maladaptive institutional arrangements, the more likely it is such institutions will persist because they continue to appear operable. Further, as existing decision-making contexts are continued to be perceived as the most viable option, the harder it will likely be to address crucial political, economic, and cultural constraints. In the case of the New Jersey shore region, the developmentalist mindset that is supported by a social and technical imaginary that engineering solutions along with rescue and recovery programs will allow the status quo to persist despite rising sea levels, land subsidence, and changing storm patterns makes imagining, designing, and implementing sustainable adaptation pathways incredibly improbable—if not infeasible. The New Jersey shore region is hardly alone in this situation. As the cascading impacts of global environmental change continue to unfold, many extant institutional arrangements in coastal landscapes will be unable to effectively and sustainably manage emerging climate impacts. Thus, dealing with the deep political, cultural, and economic factors constraining shifts towards arrangements better suited to the deep uncertainty of climate change need to be addressed in the near-term.

Addressing sociopolitical constraints is a complicated task. The factors that act as sociopolitical constraints are typically deeply entrenched assumptions about how the world works and what is important. Yet, resources can be found within the practices, visions, and beliefs of actors in coastal regions that can provide the launching point for more transformative forms of knowledge and climate services. Within the New Jersey shore region, many actors expressed frustration with the lack of widespread discussions about coastal retreat, while other actors conveyed deep ambivalence about the

future of the shore within existing management paradigms. Further, incipient, though fragmented, efforts to systemically rethink the shore can be found—such as the efforts of the New Jersey Surfrider Foundation. The production of transformative knowledge must be tailored to fit these concerns and visions as well as to interplay with emerging political efforts to holistically change governance in the region. How to go about this will be explored in the concluding chapter.

Chapter 5—Cooperation without Consensus: Brokering Resiliency with Boundary Objects

5.1—Introduction: Closing the Gap

New practices of knowledge production are needed to create climate knowledge able to inform the design of effective and sustainable coastal governance. Current modes of coastal management and planning are ill-suited to mitigating the range of projected climate hazards. Intractable uncertainty regarding the form, magnitude, and timing of potential climate impacts further increases the need for up-to-date knowledge within policy-making and management decisions (Lawrence et al. 2013; Maier et al. 2016; Walker et al. 2013). While climate scientists have produced a wealth of credible, salient, and legitimate information, policy-makers and managers have struggled to incorporate climate science into their work routines and decision-making processes (Flagg and Kirchhoff 2018; Hering 2016; Porter et al. 2015; Tribbia and Moser 2008).

One significant cause of the difficulty of translating climate science into actual policy and management action stems from a widespread assumption that credible, legitimate, and salient scientific knowledge is usable and useful to decision makers. This ‘loading dock’ approach to scientific information production is based upon the belief that creating more and better science directly contributes to improved decision making and management (Cash et al. 2006). However, research demonstrates that climate science frequently neither fits users’ specific needs nor interplays favorably with the knowledge systems used in decision-making (Dilling and Lemos 2011; Kirchhoff et al. 2013; Lemos 2015; Tribbia and Moser 2008). In light of the persistent gap between what scientists know about the causes and consequences of climate and what decision makers have done to address climate change, scholars have called for new collaborative and inclusive knowledge production initiatives that bridge multiple social worlds to produce usable

and useful climate change risk information (Hegger et al. 2014; Kirchhoff et al. 2015; Lemos and Morehouse 2005; Lemos et al. 2012; Miller 2013).

Implementing such collaborative knowledge production programs, though, has proven difficult (Porter and Birdi 2018). A number of hurdles have been encountered within efforts to convening collaborative climate knowledge efforts. A core challenge is that collaboration frequently must proceed with significant ambiguity regarding precisely what the problem is that needs to be addresses as well as what adaptive and desirable climate outcomes entail (Brugnach and Ingram 2012). That uncertainty, ambiguity, and controversy often goes unrecognized by key actors on both sides of the science-policy interface is a common cause of failure for inclusive and participatory climate knowledge efforts (Brugnach and Ingram 2012; Nightingale 2018). Research has demonstrated that effective collaboration requires working through sometimes fundamental disagreements and ambiguity about how the problems of climate change are framed, interpreted, and best addressed (Brugnach and Ingram 2012; Hegger et al. 2012).

In light of intractable ambiguity and uncertainty, researchers working on climate change policy have called for developing ‘boundary objects’ within collaborative knowledge production initiatives (i.e. Cash et al. 2006; Guston 2001; Kirchhoff et al. 2013). Boundary objects are tools for facilitating cooperation in situations where consensus is lacking, as they bridge multiple social worlds and support collaboration between actors with divergent goals and worldviews (Star 2010; Star and Griesemer 1989). However, limited theoretical and empirical engagement on boundary objects exists within the climate change vulnerability, risks, and adaptation literature (exceptions include Meyer et al. 2015 and van Pelt et al. 2015). Further, the concept is often used in a loose sense in which some specific qualities of boundary objects are overlooked or excluded (see Star 2010 for an overview of the misuses of the concept).

In this chapter, I contend that boundary objects provide a wider range of capacities for overcoming barriers to cooperative climate risk knowledge production than commonly held. Boundary objects possess unique properties that make them valuable resources to facilitate cooperation in situations where ambiguity and debate prevail. To make this case, I use examples from a case study of an effort led by the Jacques Cousteau National Estuarine Research Reserves (JCNERR) to produce tailored climate information to municipal officials within the coastal region of New Jersey. The use of boundary objects throughout the cooperative process was crucial to the JCNERR conducting a series of facilitated workshops that culminated in a collaboratively written report laying out policy and management options to increase local resiliency to sea level rise. I argue that other efforts to produce tailored and usable climate information ought to consider how collections of boundary objects can connect actors from divergent social worlds, support cooperation when consensus is lacking, and contribute to mutual learning.

In Section 5.2, I review the literature that lays out the barriers that hinder and limit collaboration as well as articulate design principles that increase the potential for successful collaborative knowledge production. Further, I provide a review of the origins of the boundary objects concept in the science and technology studies literature and then move onto how scholars have applied the concept to the problem of producing usable climate information. Section 5.3 then introduces the case study of the JCNERR's effort to generate tailored climate risk information with municipal actors within the New Jersey shore region. In Section 5.4, I describe how boundary objects aided in the convening and facilitating of a collaborative process that resulted in the generation of tailored climate risk information and policy options. The aim of this analysis is to explore the role of boundary objects in both facilitating cooperation in situations where

consensus is lacking as well as fostering a shared understanding of climate hazards and possible solutions. I then discuss in Section 5.5 how boundary objects directly relate to accomplishing theorized design principles for successful collaboration. Here, I make a case for more consideration of how collections of boundary objects interact and interface within the design of knowledge collaborations.

5.2—Barriers to and design principles for collaborative knowledge practices

5.2.1—Barriers to collaboration

Efforts to collaboratively produce climate risk information have encountered a wide range of barriers that constrain cooperation. Identifying what barriers exist and developing strategies to address them is crucial to crafting successful cooperative programs of knowledge production as creating usable and useful climate knowledge requires meaningful and high-quality interactions between diverse actors. In this section we highlight that barriers can relate to (a) differences in the fit and interplay between knowledge systems; (b) problems of institutional and individual capacity; and (c) broader societal, political, and economic challenges (see table 5).

Table 5 Barriers to collaboration

Category	Specific Barrier	Citations
Knowledge system fit and interplay	Differences in culture between scientists and decision-makers	Briley et al. 2015; Cvitanovic et al. 2016; McNie 2012; Weichselgartner and Kasperson 2010
	Differences in epistemologies	Brugnach and Ingram 2012; McNie 2012
	Divergent values, objectives, and interests	Brugnach and Ingram 2012; Weichselgartner and Kasperson 2010
	Differences in language and communication	Briley et al. 2015; Weichselgartner and Kasperson 2010
	Differences in thresholds for what counts as credible, salient, and legitimate information	Brugnach and Ingram 2012; Lemos et al. 2012; Hegger et al. 2012; Tengö

	Differences in time scales and time lines	Brugnach and Ingram 2012; Dilling and Lemos 2011
	Difficulty in recognizing and/or addressing ambiguity	Brugnach and Ingram 2012
Institutional and individual capacity	Lack of resources and time	McNie 2013; Meadows et al. 2015; Wall et al. 2017
	Lack of support from leadership positions	Cvitanovic et al. 2016; Dilling and Lemos 2011
	Complex institutional structures that hinder communication and collaboration between different groups	Cvitanovic et al. 2016;
	Mismatches in reward structures for producing information	Hegger et al. 2012; McNie 2013
	Difficulty integrating and using new information due to existing commitments	Briley et al. 2015; Dilling and Lemos et al. 2011
	Lack of available scientists to collaborate with stakeholders	Dilling and Lemos 2011
	Unequal power dynamics between knowledge systems	Brugnach and Ingram 2012; Tengö et al.
External	Lack of practical and theoretical guidance in designing collaborative efforts	Cvitanovic et al. 2016; Hegger et al. 2012; Meadows et al. 2015; Reed et al. 2014
	Political pressure to avoid controversial and/or inconvenient information	Brugnach and Ingram 2012; Nagaoda and Nightingale 2017; Ojha et al. 2015
	Marginalization of some key stakeholders	Brugnach and Ingram 2012; Ojha et al. 2015

Table 5. Barriers to collaborative knowledge production

Differences in information fit and interplay arise because scientists and policy-makers largely inhabit different social worlds. They draw upon different epistemologies, possess different objectives and interests, operate on different timelines, utilize different technical languages, and can possess fundamentally divergent worldviews (Jasanoff 2004). Due to such divergences, scientific information frequently fails to meet policy-makers' and managers' expectations and needs; at the same time, policy-makers and managers commonly struggle to find effective ways of communicating their needs to scientists (Tengö et al. 2014). These needs include both technical issues as well as political concerns. Moreover, scientists rarely consider the specific

needs of policy-makers and managers as relevant to their work (Brugnach and Ingram 2012; Hegger and Dieperink 2015; Tengö et al. 2014). Beyond differences between the worlds of science and policy, both worlds possess important internal differences. That is, disagreement and controversy do not just exist between different social worlds, but are also internal to them (Jasanoff 1987; 2004; Whatmore 2009).

