

# Governance Challenges in Adapting to Sea Level Rise

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## Abstract

As rising sea levels increasingly threaten coastal regions, there are a number of technical and policy solutions that can reduce society's vulnerability to the impacts of sea level rise, including retreat, elevation, and the construction of coastal defense structures. However, adaptation to sea level rise will be constrained not only by the realm of what is technically possible but also by how these solutions are understood and received by key decision makers and the general public.

This paper examines the governance challenges associated with adaptation to sea level rise. Drawing upon examples from California, North Carolina, and Texas, this paper examines how the political dynamics of climate change adaptation, public perceptions of natural hazard risk exposure, and private property interests influence the range of available adaptation responses.

Overall, this paper concludes that the legal and policy dynamics surrounding decisions to adapt to sea level rise can be far more significant than the technical ability to adapt. Therefore, the ultimate ability to adapt to sea level rise and reduce coastal vulnerability will depend upon the ability of the technical and policy communities to collaborate to understand the range of feasible, acceptable solutions.

## Introduction

Global sea level rise presents significant challenges to coastal populations. According to the IPCC's Fourth Assessment Report, global sea levels could rise as much as 0.6 meters by 2100. (IPCC 2007). More recent studies suggest that this IPCC estimate is too low and that global sea level rise by 2100 may be as much as 2 meters. (Vermeer & Rhamstorf 2009). Major impacts of sea level rise on coastal populations include gradual inundation of lands and salt water intrusion into groundwater tables. In addition, climate change is projected to result in increased storminess, which when combined with rising sea levels, has the potential to cause more frequent and severe storm surges.

While much of the public policy debate over climate change has focused on mitigation, or the reduction of greenhouse gas emissions, attention is increasingly focused on adaptation, the response to climate changes. Even if all greenhouse gas levels had been stabilized in 2000 the committed warming due to greenhouse gases in the atmosphere was still projected to result in 12 to 13 centimeters of sea level rise, which would result in significant coastal inundation. (Meehl et al. 2005). Furthermore, more recent studies suggest that global greenhouse gas emissions must be stabilized by 2016 to avoid catastrophic impacts. (IEA 2011). As a result, strong adaptation policy is essential to minimize the impacts of global climate change on both the built and natural environments. This paper explains the theoretical framework of vulnerability and examines actions that state and local governments in three U.S. States are taking to reduce their vulnerability to sea level rise. In particular, this paper explains how particular political, social, and economic factors shape the adaptation options that are available to policymakers and concludes that many options for adaptation to sea level rise that would be preferred from an ecological and engineering perspective are not available to decision makers constrained by real-world political, social and economic factors.

## **Defining Adaptation Governance**

This section provides the theoretical framework employed in this analysis by explaining three core concepts: vulnerability, adaptation, and governance. Vulnerability is a key theoretical construct through which options to respond to the impacts of climate change can be evaluated. Ideally, decision makers structure their adaptation responses to the projected impacts of climate change in a manner that seeks to reduce the vulnerability of the natural and social systems that society values. The study of governance examines political systems in action and explores how factors including the structure of a government and its interaction with other societal forces produce policy decisions. Adaptation governance thus examines how the relationships between legal structures and stakeholders shape policy decisions that constitute adaptation to climate change.

## **Understanding Vulnerability and Adaptation**

Two interrelated concepts that arise in discussing responses to the impacts of global climate change are vulnerability and adaptation. The concept of vulnerability in the climate change literature has its origins in two distinct bodies of research: disaster preparedness and response and the social science discipline of geography. In disaster preparedness and response research, vulnerability has traditionally been understood as a measure of the physical hazards to which a system is exposed and its sensitivity to them. (Brooks et al. 2005). In contrast, the discipline of geography defines vulnerability as a measure of the organization of social systems and their ability to respond to external stressors. (Brooks et al. 2005). In the context of climate change adaptation, these definitions have been combined to produce a working definition of vulnerability as the ability of a system to respond to and cope with the impacts of global climate change. (IPCC 2007; Adger 2006). It is important to point out that this definition of vulnerability, which incorporates the resilience of built, social, and natural systems, opens up a very broad range of options to reduce vulnerability. For example, vulnerability to sea level rise could be reduced by either moving people and infrastructure out of areas exposed to inundation or by having coastal insurance that is sufficient to rebuild a coastal community in the event of a destructive storm.