An important cause of disagreement is that climate change is a fundamentally ambiguous phenomenon in that there are multiple legitimate and, frequently, contradictory ways of understanding, envisioning, and valuing problems and solutions (Brugnach and Ingram 2012). Even in situations where general agreement exists about the broad causes and consequences of climate change, disagreement still frequently exists regarding how to best address risks and hazards—or even what constitutes an unacceptable risk (Barnett et al. 2015; Nightingale 2018). It is unlikely that such disagreements can be solved through appeals to facts; rather, it is crucial to draw upon "value-based knowledge that can provide judgements about preferences, tolerance to change, and to risk" (Brugnach and Ingram 2012, p. 62). Without attending to the subjective differences between socially-situated actors, it is difficult for productive collaborations to unfold (Brugnach and Ingram 2012; Cvitanovic et al. 2016; Hegger and Dieperink 2015; McNie 2012; Weichselgartner and Kasperson 2010). Such conversations can be challenging for scientists who often lack training in dealing with social and political debates.

Beyond issues of information fit and interplay, a general lack of financial and institutional capacity inhibits collaboration. Effective collaboration can require allocating substantial time and resources, which frequently are difficult to locate—especially if climate change hazards are not considered as pressing compared to other issues. Moreover, there are rarely explicit incentives for scientific and policy actors to collaborate (Hegger et al. 2012). Further, user demand for

partnerships with scientific actors generally exceeds the supply of scientists willing and able to work with policy actors on developing usable information (Dilling and Lemos 2011). The lack of support from scientific institutional authorities or leaders can exacerbate this gap between supply and demand, as scientists might not want to participate if their work is not recognized as conducting 'real' science within academic reviews (Hegger and Dieperink 2015). Complex institutional structures also can deter collaboration due to silo-effects and/or rules that restrict communication (Cvitanovic et al. 2016). Thus, even after securing buy-in, the lack of resources and capacities to actually conduct collaboration can slow the production of usable climate knowledge.

Finally, even when scientists and practitioners are motivated to work together, there is a lack of guidance on how to design and implement collaborative knowledge programs (Hegger et al. 2012; Meadows et al. 2015; Reed et al. 2014; Wall et al. 2017). As Meadows et al (2015, p. 181) state, "confusion remains about exactly what should occur in a coproduction process to yield actionable science—what coproduction actually 'looks like.'" Therefore, collaborative knowledge practices typically unfold on an ad-hoc basis "based on 'what seems to work' with little theoretical, methodological, or empirical grounding" (Reed et al. 2014, p. 338). Consequently, efforts to facilitate the production of usable climate information so far have been innovative and experimental.

5.2.2—Design Principles

While the scarcity of guidelines has curtailed the quick spread of collaboration, researchers have begun to identify a range of design principles to help overcome barriers to collaboration and inform the process of collaborative climate knowledge practices (table 6). In the remainder of

this section, I summarize key findings regarding best practices and principles for designing effective collaborative knowledge production initiatives.

	Design Principle	Citations
Convening	Secure buy-in from a broad, interdisciplinary coalition of actors with relevant and pertinent knowledge and skills	Cvitanovic et al. 2016; Hegger et al. 2012; Lemos and Morehouse 2005; Meadows et al. 2015; Reed et al. 2014
	Form lines of accountability to authorities on both sides of the science-policy interface	Guston 2001
	Include skilled facilitators and knowledge brokers	Reed et al. 2014; Wall et al. 2017
	Consider how including or excluding actors could contribute to sabotage	Hegger et al. 2012
	Set an upper limit on how many actors participate	Hegger et al. 2012
	Create reward structures that incentive collaboration and generating usable information	Cvitanovic et al. 2016; Hegger et al. 2012
Stabilizing	Insulate actors from extraneous political forces	Cash et al. 2006; Guston 2001
	Recognize differences in perspectives	Hegger et al. 2012; McNie 2013; Reed et al. 2014
	Define needs and roles of different actors and communities of practice	Fazey et al. 2014; Ferguson et al. 2014; Hegger et al. 2012; McNie 2013
	Collectively define problems and objectives	Brugnach and Ingram 2012; Citanovic et al. 2012; Hegger et al. 2012; Lemos and Morehouse 2005; McNie 2013; Reed et al. 2014
	Coordinate how different knowledge systems are integrated and/or incorporated	Brugnach and Ingram 2012; Tengö et al. 2014
Collaborating	Empower all participants to have an active and meaningful role in knowledge production	Brugnach and Ingram 2012; Dilling and Lemos 2011
	Translate, mediate, and broker between different knowledge systems and communities of practice	Cash et al. 2006; Citanovic et al. 2016; Dilling and Lemos 2011; Lemos and Morehouse 2005; McNie 2013; Reed et al. 2014
	Utilize specific resources, such as boundary objects, organizations, and expertise	Brugnach and Ingram 2012; Hegger et al. 2012; McNie 2013; Meadows et al. 2015

	Manage power dynamics and foster mutual respect	Brugnach and Ingram 2012; Ferguson et al. 2014; Meadows et al. 2015; Tengö et al. 2014
	Iterative interactions	Dilling and Lemos 2011; Lemos et al. 2013; McNie 2013

Table 6. Design principles for collaboratively producing effective and usable climate information

First, convening successful collaborative knowledge production efforts requires securing buy-in from the widest feasible array of relevant actors (Hegger et al. 2012). This entails securing participation from actors with a range of relevant scientific and practical knowledge related to projected climate change impacts and possible policy solutions (Hegger et al. 2012). Creating incentives and rewards for participating can increase willingness to participate (Cvitanovic et al. 2016; Hegger et al. 2012). Including skilled facilitators conversant in both the worlds of science and policy can contribute to more effective and efficient collaboration between actors with different technical and practical vocabularies. Finally, it is important to consider who is being left out, as excluding marginalized communities can contribute to unequitable outcomes. Additionally, powerful actors not invited to participate could sabotage the collaborative project (Hegger et al. 2012).

Stabilizing a space for collaboration entails creating forums where diverse actors can work through differences and generate shared knowledge that meets collective needs (Brugnach and Ingram 2012; Cvitanovic et al. 2016; Dilling and Lemos 2011; Fazey et al. 2014; Guston 2001; Hegger et al. 2012; Lemos et al. 2012; Meadows et al. 2015; Morehouse and Lemos 2005; Reed et al. 2014; Tengö et al. 2014). Crafting a space in which actors from different social worlds and communities of practice can work together requires ‘boundary work’ that—at least tentatively—clarifies and organizes how the worlds of science and policy are demarcated and connected

(Guston 2001; Jasanoff 1987; 2004; Kirchhoff et al. 2013). At the same time, creating a space for collaboration often entails providing some level of insulation from extraneous political and societal factors (Guston 2001; Kirchhoff et al. 2013). This is not to say that the process is apolitical—indeed determining what is and is not an extraneous factor is a political and social choice (Jasanoff 1987; Latour 1987)—but rather actors are given some autonomy from some forces while collaborating. As the stabilization process unfolds, actors should work together on defining the problem to be tackled (Brugnach and Ingram 2012; Citanovic et al. 2012; Hegger et al. 2012; Lemos and Morehouse 2005; McNie 2013; Reed et al. 2014). A successful process of collaborative knowledge production will focus on a problem each community of practice can provide insight into, while recognizing the differences in perspectives and understandings of a problem, how to address it, and what success entails (Hegger et al. 2012; Wall et al. 2017).

Once actors have stabilized a space and defined a goal to work towards, the actual work of collaboration can unfold. Throughout the process of collaboration, it is important all actors feel empowered to take a meaningful role in the generating and critiquing information (Brugnach and Ingram 2012; Dilling and Lemos 2011). A sense of mutual respect is crucial for all participants to be seen as possessing valuable information (Brugnach and Ingram 2012; Ferguson et al. 2014; Meadows et al. 2015; Tengö et al. 2014). Active facilitators and brokers capable of mediating disputes and translating differences can enable more effective collaboration between different knowledge systems (Cash et al. 2006; Citanovic et al. 2016; Dilling and Lemos 2011; Lemos and Morehouse 2005; McNie 2013; Reed et al. 2014). Creating and using specific resources, such as boundary objects, has also been identified as increasing the chances of successful collaboration (Brugnach and Ingram 2012; Hegger et al. 2012; McNie 2013; Meadows et al. 2015). Finally, structuring interactions between communities of practice to be iterative and long-lasting has been

found to allow more effective collaboration to unfold (Dilling and Lemos 2011; Lemos et al. 2013; McNie 2013).

5.2.3—Boundary objects and climate information

Boundary objects possess some degree of interpretive flexibility, meet the informational and work requirements of multiple communities of practice, and allow actors to tack back and forth between ill- and well-defined versions (Star 2010). Susan Leigh Star and collaborators developed the concept of boundary objects (i.e. Bowker and Star 1999; Star 2002; 2010; Star and Griesemer 1989) to explain how scientific cooperation could unfold in situations where consensus was lacking. In particular, they were interested in how scientific work succeeds even though collaborators frequently have fundamentally different understandings of a problem (Star and Griesemer 1989). Moreover, scientific research operates within conditions in which the facts that could settle disagreements often remain unknown or uncertain—indeed, research aims to produce the information that can settle controversies (Latour 1987; Star and Griesemer 1989). Boundary objects support cooperation in such situations where consensus is lacking but people still need to work together.

Boundary objects' qualities of interpretive flexibility and meeting informational and work requirements have received the most attention within climate knowledge scholarship. Interpretive flexibility, here, means that actors from different social worlds can define, understand, and value the boundary object in distinct manners. Meeting the informational and work requirements of multiple communities of practice, in turn, entails the boundary object being relevant and useful to those actors. However, the capacity to facilitate the tacking back and forth between ill- and well-structured forms tends to be overlooked or elided. Yet, in practice, this is often the most crucial aspect of boundary objects.

As Star (2010) has acknowledged, almost anything can be a boundary object; however, what is important in determining whether or not something actually acts as a boundary object is how it is used in practice. There are three crucial dynamics that determine whether something acts as a boundary object. First, they reside between multiple social worlds or communities of practice and maintain a common, ill-structured identity within all such worlds—this allows for multi- and trans-disciplinary work. In other words, all participating actors share a common, though general, understanding of a boundary object around which collaboration unfolds. Second, when being used by a particular community of practice, a boundary object gains a more specific and tailored identity—this allows for specialized work. Third, cooperating groups can tack back and forth between ill-structured and tailored forms of a boundary object. This tacking back between two forms is how boundary objects support cooperation without consensus (Star 2010). Consequently, assessing whether or not something is a boundary object requires a constructivist approach in which what matters is less inherent qualities of a thing and what matters more is if it meets a variety of actors' specific work and informational needs while maintaining a shared identity.

Within the climate change adaptation literature, research has typically focused on the capacity of boundary objects to support cooperation without consensus in producing and disseminating tailored and usable information (Cash et al. 2006; Guston 2001; Kirchhoff et al. 2013; Lemos et al. 2012; Tribbia and Moser 2008). Boundary objects are of particular importance due to the prevalence of ambiguity within understandings of climate change (Brugnach and Ingram 2012). As Brugnach and Ingram (2012, p. 61) contend, failing to recognize and respect that there is a "simultaneous presence of multiple valid and sometimes conflicting ways of framing a problem" contributes to the failure of inclusive, collaborative climate knowledge efforts. In light of this,

there has been significant academic efforts to elucidate strategies for brokering (Kirchhoff et al. 2015; Leach et al. 2012; Michaels 2009), bridging (Feldman and Ingram 2009; Guston 2001; Lemos et al. 2012), and weaving (Johnson et al. 2016; Tengö et al. 2014; 2017) alternative knowledge systems so as to contribute to the creation of shared climate risk knowledge. Such efforts do not necessarily entail achieving consensus regarding "what the problem is or how it should be solved, but [rather] working through differences with participants to arrive at a mutually acceptable solution" (Brugnach and Ingram 2012, p. 66). Thus, recent scholarship has sought to theorize and test strategies for convening, stabilizing, and supporting collaborative and inclusive climate knowledge practices that can unfold in situations where agreement does not exist (Cvitanovic et al. 2016; Dilling and Lemos 2011; Fazey et al. 2014; Hegger et al. 2012; Meadows et al. 2015; Reed et al. 2014; Wall 2017).

While boundary objects have frequently been identified as valuable resources for collaborative processes of generating climate knowledge, there have been few in-depth theoretical or empirical engagements with the concept (exceptions include Meyer et al. 2015 and van Pelt et al. 2015). Instead, research in the field has generally framed boundary objects as bridging social worlds and possessing interpretive flexibility (Cash et al. 2006; Cutts et al. 2011; Dannevig and Aall 2015; Guston 2001; Lee et al. 2014), while overlooking the more constructivist aspects that contribute to actors' capacity to tack back and forth between common and specialized work in order to facilitate cooperation without consensus. For instance, Brand and Jax (2007) argue that the concept of resilience can act as a boundary object because it both is "increasingly viewed in a rather vague and malleable" fashion and spans multiple disciplines (p. 8). However, they argue that the malleability of resilience could hinder scientific progress because if the term becomes diluted and unclear, then that could lead people to believe the concept of resilience is arbitrary

and, ultimately, prevent collaboration to unfold around the concept. In such a situation, though, resilience would no longer meet the informational and work requirements of relevant communities of practice, which would preclude the tacking back and forth from an ill-structured form of resilience and a tailored form of resilience. Thus, resilience would fail to meet the definition of a boundary object. It is crucial to evaluate how objects are able to possess an interpretive flexibility that bridges social worlds while supporting cooperation between and in those worlds.

Research by Meyer et al. (2015) demonstrates the capacity of boundary objects to facilitate and support interactions between divergent communities of practice without the need for consensus. Meyer et al. (2015) document how an assortment of boundary objects fostered interest from a wide range of scientific and policy communities to cooperate in the pursuit of developing solutions to the combined problems of hypoxia and ocean acidification along the Pacific Coast of the United States and British Columbia. Two key lessons emerge from this case study. First, not every boundary object deployed within a collaborative knowledge process assemblage needs to bridge every community of practice involved. Some boundary objects might only exist within the scientific communities participating, while others are only used within policy communities. Second, and relatedly, boundary objects must be understood as working in relation to other boundary objects. Ensuring buy-in and cooperation from a wide range of actors requires the design and deployment of a carefully attuned assemblage of boundary objects in which each boundary object amplifies others. While it is crucial that some boundary objects span all communities involved—in the above case the ‘hypoxia-ocean acidification’ problem and ‘West Coast’ region connected all participating communities of practice—in other cases, it is necessary that boundary objects are only utilized by a subsection of participating communities, such as the

scientific community or even particular scientific disciplines. Some boundary objects might meet the work and information requirements of scientists, while others only meet the needs of policy-makers or other decision-makers. These two lessons demonstrate that attention must be given to how boundary objects work together in fostering cooperation. In short, well-crafted assemblages of boundary objects can help convene the process of cooperative knowledge production, support dialogue between different forms of knowledge, and allow for specialized work to unfold within particular communities of practice.

Another example of how boundary objects can support better relations between the worlds of science and policy can be found in an examination of the climate simulation game 'Sustainable Delta' by Van Pelt et al. (2015). In this case, the simulation game acts as a boundary object even though there are no direct interactions between scientists and managers. Climate scientists played a role in the design of the 'Sustainable Delta' game and also used it to develop knowledge. Water managers and students played the game to gain insights about uncertainty in climate change projections. Thus, actors from both sides of the science-policy interface used and gave meaning to 'Sustainable Delta' differently. (van Pelt et al. 2015, p. 48-49). This demonstrates that boundary objects are valuable in supporting the creation of better understandings of climate change and more tailored and usable climate information even in situations where scientists and managers do not directly interact.

Thus, boundary objects have the capacity to facilitate cooperation in more ways than typically acknowledged within scholarship on collaborative climate knowledge production. Boundary objects can be of use in every stage of collaboration—from convening to stabilizing to actually working together—in situations where ambiguity and uncertainty prevail.

5.3—The JCNERR and the New Jersey Shore Region

Municipal government actors in the New Jersey Shore region are in need of tailored, usable climate risk information (Bates 2016; O'Brien and van Abs 2016). Coastal areas of New Jersey are vulnerable to climate change impacts, such as sea level rise, more prevalent flooding events, and potentially more powerful and frequent coastal storms. Residential and business development exists along most of the ocean and back bay shore-lines—including a number of narrow barrier islands and peninsulas. In recent years, multiple powerful storms, such as Superstorm Sandy and Tropical Storm Irene, have caused significant damage to infrastructure and property (Bates 2016; Leichenko et al. 2014; Leichenko and Solecki 2013; O'Neil and van Abs 2016). In the face of these trends, however, local governments and communities in the region have largely continued to follow existing development and policy trajectories with few signals of transformative change (Bates 2016; Leichenko et al. 2015; O'Neill et al. 2016; van Abs and O'Neill 2016). In response to the continued exposure of the shore region to climate impacts and the persistence of vulnerable development patterns, scholars have called for new approaches to communicating climate risks, developing policies to respond to projected climate impacts, and supporting on the ground actions (Bates 2016; Leichenko et al. 2015; O'Neill et al. 2016).

The Jacques Cousteau National Estuarine Research Reserve (JCNERR) acts an intermediary and knowledge broker between the social worlds of science and policy in order to create more resilient policy and development pathways in coastal areas of New Jersey. As one of twenty-nine National Estuarine Research Reserves, the JCNERR represents a formal partnership between NOAA's Office for Coastal Management and Rutgers University that exists to support long-term research, education, and coastal stewardship in the region. The JCNERR's connections to

Rutgers University have allowed staff members to help design and refine climate change services and decision-support tools in collaboration with scientific actors. The organization also collaborates with municipal governments to generate knowledge on local climate change vulnerability as well as identify strategies local governments can employ to increase municipal resilience. By working with both policy and scientific actors, the JCNERR staff are able to connect these two worlds. In other words, the JCNERR seeks to reconfigure the relationship between science and policy in the New Jersey shore region in order to support the creation of more resilient development pathways.

Within this section, I examine how the JCNERR convened and stabilized a space for collaborative climate change knowledge creation through its 'Getting to Resilience' (GTR) program. This initiative entails JCNERR staff members facilitating a series of discussions with municipal actors regarding projected sea level rise, municipal vulnerability and strengths, as well as potential policy solutions local governments could pursue in response to climate change. The program is organized around, and takes its name from, an evaluation tool entitled 'Getting to Resilience' developed by the New Jersey Department of Environmental Protection. The tool centers around a questionnaire designed to be completed by municipal government actors. The questionnaire is organized into five sections: risk and vulnerability assessments; planning integration; public engagement; disaster preparedness and recovery; and hazard mitigation implementation (NJ Office of Coastal Management, 2010). By collectively answering these questions, municipal actors are supposed to gain a better understanding of current strengths and weaknesses of local approaches to coastal management as well as learn about possible strategies for creating more resilient and effective planning and policy pathways. The JCNERR staff facilitates a discussion around this questionnaire that includes municipal staff and officials from

a variety of departments in order to enable both (a) mutual learning in which different participants learn about the concerns and perspectives of other municipal actors and (b) collective learning about recent scientific research on the potential impacts sea level rise will have on the local landscape during the 21st century. The goal of this exercise was for key actors in the municipal government to share a baseline of knowledge about the risks of sea level rise as well as possible strategies to mitigate risks and improve resilience. This knowledge is then collected in a collaboratively written recommendations report.