Adaptation is any action that is taken to reduce vulnerability to climate change. (Heltberg et al. 2009). Adaptation can be divided into two categories: passive and active adaptation. (Adger et al. 2006). Active adaptation involves forward-looking planning to reduce the impacts of global climate change upon a population. In contrast, passive adaptation is the response to the impacts of climate change once they have been felt. An example of active adaptation would be the construction of water storage systems to mitigate against the threat of changes in the amount and seasonality of water availability that may result from climate change. In contrast, passive adaptation would involve the purchasing of additional water rights once water scarcity is experienced. (Adger et al. 2006). It is important to emphasize that any action taken in response to climate change impacts is adaptation. The policy question is thus whether to engage in proactive planning, leading to more efficient adaptation by reducing future vulnerability, or to wait for climate change impacts to be experienced and choose from a more limited set of options to respond to them.

In the context of responding to sea level rise, there are three major categories of adaptation responses: coastal defense, creating economic incentives to encourage retreat, and managed realignment. Coastal defense involves the installation of physical structures to hold back the rising sea. These structures would include seawalls, riprap, and sandbags. At the other end of the spectrum, managed realignment involves large-scale land use planning to move populations out of areas vulnerable to inundation and make way for rising water. In the middle, there are a range of adaptation options that keep coastal populations in place in the short-term, but ultimately provide for their relocation when the land becomes inundated. (Titus 1998). These options all provide various advantages and disadvantages. The creation of economic incentives is not discussed further in this paper because research demonstrates that individual property owners are generally not responsive to these incentives and therefore they are unlikely to be a meaningful adaptation option. (Burby 2006; Kunreuther et al. 2008; Peloso 2010). Coastal defense may be preferable from a political perspective because it does not involve relocating coastal property owners. However, approaches that involve defense and fortification of the coast lead to the worst outcomes ecologically, as important habitats such as wetlands will ultimately be lost as they are squeezed between rising seas and hardened shorelines. It is important to note that the ideal adaptation solution is likely to involve a mixture of options. For example, in the San Francisco Bay Area both the Oakland and San Francisco airports are projected to be inundated by sea level rise. It is difficult to imagine that such critical infrastructure would not be protected with coastal defense structures. However, coastal defense structures are costly to construct and maintain and their wide-range installation could have severe ecological ramifications. Therefore, the key adaptation challenge for coastal areas will be to determine the relative values of particular aspects of the built environment and natural systems in order to determine how to preserve both in appropriate areas.

### **Defining Governance**

There is a distinction between governance and government that is essential to evaluating how adaptation decisions in the coastal zone are reached. Government is the structures that constitute a political system and its laws. In contrast, governance is the interaction of systems of government with civil society organizations that results in actual decision making and the carrying out of government functions. (Folke et al. 2005). While coastal government may be narrowly defined as the laws and institutions that apply to the coastal zone, coastal zone governance describes the interaction of these institutions with citizens and citizen groups through a process that results in actual decision making. Therefore in order to understand coastal adaptation governance, it is essential to examine how governmental structures, citizens, and institutions interact to produce decisions about property use and adaptation in the coastal zone.

### **Public Risk Perception**

Underlying all decisions about adaptation to sea level rise and future coastal development are the perceptions of risk held by the general public and coastal property owners. If coastal property owners can be shown to be rational economic actors, then it would be theoretically possible to design a structure by which the risks of inundation due to sea level rise were fully incorporated into the valuation of property. Such information could conceivably be conveyed by providing property owners notice of flood hazards, which should decrease the amount a buyer would pay for a property, or through insurance pricing schemes that are tied to the risk of loss. If either system were to get the pricing right, classical economic theory would dictate that property

owners will only live at the coast until it becomes too risky according to their personal preferences. At that point, the rational economic actor would choose to relocate inland, thereby avoiding the risk to inundation due to sea level rise. (Peloso 2010).

Unfortunately, research in both economics and disaster response clearly demonstrates that, at least with respect to real estate in hazard areas, people are not rational economic actors. A study examining the impact of informing property owners of their location in a flood zone found moderate impacts on the prices of inland homes, but no effect for the first row of homes along the coast. (Bin et al. 2008). Other studies find that people are generally very poor at understanding and quantifying risks. In general, people will tend to assume that natural disasters will not happen to them and they will systematically underinsure their homes and fail to take low cost mitigation measures that would avoid substantial damages in the event of a disaster. (Kunreuther et al. 2008). Finally, the Safe Development Paradox dictates that given unrestricted choice of where to live, Americans will tend to build their homes in high hazard areas under the belief that if enough people live in a hazard area, the government will protect them from the hazards. (Burby 2006).