To examine this effort, we conducted twenty-five semi-structured interviews with municipal actors from nine municipalities that participated in the program and attended one set of facilitated meetings. The selected municipalities were Perth Amboy, Atlantic Highlands, Sea Bright, Toms River, Brick, Tuckerton, Little Egg Harbor, Longport, and Atlantic City. Interviews included both elected officials and municipal staff, such as planners, engineers, and flood plain managers. Interviews typically lasted between forty and sixty minutes and explored what interviewees learned through participating in the GTR program, what aspects of the program were most helpful, and to what extent the program contributed to adaptive actions. Interviews were transcribed and analyzed to identify patterns and trends between responses.

5.4—Results

In this section, we highlight findings from our semi-structured interviews with municipal actors that participated in the Getting to Resilience process. We first document the existence of constraints hindering effective collaboration in the region. Following this, we detail how boundary objects acted as crucial resources throughout the entirety of the collaborative process—from creating interest to finalizing recommendations.

5.4.1—Constraints to collaboration

Three broad categories of constraints to adaptation were mentioned by interviewees: problems of information fit and interplay, challenges of institutional and individual capacity, and issues of political will and public support (see table 6). While none of these types of constraints prevented collaboration from occurring, they all needed to be addressed in order to effectively produce tailored climate information.

Table 6 Barriers in New Jersey

Category of Barrier	Specific Barriers
Informational fit and interplay	The technical language of scientific work presents a challenge for municipal government actors
	The policy and management requirements of municipal governments does not align with the temporal and spatial scales of climate science
	Scientific information is difficult to integrate into existing knowledge systems used in municipal government decision-making.
Capacity	Municipal governments lack the staff and funding necessary to gather and deploy climate information in pursuit of adaptive actions
	Challenge of identifying and partnering with technical experts
Politics	Hesitancy to pursue information that might challenge prevailing development patterns
Table 6. Barriers found in the New Jersey shore region	

Interviewees frequently stated that scientific information rarely fit their specific work needs. For instance, floodplain managers in multiple municipal governments stressed that projections of future sea level rise were not directly relevant to their work requirements. Instead, they relied on flood zone information from FEMA, which is based upon historical data. Thus, while they often reported finding scientific information as generally important and frequently worrisome, floodplain managers did not consider the information as possessing high levels of fit or interplay. Such views were similarly reported by other municipal actors who also did not consider scientific information as existing in forms directly relevant to their work on issues such as

economic development, zoning, or infrastructure investment. Because of this, many interviewees stated that they entered the GTR process with some reservations as to the overall usefulness of the program.

Additionally, the lack of staffing and financial capacity for municipal governments to participate in long-term, iterative collaborations presented a significant constraint. Interviewees repeatedly highlighted the difficulty of finding the staff and financial resources to allocate towards issues related to future climate change hazards. This constraint was particularly keen in smaller municipalities that tended to have smaller staffs and budgets. That municipal actors often did not see climate change information as being particularly relevant to their work responsibilities, it was difficult for them to justify allocating scarce financial and human resources on gathering and/or producing information about climate change.

Indeed, some interviewees reported a sense that municipal leaders actively wanted to avoid discussing climate change hazards in general and long-term sea level rise in particular. Municipal staff expressed the belief that elected officials' concerns about short-term election cycles made them hesitant to openly discuss the medium- and long-term problems related to sea level rise because addressing the latter could hurt their re-election chances. One reason for this belief is areas most exposed to sea level rise impacts are typically some of the most valuable and, therefore, represent a significant portion of the municipalities local tax base. Thus, there are concerns that some possible responses to sea level rise could reduce local tax revenue if property values decline due to being located in areas projected to become more flood prone. Another concern was public reaction to policies aimed at addressing long-term sea level rise, which might entail reduced services or even managed retreat in flood prone areas. Staff members in multiple municipalities used the term 'NIMTOO'—or 'not in my term of office'—to describe elected

officials' views on when coastal hazards ought to be addressed. Thus, while there existed an overwhelming consensus within interviews that sea level rise and climate change were real problems that needed to be addressed (only one interviewee expressed any skepticism in anthropogenic climate change), there did exist a lack of political will to address the implications of climate hazards in the region.

5.4.2—Boundary objects and the Getting to Resilience process

To overcome the constraints described above, the JCNERR staff used a collection of tools and concepts that acted as boundary objects. These boundary objects included the concept of 'resilience', local level sea level rise and SLOSH ('Sea, Lake, and Overland Surges from Hurricanes') model maps, the 'Getting to Resilience' (GTR) evaluation tool, and a jointly written final report. The concept of resilience operated as the central, foundational boundary object that influenced how the other boundary objects were used in the GTR process. The other boundary objects, in turn, conditioned how resilience was understood within the collaborative process. In the remainder of this section, we report how this collection of boundary objects supported the convening and stabilizing of the collaborative process as well as the generating of tailored, usable climate risk information collected within a jointly composed recommendations report.

5.4.1—Convening collaboration through the concept of resilience

The concept of 'resilience' helped secure buy-in from key municipal actors for participating the GTR process. Municipal officials reported agreeing to participate in part because they saw resilience as a positive state to work towards. The lingering impacts from Superstorm Sandy and the desire to avoid many of the experiences from the storm were frequently mentioned as heightening the relevance of the concept. Moreover, many municipal governments were in the

process of updating planning documents in response to Sandy and looking for guidance. As one municipal floodplain manager working on a densely developed barrier island stated: “Resiliency gives you direction. The best thing about it is that it is pulling all the different components that we have when it comes to our ordinances, when it comes to planning, [and] when it comes to enforcement. And, hopefully, it’ll provide some direction.” As this quote suggests, that resilience had the ability to connect to and guide municipal planning was crucial to incentivizing participation. Moreover, the notion of resiliency was seen as prompting long-term thinking. One municipal planner stated that “resiliency is a way of looking at whether land-use decisions that you make are viable over a long period of time given whatever changes that will occur.” Thus, for municipal government actors, the notion of resilience represented a positive, desirable state as well as the necessity of thinking about how plausible future climatic conditions might require impact their location.

The concept of resilience also possessed the conceptual and interpretative flexibility to allow municipal officials to use it in more specific and tailored ways. At the beginning of each interview, municipal actors were asked how resilience related to their job. The responses differed for each interview, but every municipal actor was able to connect resilience to their personal responsibilities. For instance, municipal officials responsible for promoting economic development typically connected resilience to the pursuit of a local economy that can withstand and bounce back from both external and internal shocks—including natural hazards. Municipal engineers tended to focus on the need to plan and budget for infrastructure investments in anticipation for a changing climate. It was not uncommon for individuals to give personal definitions of resilience that conflicted, at least partially, with others working in the same municipal government. For instance, municipal staff that worked on issues of economic

development tended to frame resilience as including the capacity to quickly rebuild after extreme events whereas individuals working on engineering and planning issues sometimes incorporated managed retreat from severely impacted areas within their definition of resiliency. The JCNERR staff, therefore, were able to use the concept of resilience to interest multiple communities of practice even when complete consensus around the concept was lacking. Interviewees regularly brought up that the JCNERR staff were skilled in mediating and facilitating conversation around resiliency to focus on general agreement about the positive qualities of resiliency.

5.4.2—Stabilizing a space for collaboration with sea level rise maps

After securing buy-in from key municipal actors, the JCNERR facilitators moved on to stabilize a space for collaboration through a presentation of local-level sea level rise projections for the years 2050 and 2100. These maps enhanced the relevance of the concept of resilience, as the range of plausible sea level rise and coastal flooding scenarios included many significant challenges for local governments. One member of a municipal environmental commission stated that “the thing that really got my attention was the projections. One was the projections of what the potential water rise would be [in the future]. Particularly because I spend a lot of time on the water doing fishing, and I’ve seen the tides be outrageously high consecutively or on a consistent basis. There’s one woman on the environmental commission who lives in an area that floods, and she said she’s seen nothing like this in the first 30 years [of living here], but, in the last five years, you get flooding every nor’easter. It was only the really severe storms or the super storms once a year. Now it is several times a year. But the other thing that I thought was really informative was the SLOSH models—that opened some eyes, I think. It opened my eyes. Particularly as they rolled them out into the future with sea level rise.” Crucially, this quote shows how sea level rise maps and SLOSH models not only contain objective information

regarding plausible future climate impacts but also that non-scientists are able to make connections between their personal experiences with what the maps display.

Further, the facilitators used the maps to connect the social worlds of climate science and municipal government policy and planning. The maps were created with input from climate change researchers at Rutgers University. This allowed the facilitators to present the maps as legitimate and objective data. However, the JCNERR facilitators also made clear during the GTR meetings that the science behind the maps further deepen climate risk knowledge and play an important role in the development of policy and planning solutions. By acting as an intermediary between actors from the social worlds of science and policy, the JCNERR facilitators were able to integrate knowledge claims from both sides even through the actors did not directly interact. Thus, the facilitators were able to use the sea level rise and SLOSH model maps to configure the science-policy interface. By doing so, they were able to clarify the roles and capacities of different knowledge sources, and to jointly define collective problems and objectives for actors to address.

In this regard, the maps also helped define the value and role of different information sources as well as clarified the importance of recognizing differences in perspectives. Within a discussion about risks and vulnerabilities that stemmed from sea level rise, JCNERR queried municipal actors on what communities, infrastructures, and spaces they were concerned about due to sea level rise. Municipal actors with different sets of expertise and experience volunteered information about how and why increased sea level rise might impact the local community, infrastructure, and economy. This helped validate the knowledge claims of some municipal actors. For instance, one municipal engineer relayed: “When the SLOSH maps were put up and we had a new mayor and administrator, they were like, ‘wow, look at that!’ I said, ‘no, that is

what flooded during Sandy. That is the area that was flooded already.'" Afterwards, the engineer reported that she was able to get more support for projects to plan for possible flooding. Thus, the engineer's existing concerns about coastal flooding gained credibility because of the maps. Multiple interviewees conveyed similar stories in which the displaying of maps validated their concerns and arguments for addressing coastal flooding problems both in the short- and medium-term. Through these map-centered discussions, the JCNERR facilitators weaved together knowledge from both sides of the science-policy interface to elucidate specific risk information regarding the local context. This allowed for participants to collectively generate coastal resiliency problems in need of being addressed. Crucially, the maps played an important role in conditioning how the concept of resilience was used during the GTR process by both highlighting and spatializing the issue of sea level rise risks. In other words, resilience was firmly connected to the challenges presented by increasing sea level.

5.4.3—Collaborating with the Getting to Resilience evaluation tool

After actors collectively identified common problems the process moved onto a more structured discussion regarding actions the municipal government was currently taking to address coastal hazards. To accomplish this, the JCNERR facilitated discussion among municipal actors around the Getting to Resilience evaluation tool. The evaluation tool is an online resource consisting of a list of questions about whether the municipal government is taking particular actions related to coastal resiliency. Beyond answering the questions, the JCNERR facilitators also work to spur a conversation about how additional actions could address concerns participants expressed regarding coastal resilience. This allowed for participants to further apply their specialized knowledge to improving resilience. Because other participants had the ability to respond and add

their own perspective, mutual learning unfolded so that different municipal actors gained an appreciation for how other departments could add to potential solutions.

Moving through the evaluation tool typically requires three meetings. Thus, when there are uncertainties about the answer to a specific question, municipal actors are asked to find out the answer or bring another person with relevant expertise to the next session. This contributes increasing the amount of iterative interactions to the process. Further, the tool includes room for notes, which the JCNERR facilitators populate with additional information and comments about climate change risks that relate to the topic being discussed. This gives participants flexibility to explore the problem of coastal resilience beyond simply answering questions in a ‘yes’ or ‘no’ fashion. Interviewees frequently mentioned that the JCNERR facilitators were skilled at guiding discussion and fostering learning.

5.4.4—Jointly generating recommendations and producing a new boundary object

The GTR process culminates in the joint creation of a report laying out vulnerabilities to coastal hazards facing the municipality as well as policy and management options to mitigate them. The first draft of the report was based upon the information generated during the facilitated meetings. The draft was then circulated to all participants for comments and revisions. The amount of feedback varied from community to community. In some cases, few changes were proposed to the initial draft by municipal actors, while in others significant revisions were made. The reasons for revision varied. In some cases, participants clarified risk information or highlighted missing aspects. In other cases, participants had concerns about the political implications of some information being included—such as projected flooding in areas with high-value property. Importantly, the report could not be finalized without agreement from key municipal officials, such as mayors, township administrators, and councilmembers. Thus, a final report was authored

by both municipal staff and outside experts and approved by key decision-makers within the municipal government. To facilitate the collaborative production of the report and its final approval, all actors had to gain something from the report. Indeed, interviewees were able to highlight a variety of both general benefits to the municipal government as well as specific benefits they gained from the report.

Interviews with municipal staff uncovered four broad benefits from the report: facilitate grant application, acting as external validation, providing new ideas, and materializing institutional memory. The ability to draw upon the GTR report to apply for grants was the benefit most frequently highlighted by staff members. As one borough administrator in a municipal government with relatively few staff members stated in what they gained from the GTR process: "The main factor is obviously the opening of the door to other grants. The report has helped us get quite a few grants." This sentiment was echoed by a planner in a municipal government with a significantly larger staff and tax-base. This planner explained: "When the federal government comes out with a grant, they announce it on a Friday and they want it on the following Friday. It is never enough time to amass the information necessary. The report prompted us to make 10 affidavits of random projects that essentially have all the information that always is requested in the federal docket. So now when a federal program becomes available, you fill in the one-page application form and attach the application form to it and send it out. So that is something that is really helpful. We've already used it to apply to several grants."

Beyond helping within the process of applying for grants, the report was also seen by some municipal actors as a valuable source of external validation of their concerns and ideas. One municipal staff member that had worked on floodplain management issues on a barrier island for more than two decades stressed that the report had helped him increase focus on problems

associated with sea level rise and coastal flooding. In particular, he reported that the planning commission is now much more receptive to his concerns than they were before he could point towards the sea level maps and recommendations in the GTR report. Similarly, both the engineer and planner in a municipality with a relatively large land area outside coastal flood zones stated that the report has allowed them to begin broaching the topic of managed retreat in some areas. Though this conversation remains extremely preliminary and little to no support from key decision-makers exists for retreat, the report has at least allowed the issue to be raised whereas in the past it was off limits.

Staff members also relayed that the report provided them with new ideas as well about how to plan for plausible climate impacts. The inclusion of examples of policies and plans implemented by local governments in other mid-Atlantic states, such as Maryland and Rhode Island, provided one source of new ideas for municipal actors. Another important source of actions municipal governments could pursue was the highlighting of various policies that, if implemented, would earn CRS credits.

Finally, staff members found that the report acted as a valuable repository of institutional memory. “I think the nice part about the report is having it all written down. Everybody here knew what happened after Sandy and what needed to be done. If something happens next year, we will know what to do. But the new people that come in, they’re not going to know what to do and if we all retire or leave these positions than the township won’t be prepared. So that was a major thing that stuck in my head: how do you prepare for continuity when we are no longer here or the officials are no longer here.”

Elected officials and high-ranking municipal staff, such as administrators, were typically more general in explaining the benefits they saw as arising from the GTR report. They tended to

mention that finalizing the report was the right thing to do as coastal resiliency was important for the long-term success of their community. In this sense, the report presented a concrete example of the government they played a role in running doing something about coastal hazards—an issue especially salient to the public in the years immediately after Superstorm Sandy.

5.5—Discussion

Our results show that boundary objects provide a range of attributes that help overcome barriers to the generation of usable climate risk information by supporting the stabilization of a space for collaboration despite ambiguity, disagreement, and controversy about how to frame and address the problems of sea level rise and coastal flooding in New Jersey. Each boundary object employed—the concept of resilience, sea level rise and flood maps, the GTR Tool, and the final report—bridged multiple worlds of practice by possessing interpretive fit and meeting the work requirements of each community. These capabilities helped overcome the three broad categories of barriers to collaboration. Moreover, our research demonstrates the importance of not designing and assessing boundary objects in isolation; rather, it is crucial to treat them as a bundle. In the remainder of this section, we highlight how the deployed boundary objects specifically aided the JCNERR facilitators to foster collaboration and produce tailored, usable climate information.

5.5.1—Increasing fit and interplay between knowledge systems

Interpretive flexibility increases the likelihood of each object to interplay with existing knowledge systems used within decision-making processes. That is, by possessing some degree of flexibility, boundary objects can be articulated into forms that complement different actors' information needs. For instance, sea level rise and flood maps were articulated in ways that made

sense to diverse sets of communities of practice—including climate scientists, planners, and engineers. Additionally, the boundary objects utilized in the GTR process also met multiple work requirements of various communities of practice, which increases climate information fit. This partially arises from interpretive flexibility, as the more an object can be tailored for specific use, the more likely it is to meet different communities of practices' work needs. However, flexibility by itself, is not sufficient to meet work requirements. Instead, each boundary object must present something of value to communities of practice. Returning to the example of the sea level and flood maps, beyond articulating with existing knowledge systems, the maps also provided specific forms of value to communities of practice. For municipal engineers, the maps provided information useful to assessing vulnerabilities of existing infrastructure as well as for thinking about the long-term development of coastal flood defenses. Meanwhile, for planners, the maps offered insights about community vulnerability.

Beyond fitting the needs of and interplaying with the knowledge systems used by different communities of practice, boundary objects also facilitated collaboration between those communities. Interviewees repeatedly reported that having common resources and concepts to discuss helped foster collaboration with individuals that they had differing views of challenges and objectives. The capacity of boundary objects to tack back-and-forth between the tailored forms used by specific communities of practice and an ill-structured form bridging each community was crucial in this endeavor.

5.5.2—Overcoming constrained institutional and individual capacity

In structuring collaboration, the ways in which the individual boundary objects connect with one another is important. For instance, the concept of resilience is often seen as nebulous and difficult to pin-down. Yet, within the GTR program, it acted as the central organizing boundary

object within collaboration. The success of the GTR program was, in part, due to the ways in which the entire bundle of boundary objects was composed. For instance, the concept of resilience was directly tied to the problems of sea level rise, coastal flooding, and emerging climate vulnerabilities. Thus, the use of various maps helped structure how the concept of resilience could be used within the GTR program. Additionally, because these maps were created in collaboration with climate scientists, the maps increased the legitimacy and credibility of the GTR program. This helped structure the science-policy interface by clarifying what information and resources climate science offered to municipal actors in relation to coastal resilience. Further, the GTR Tool provided two more valuable dynamics to fostering collaboration. First, it provided a general framework that both guided and constrained the range of potential trajectories for collaboration without closing down the capacity of actors to meaningfully participate. The skill of the JCNERR facilitators was key in maintaining this balance. Second, the GTR Tool also played a part in structuring the science-policy interface.

Furthermore, the GTR Tool provided additional constraints on how collaboration could unfold. Because the tool had been developed by the NJ DEP, it helped focus discussion on policy related issues that the local municipalities had authority to impact. Moreover, the tool highlighted potential financial benefits to local residents by connecting policy changes to FEMA's Community Rating System. Consequently, the GTR Tool helped prevent irrelevant digressions while also illustrating tangible benefits.

Crucially, collaboration resulted in the production of new forms of information, which were collected within the final report, which also has acted as a boundary object. The final GTR Report became a valuable resource that municipal actors were able to draw upon to meet their specific needs. Planning staff relied on it to apply for grants. Engineers used it to prioritize long-

term projects. More generally, having a collectively produced document that included outside authorities facilitated policy entrepreneurship because actors were able to use it to support their arguments for addressing long-term sea level rise and other climate risks.

5.5.3—Navigating external societal, political, and economic challenges

Boundary objects played a role in alleviating some of the social, political, and economic constraints to producing and deploying usable climate information. The concept of resilience was crucial to securing buy-in from key decision-makers in large part because of its high degree of interpretive flexibility. Municipal actors were able to apply the concept of resilience in multiple ways that they saw as positive. Additionally, the GTR Tool connected policy options to concrete benefits in the form of CRS credits. Moreover, the GTR report included model language that could be used to apply for grant funding. This helped attenuate concerns about potentially needing to increase local tax-rates to pursue new policies and implement infrastructure projects.

At the same time, a number of significant constraints to using the information generated within the GTR process still persist. Even in situations where the long-term need for transformative change in development and management practices was recognized—such as pursuing managed retreat due to sea level rise—municipal actors still reported an obdurate unwillingness to publicly discuss these challenges. In large part, this was due to a fear that the public would respond by voting against any politician seen as supporting retreat. Additionally, municipal officials and staff worried about the implications of retreat on the local tax-base—both because there might be fewer properties as well as the potential for property values declining. Thus, in the case of the GTR process, not all constraints were able to be surmounted. However, it is unlikely that any one initiative would have the capacity to do so.

5.6—Achieving design principles with boundary objects

As the above discussion makes clear, boundary objects present a wide variety of useful capacities for facilitating collaborative knowledge production in situations where ambiguity, uncertainty, and controversy exist. While the existing literature has typically focused on the value of boundary objects during the actual collaboration phase, they also can play an important role in convening and stabilizing phases of collaborative knowledge production. In this section we highlight insights that can be used in convening and stabilizing collaboration.

5.6.1—Convening collaboration

By possessing interpretive flexibility, boundary objects can help secure buy-in from a wide variety of important actors to participate. Therefore, including a boundary object that actors from a range of social worlds consider valuable can contribute to both a rich array of perspectives as well as support from key decision-makers. Further, this can lead to the forming of lines of accountability to both sides of the science-policy interface. Both scientific and policy authorities might interpret a boundary object differently, yet it can still form an important connection. In this regard, a single boundary object does not necessarily need to form lines of accountability to all relevant authorities. In the case of the GTR process, the GTR checklist tool formed a line of accountability to the New Jersey Department of Environmental Protection and the sea level rise and SLOSH maps formed a line of accountability to climate scientists. Finally, when paired with skilled knowledge brokers and facilitators, boundary objects can reduce the total number of actors that need to participate. For instance, in the GTR process, the facilitators were able to draw upon the maps to include the knowledge of climate scientists. This helps prevent the problem of too many actors being involved making collaboration unwieldy.

5.6.2—Stabilizing collaboration

While interpretive flexibility is crucial to interesting relevant actors in participating, the ability of boundary objects to meet the work and information needs of actors from different social worlds facilitates the stabilizing of a collaborative space. When a boundary object is in its well-structured form, discrete communities of practice can use it to achieve specific objectives and when it is in its ill-formed state the entire group can collaborate. This capacity to tack back and forth between these forms can help actors recognize differences in views as well as coordinate how different knowledge systems are used.

5.7—Conclusion

The JCNERR facilitators were able to conduct a successful collaborative process in part because they deployed a well-crafted set of boundary objects. The concept of resilience acted as the central boundary object around which collaboration unfolded. Each assembled actor had the capacity to interpret and deploy the concept of resilience in ways specific to their own information and work requirement. The inclusion of other boundary objects helped to condition this flexibility. These constraints were necessary to generate meaningful collaboration from distinct communities of practice both within municipal governments as well as from external scientific and policy authorities that provided additional information and support. Nonetheless, the set of boundary objects employed still retained degrees of flexibility that allowed participants to tack back and forth from tailored and ill-structured forms of each object in order to meet their specific information and work requirements. For instance, sea level rise maps provided value to different participants in various ways. For the JCNERR facilitators, the maps allowed for the brokerage of scientific information regarding local sea level rise impacts as well as the spurring of discussion about municipal actors' concerns and contextual knowledge. In turn, various

municipal actors used the maps in unique ways. For some municipal actors—particularly planning and engineering staff—the maps were used as resources to lend credence to their concerns about coastal flooding and the need to develop strategies to mitigate potential risks. For other municipal actors, the maps provided an opportunity to learn about existing and emerging risks. Because of this, the concept of resilience still remained adaptable to specific needs—just to a lesser degree than it would without being attached to other boundary objects.

By using boundary objects as resources to foster cooperation throughout the GTR process, the JCNERR staff were able to overcome barriers to collaboration and, ultimately, produce a new boundary object—the GTR recommendations report. Boundary objects were useful in securing buy-in from key stakeholders, tailoring scientific climate information, mediating between knowledge systems, and fostering active participation. These results demonstrate that boundary objects can help meet a wide range of design principles for successful collaborative climate knowledge production beyond what has been identified within previous research on collaborative climate knowledge projects. Boundary objects are valuable at all stages of the collaborative process (see table 7). The interpretive flexibility and adaptability of the boundary objects used within the GTR program allowed actors with different understandings and objectives related to the challenges of climate change and sea level rise to cooperate in the production of new, shared risk information. Thus, boundary objects helped the JCNERR facilitators navigate the ambiguity and debate of coastal planning without requiring participants to reach a consensus. Further, our results also demonstrate the importance of examining how boundary objects interact and interface within collaboration. Examining how boundary objects work in tandem often reveals important synergies and emergent properties. For example, without being directly connected to sea level maps and the Getting to Resilience evaluation tool, the concept of resilience would

have likely remained vague and likely untenable for meaningful collaboration. Consequently, it is vital to not only reflect on the design and inclusion of specific boundary objects within efforts to jointly generate climate information but also to reflect and consider how boundary objects can amplify, constrain, and/or conflict with one another.

Table 7 Accomplishments of boundary objects

Boundary Object	Accomplishment
Concept of Resilience	Secured buy-in from stakeholders by meeting divergent visions and values
	Connected municipal actors, state government actors, and scientific actors around a broad concept
Sea Level Rise Maps	Supported the identification of common problems around which collaboration could unfold while allowing specific communities of practice to identify unique problems
	Bridged the social worlds of climate scientists and municipal actors while gaining a unique, tailored identity in both worlds
	Conditioned the concept of resilience to relate to a specific range of issues and challenges
GTR Evaluation Tool	Organized and coordinated collaboration between communities of practice
	Bridged the social worlds of state government actors and municipal actors
	Conditioned how collaborative efforts to address the challenges of sea level rise and resilience
GTR Report	Allowed multiple communities of practice to play a role in producing documented knowledge
	Provided multiple communities of practice a concrete resource to pursue new programs

In particular, additional research is needed on how boundary objects can play a larger role in facilitating systemic and transformative change. While this research demonstrates that boundary objects can foster incremental and transitionary change, the potential for boundary objects to support transformation remains speculative. However, the ability of boundary objects to inhabit multiple social worlds, foster collaboration, and contribute to new knowledge suggests that significant potential exists for catalyzing the rapid transformative necessary for sustainably and equitably planning for climate change risks and hazards.

Chapter 6—Conclusion: The Politics of Imagining a Different Shore

6.1—Fitting In: Normalizing Climate Change in the New Jersey Shore Region

After two centuries of accelerating development punctuated by destructive events and recovery, the general narrative of climate change and the challenges it entails fits within the prevailing sociotechnical imaginary of the New Jersey shore region. As documented in Chapters Two and Three, the prevailing sociotechnical imaginary of the contemporary shore has deep historical roots. For more than two centuries, technological and social innovations were able to cope with emergent and surprising developments. The decline of slavery in New Jersey and its sudden conclusion within the United States more broadly contributed to shifts within the economic organization across the country. These shifts occurred as the coastal resort industry emerged and developed during the 19th century. The post-Civil War years were initially characterized by governmental programs aiming to provide Black Americans with rights as citizens; however, as Reconstruction was sabotaged and undermined, Jim Crow become institutionalized in the New Jersey Shore. Business owners and other resort boosters justified segregation as necessary for economic growth and prosperity.

By the beginning of the 20th century, coastal erosion also became framed as a challenge to the prosperity of the shore region and the state. Rendering 'coastal erosion' a legible and tractable problem amenable to technical interventions. Through a comprehensive survey, described in Chapter Three, the New Jersey Board of Commerce and Navigation (NJBOCN) was able to mobilize a wide variety of evidence—archival, empirical, and anecdotal—to demonstrate that coastal erosion was occurring in New Jersey as well as that coordinated management by the state government was needed. In the decades following this report, coastal management and coastal engineering developed in ways that largely sought to solve the problem discovered by the

NJBOCN: how to manage erosion so as to protect private property and development. Despite frequent flooding and storm damage—along with occasionally devastating nor'easters and tropical storms—the problem of coastal erosion has maintained a coherent framing of being about protecting property and development from natural processes.

Thus, the perspective encountered within Chapter Four and Five amongst those working in municipal governments that storms and floods will frequently inconvenience residents and occasionally cause significant damage reflects two centuries of co-production between social organization and technological innovations. In this context, the impacts of climate change are not perceived as novel. Rather, they represent an intensification of existing challenges. Indeed, as Chapter Five demonstrates, knowledge brokers working within the New Jersey shore region frame the challenges of climate change in ways that fit within the existing visions, values, and motivations of actors working within municipal governments. Decision-makers are able to learn about the challenges of climate change and still imagine a future that largely reflects the present—only with more floods, more storm damage, and more coastal erosion.

Because climate change can fit—sometimes well and other times poorly—the prevailing imaginary of the shore region, the solutions put forward to address plausible impacts of climate change largely continue to follow existing, conventional approaches that seek to stabilize the coastline, preserve private property rights, optimize economic returns, and require extensive and recurring investment in emergency management and disaster recovery efforts. As documented in Chapter Four, these deeply held sociopolitical views act as the central constraints to effective and sustainable adaptation in the shore region. Thus, the main responses to the destruction brought by Superstorm Sandy has been to elevate homes rather than move them, rebuild hard engineering solutions to beach erosion rather than let beaches move inland, and construct more resilient

infrastructure in flood prone areas rather than decrease services to hazardous places. In short, in the aftermath of Superstorm Sandy, existing modes of governance and management in the shore region were entrenched rather than transformed.

Even the most distinctive response to Superstorm Sandy still fits within the prevailing sociotechnical imaginary. The growing acceptance in New Jersey of 'living shorelines' as a flood mitigation strategy is, at least partially, a response to the experience of towns with salt marshes and dunes experiencing less storm damage than ones more reliant on hard structures. As explored in Chapter Four, more communities are now willing to consider investing in projects to restore marshes and dunes. However, living shorelines are framed as green infrastructure projects that control erosion and protect private property along the shore. In other words, they fit within the broad contours of the sociotechnical imaginary of the shore that trusts in technology and policy to stabilize the coast and protect private property rights. As acknowledged by some proponents of living shorelines, this makes marshes and dunes a short-term solution, because projected sea level rise will cause these ecosystems to become inundated and die out—unless they can migrate landward. Because property and infrastructure remain immediately behind living shorelines, there is no room for such inland migration to occur. Unless this situation changes, living shorelines will be unable to persist in the face of climate change.

As detailed within the preceding chapters, there are a number of reasons to question the long-term viability of current development and management processes in the New Jersey shore region. Chapter One documents that conventional approaches to coastal governance are ill-suited for the deep uncertainty caused by climate change and that, in many cases, coastal regions exist within maladaptative space. Chapter Two highlights how this prevailing sociotechnical imaginary of the New Jersey shore region is increasingly out of synch with the emerging conditions of the

Anthropocene. Moreover, Chapter Three describes how the cultural, political, and economic visions and practices that have configured the shore region for more than two centuries have always contributed to a highly precarious mode of development that depended upon marginalizing and discriminating against some people so others could thrive. Chapter Four traces how existing sociopolitical commitments to protect private property rights and increase property tax revenue have hindered effective and sustainable adaptation policies. Chapter Five demonstrates that some constraints to adaptation can be overcome through well-designed initiatives operating within the boundaries of science and policy, despite controversy and ambiguity, to foster collaborative knowledge production that places adaptation on the policy-agenda; yet, at the same time, such initiatives have still largely supported conventional rather than transformational approaches to policy-making.

In short, this dissertation demonstrates that initiatives to tailor climate information to existing decision-contexts can have both positive and negative effects. It is important to acknowledge and stress the positive aspects. The initiative described in Chapter Five had numerous beneficial outcomes. Staff members learned about the plausible impacts that climate change might cause in the region. Adaptation to climate change became a policy priority within many municipalities. Perhaps most importantly, a few municipal officials and staff members began to argue that conventional approaches were no longer feasible and transformational approaches were needed—such as coastal retreat.

Yet, the production of climate information usable within existing decision-contexts also runs the risk of creating lock-in effects and path dependencies—both materially and mentally. As described in Chapter One, by aiming to meet current decision-making demands, usable information tends to support conventional planning and policy-making approaches. Thus, in the

New Jersey shore region, usable information generally supports plans and policies that aim to stabilize the coastline though technical means—including 'green infrastructure'—while framing future destructive storms as unavoidable events for which policy ought to prioritize emergency management and speedy recovery. Thus, while adaptation to climate change has been placed on the policy agenda of many coastal municipalities, the adaptations being pursued are nearly universally incremental and conventional. As municipal, state, and federal governments invest money and time in pursuing incremental adaptations that frequently are embedded within the material infrastructure of the region, the risk of creating path dependencies and lock-in effects is increased. Because of this, information tailored to the existing needs of municipal level decision-makers could contribute to entrenching maladaptive pathways.

Further, usable information also could contribute to mental path dependencies. By tailoring information to the prevailing sociotechnical imaginary found in the shore region, decision-makers are likely to come to the conclusion that current modes of governance and management are capable of addressing the challenges climate change will cause along the coast. This trust in the capacity of existing modes of governance and management dampens efforts to reimagine and rethink the region. For instance, as briefly mentioned in Chapter Four, in the immediate aftermath of Superstorm Sandy, the New Jersey chapter of the Surfrider Foundation launched a campaign entitled 'Rethink the Shore' that sought to change the fundamental characteristics of development in the region; yet this effort failed to gain a foothold. Moreover, and also documented in Chapter Four, some staff members in the region expressed to me a belief that retreat was a necessary component of coastal adaptation planning; yet, discussing it openly was not politically feasible.

Thus, as I argued in Chapter One and demonstrated throughout the other chapters, transformational change is necessary in the here and now. While such transformational change is needed within planning and management approaches utilized in the region, it is more urgently needed within the sociotechnical imaginaries that configure those approaches. Within the next section, I argue that one reason for the lack of transformative knowledge production is that knowledge brokers have worked within prevailing modes of coproduction between science and society. As I contended at the end of Chapter One, moving towards a more explicit engagement with the imaginative dimensions of knowledge production and communication could open up more possibilities for cultivating transformational approaches to climate change governance.

6.2—Coproducing Anthropocene Orders: From Civic Epistemologies to Sociotechnical Imaginaries

Efforts to provide decision-makers with climate information tailored to their decision-contexts continues to fall within the historical patterns of the co-production of ways of knowing and ways of acting (Jasanoff 2004). The success of such initiatives within the New Jersey shore region is, at least partially, due to this. As explored in Chapter Five, knowledge brokers do not follow a 'knowledge deficit model' in which the municipal officials they work with are assumed to be ignorant or illogical, but rather 'differently informed' (see: Jasanoff 2004). Moreover, scientists also collaborate with knowledge brokers to provide robust and up-to-date information about climate change risks in the shore region to be tailored to the needs of policy makers. This avoids the weaknesses of the 'loading dock model' of knowledge production. In other words, efforts to provide municipal government actors with usable climate knowledge have integrated many of the lessons from the past three decades of science and technology studies.

This reflects decades of scholarship within science and technology studies (STS) that has documented the ways in which scientific facts and social values are always entwined (Jasanoff 2004; 2015; Latour 1987; 2005). This understanding of the coproduction of ways of knowing and ways of acting within the world helps distinguish the goals of usable and transformative knowledge—as discussed in Chapter One. According to Jasanoff (2004), the process of coproduction plays out in different ways within different places—this leads to distinct civic epistemologies. A civic epistemology refers to the "culturally specific, historically and politically grounded, public knowledge-ways" that are used to judge the credibility of scientific claims in political life (Jasanoff 2004, p. 249). In other words, that the public finds some scientific claims credible and legitimate is, in itself, a phenomenon that must be explained. This is especially the case in which scientific and technical claims touch upon questions of how social life ought to be organized. This conceptualization of civic epistemologies provides a descriptive basis for better understanding the differences between the purposes of usable knowledge and transformative knowledge. Usable knowledge can be understood as scientific and technical claims that are able to meet conditions of tacit knowledge-ways through which legitimacy and rationality are judged. The conditions of information 'fit' and 'interplay' described in Chapter One entail meeting such conditions.

The Getting to Resilience (GTR) program described within Chapter Four can be seen as extremely effective in meeting knowledge-ways of the New Jersey shore region in judging the validity and relevance of climate information. This is partially due to the skillful use of a well-crafted bundle of boundary objects, but it is also due to the JCNERR staff possessing a strong understanding of the tacit ways in which technical information is assessed by municipal officials. However, as the emergent, unpredictable conditions of the Anthropocene unfold, so too emerge

rifts between established orders and planetary conditions (Connolly 2017; see also Chapter Two). The ways in which civic epistemologies assess questions that "revolve around how science and technology *ought* to constitute lives" (Jasanoff 2004, p. 251) in the New Jersey shore region continue to center on preserving the status quo of protecting infrastructure and private property.

Transformative knowledge, then, can be conceived as addressing problems of how to purposefully intervene within civic epistemologies and configure them to more sustainably, effectively, and justly address the urgencies of the Anthropocene. Accomplishing this requires expanding insights gleamed from scholarship utilizing the idiom of coproduction. Coproduction elucidates how scientific, political, and social orders come together in historically and materially specific ways. In Chapter Three, I documented how actors developed a number of technical and political solutions to address a range of problems and controversies in the shore region. The existing civic epistemology of the region is a legacy of many of these projects.

Understanding how civic epistemologies developed cannot fully answer questions of how to design interventions within civic epistemologies or the broader coproduction of science and society. As Jasanoff (2015, p. 3) recently stated: "Left unaccounted for by the bare idiom of coproduction are some of the biggest 'why' questions of history—why upheavals sometimes seem to come from nowhere and why attempts to remake the world sometimes fail despite much concerted effort and expenditure of resources." In other words, research within the tradition of the idiom of coproduction excels at explaining how things fit together but not necessarily how and why things came to fit together.

The notion of 'sociotechnical imaginaries', which I explored in more depth in Chapter Two, helps answer such questions by placing more attention on the "aspirational and normative

dimensions of social order captured by the notion of imaginaries" (Jasanoff 2015, p. 5). As I have argued throughout this dissertation, the prevailing sociotechnical imaginary found within the New Jersey shore region is one that imagines the persistence of development patterns prioritizing property and infrastructure through the use of technical interventions. These interventions include hard engineering solutions like sea walls and jetties along with soft solutions like dunes and marshes. Regardless of whether interventions are hard or soft, though, the purpose remains to protect the built environment and keep the economy growing. The civic epistemology found in the New Jersey shore region reflects the aspirations, values, and visions found within this sociotechnical imaginary. Transformative knowledge needs to engage with these imaginative dimensions of collective life. In the following section, I sketch out what that might look like in the New Jersey shore region in light of the findings of this dissertation.

6.3—Telling Stories that Change the Story: Imaginative Fit and Interplay

In Chapter One, I discussed Ursula K. Heise's (2016) argument that narratives about ongoing species extinctions will only gain sociocultural traction to the extent that they become part of the story people tell about themselves and the communities to which they belong. I suggested that climate change *has* become part of the story of the New Jersey shore region—at least for the municipal government actors I spoke with. Indeed, narratives about climate change were specifically tailored, translated, and brokered to fit existing sociotechnical imaginaries. In this case, the integration of climate change into the stories being told did not lead to transformational change that effectively addressed the causes and consequences of climate change in the region. Arguably, then, climate change has become part of the story being told but has not gained the sociocultural traction needed to alter the trajectory of development.

Another way to think about climate change becoming part of the stories people tell about themselves and the world around them, though, is that prevailing stories need to be tweaked, shifted, and recomposed to better fit the ongoing rush of urgencies associated with the Anthropocene. As explored in Chapter Two, spatial theory (i.e. Amin and Thrift 2002; Massey 2005), the environmental humanities (i.e. Alaimo 2016; Haraway 2016; Heise 2016), and political theory of the Anthropocene (i.e. Connolly 2017; Stengers 2015) can help guide the composition of stories that make a difference in the organization of collective life.

Composing stories about climate change that can both become part of stories people tell about themselves and the communities they belong to while also fostering a sense that new modes of collective life are needed is a significant and complicated challenge. At the conclusion of Chapter One, I developed the concept of imaginative fit and interplay to help guide such efforts. Imaginative fit refers to the ways in which knowledge claims gain purchase within collective ways of imagining life and the future. Imaginative interplay describes how knowledge claims resonate with alternative imaginaries present though often inchoate and disorganized.

Deciding what imaginaries to tailor climate narratives to fit within is an inherently normative and political question. Seeking resonance within existing stories means choosing to tailor information about climate change to fit particular stories. However, such choices are already being made in New Jersey. As I document in Chapter Four, the mindset among many organizations seeking to produce usable climate information is that municipal governments are their clients. Thus, narratives about climate change are brokered to fit the imaginaries of the local governments as they currently exist. This has direct implications for which communities of practice are invited to participate in the types of initiatives examined in Chapter Five. Thus, to inform and support transformational change, other communities and identities need to be brought into the fold.

However, fitting into existing senses of belonging is likely to be insufficient if the broad contours of the prevailing sociotechnical imaginaries make just and sustainable futures difficult to envision and enact, as is the case in the New Jersey shore region. In Chapter Two, in particular, I argued that the Anthropocene creates a variety of rifts and dissonances within how people understand their place within the world. The aspect of 'imaginative interplay' aims to address this problem. Imaginative interplay relates to emerging, often inchoate, and frequently disorganized movements of denormalization, becoming, and creativity that have the power to alter—sometimes fundamentally—the existing contexts of belonging. Connolly (2017, p. 21) refers to such projects as 'the politics of denormalization' in which some formerly internalized norms and disciplines become denormalized and replaced. Historical examples of this include abolition, suffragism, and the civil rights movements.

In other words, increasing imaginative interplay entails integrating and amplifying ongoing practices of creating something new and more desirable. For instance, in the context of the New Jersey shore region, that might include movements to restore salt marshes, bays, dunes, and other coastal habitats; fights against the ocean front development and privatization of public access; and the emerging, inchoate sense that coastal retreat must occur. The aim of increased imaginative interplay, therefore, is to contribute to the creation of something new, or what Ranciere would refer to as a new distribution of the sensible (2004).

Unlike the concepts of 'informational fit and interplay' or 'institutional fit and interplay', the two components of imaginative fit and interplay possess some degree of irreducible tension. Increasing imaginative fit seeks resonance within existing sociotechnical imaginaries in order to gain sociocultural traction. Increasing imaginative interplay aims to disrupt the given distribution of things and produce something new. Too much imaginative fit might reinforce unsustainable

and unjust imaginaries; too much imaginative interplay might fail to gain a foothold in prevailing practices and narratives. Thus, simultaneously gaining purchase within the existing norms and disciplines that comprise an existing context of belonging while also amplifying emerging political movements of denormalization is a core challenge of imaginative fit and interplay.

Such a challenge is not novel; it is endemic to politics. However, as Connolly (2017, p. 19) argues: "Today the question becomes how to renegotiate persistent tensions between freedom and belonging during an era when fateful intersections between the social organization of life and planetary processes…with powers of their own have again become so palpable." That is, while there have always been tensions between existing contexts of belonging and politics of denormalization, the Anthropocene and its planetary changes, complicates this due to the fundamentally novel conditions of the Earth System. Thus, Connolly (2017, p. 22) asks: "What sites of and modes of attachment are appropriate to an era when planetary forces impinge with cataclysmic effect upon so many dimensions of life?" There is no universal answer to this question; rather, it can only ever be addressed partially and contentiously.

In moving forward, the notion of desirability can help guide achieving a balance between imaginative fit and interplay. Indeed, the concept of sociotechnical imaginary explicitly includes the normative dimension of "visions of desirable futures" (Jasanoff 2016a). For the majority of the individuals I interviewed—both in government and working in nonprofit organizations—the future they could imagine was rarely truly desirable. Instead, it was the most desirable one they could imagine as plausible. Thus, there was frequently a nagging sense within interviews that, perhaps, the shore region ought not be organized to continue prioritizing private property rights and economic growth. Yet, there were few well developed alternatives being offered.

Increasingly, research in the field of environmental governance is highlighting the potential for climate information and service provision to address such imaginative needs (Adloff and Neckel 2019; Escobar 2015; Knappe et al. 201; Page et al. 2016; Longhurst et al. 2016; Rickards et al. 2014; Tyszczuk and Smith 2018; van der Voorn et al. 2017; Veland and Lynch 2016; Vervoort et al. 2015; Vervoot and Gupta 2018). Central to much of this scholarship is the belief that imagining alternative futures requires developing strategies for decision support that overcome the 'consensual present' and encourage "participants to discover their capacity to shape worlds through and through" (Vervoort et al. 2015, p. 64). Such scholarship does not necessarily call for injecting imagination into environmental governance; instead, it makes the case for explicitly recognizing the already imaginative dimensions of governance. Governance exercises such as scenario planning, foresight practices, pathway development, visioning sessions, and so forth reflect existing ways of imagining the world as well as present opportunities to intervene within the collective imaginations shaping social beliefs, values, and aspirations. Thus, imagination already acts as a resource within governance as well as a target of governance.

The concept of imaginative fit and interplay can play a role in more effectively drawing up and intervening within imagination. By shifting focus towards the still plausible and desirable future possible while probing the tensions between imaginative fit and interplay, it is possible to begin the process of envisioning, designing, and implementing transformational pathways of responding to the urgencies of climate change. In pursuing this objective, sociotechnical imaginaries can help "direct our attention toward the practices of sense making and the tacit assumptions that allow collectives to hold together in understandable sustainable, livable modes of being" (Jasanoff 2015b, p. 338). At the same time, it is necessary to examine how political

projects can emerge to radically reconfigure what is seen as possible and desirable and transformational adaptation can be created in the here and now.

6.4—Future Research Directions and Needs

In this dissertation, I stressed the importance of examining the imaginative, normative, historical, and political dimensions of climate change adaptation. Frequently, identifying the factors constraining the creation of effective climate change adaptation policies requires understanding the historical and material roots of vulnerability. Concepts from science and technology studies—such as the idiom of coproduction, sociotechnical imaginaries, and boundary objects—can help elucidate the ways in which particular arrangements of social and physical vulnerability became stabilized through time. Finding ways to change the sedimented values, beliefs, and aspirations that make transformational change seem implausible. Thus, this dissertation points towards two related research needs. First, historically attentive research on social vulnerability that traces the emergence of deeply rooted values, beliefs, and aspirations found at the center of ineffective climate responses. Second, exploration of the connections between imagination and climate change policy.

The first research need reflects recent calls for better understanding how discrete barriers and limits to adaptation connect, interact, and reinforce another, as discussed in depth during Chapter Four. Through semi-structured interviews with municipal actors, I found that the factors most driving ineffective responses to climate change tended to fall within the category of sociopolitical constraints. In the case of the shore region of New Jersey, a reliance on property taxes to fund local government services, a ‘pro-growth’ mindset, and trust in technical solutions have contributed to short-term policy visions that continue to place people and infrastructure in harm’s way. These sociopolitical constraints have deep historical roots in the region, as

documented in Chapter Two and Chapter Three. Understanding how and why these sociopolitical constraints emerged provides a richer understanding of the current configuration of constraining factors. Future research can build upon the heuristic developed within Chapter Four to further explore how constraints connect as well as to examine the historical processes that led to their emergence and stabilization. This knowledge can help with the design of governance interventions aiming to overcome constraints to sustainably respond to the urgencies of climate change.

The second research need complements efforts to implement more effective, sustainable, and socially just policies by documenting the imaginative dimensions of social, material, and political change. More work needs to be conducted that elucidates how people and communities imagine climate change, what futures they envision remain plausible, and how values, expectations and aspirations get tied up in efforts to address problems associated with climate change. The concept of imaginative fit and interplay can help guide research on these dimensions.

6.5—Achieving a Thriving New Jersey Shore

Contrary to the notion that the Holocene was the geological epoch in which humanity in general thrived, the story of the New Jersey shore region is one in which some people have thrived at the expense of others—both human and non-human. Imagining, composing, and achieving a landscape in which social and ecological thriving truly occurs requires transforming many of the fundamental beliefs and practices that have structured development for the past two centuries. Development patterns that have contributed to the growing social and ecological precarity of life along the coast by causing significant carbon emissions, placing homes in hazardous areas, and

fostering a mindset that shorelines and barrier islands can be kept in place. Escaping the maladaptive space of the region requires transformational change in the here and now. Future research must engage directly with the challenge of how climate science can inform and support radical change that expands the sphere of who and what gets to thrive.

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