These dynamics of public risk perception are all the more difficult when it comes to sea level rise. While many individuals have experienced or witnessed natural disasters such as hurricanes or earthquakes, and thereby perceive them as risks. Climate change is happening gradually over time. Studies of public perceptions of climate change generally show that it follows the pattern of risk perception seen with natural disasters: people who are currently experiencing impacts they associate with climate change are more likely to believe that it exists and that we must take actions to both mitigate greenhouse gas emissions and adapt to the impacts of climate change. (Schiermeier 2011). As a whole, Americans are likely to believe that climate change impacts are distant in both space and time. (Liserowitz 2008). Furthermore, the impacts of sea level rise are so gradual and potentially indistinguishable from erosion that it can be particularly difficult for the general public to fully comprehend the risks of sea level rise. As discussed below, this failure of public risk perception can create particular challenges in facilitating adaptation to sea level rise because decision makers are often faced with the very real concerns of private property owners who may not fully understand the risk of inundation due to sea level rise.

### **Assessment of Adaptation Governance in Response to Sea Level Rise**

California, North Carolina, and Texas provide a wealth of information on how political and social factors shape adaptation responses. This section will provide an overview of the regulatory structure governing the coastal zone in each state and focus on specific examples of coastal decision making to explore various aspects of adaptation governance. In California, this part describes the California Bay Conservation and Development Commission's efforts to make new rules amending the Bay Plan to require specific consideration of climate change. While the Bay Plan represents an important step forward in sea level rise planning, an assessment of the BCDC's efforts reveals that there is a fundamental mismatch between the scope of jurisdiction and the area where action is needed to truly adapt to the impacts of sea level rise. In addition, this section examines the ongoing legal controversy regarding the construction of seawalls to protect coastal property in California. In North Carolina, this paper examines the series of events related to sea level rise planning that ultimately led to state legislation restricting the consideration of sea level rise and the replacement of a number of representatives on the Coastal

Resources Commission—the state’s governing body for coastal development and resource protection. Finally, in Texas, this paper focuses on the litigation in *Severance v. Patterson* as an example of how the concerns of individuals can upset a system of rules that are generally agreed upon. Collectively, these case studies demonstrate that governance factors unrelated to the particular structure of a coastal government are the primary forces that shape adaptation actions in the coastal zone. This finding is significant because it suggests that although certain adaptation options may be technically achievable, other factors in the decision making process, such as political pressures and individual property owner behaviors, may make them unavailable.

## **California**

California has one of the longest coastlines in the United States and the San Francisco Bay is one of the largest developed estuaries in the world. California projects that by 2100 it will experience 1.4 meters of sea level rise, resulting in significant inundation of low lying areas and increased erosion of coastal bluffs. (BCDC 2011). The San Francisco Bay is perhaps the part of California that is most vulnerable to the near term impacts of sea-level rise: the San Francisco Bay Conservation and Development Commission projects that nearly \$62 billion of development will be threatened by sea level rise by the end of the century. (BCDC 2011). This value represents nearly two-thirds of the value of all development threatened by sea level rise in California. (BCDC 2011).

California has distinct legal structures that govern its ocean coastline and the shores of the San Francisco Bay. Along the ocean coastline, the California Coastal Act applies to covers a statutorily defined area reaching from three miles offshore to an inland area varying from two hundred feet in some urbanized areas to several miles in some mountainous rural areas. (CAL. PUB. RES. CODE §§ 30300-30305, 30416). Under the Coastal Act, the California Coastal Commission serves as the lead permitting agency at the state level. Development at the local level may be controlled by local authorities when they have a Local Coastal Plan that has been certified by the Coastal Commission. (CAL. PUB RES. CODE § 30512). However, the Coastal Commission will retain direct jurisdiction over seawalls and the ability to hear appeals of other local permitting decisions.

In contrast, the San Francisco Bay Conservation and Development Commission (“BCDC”) has much narrower jurisdiction in the San Francisco Bay. Established in 1965 to limit infill and ensure the continued existence of the Bay, the BCDC is now faced with the challenge of using its limited authorities to prepare the Bay for rising sea levels. (BCDC 2006). Under the statute that created the BCDC, it is granted broad authority to write its own rules in the form of the Bay Plan, which constitutes the regulatory framework for the Bay. (BCDC 2008). While BCDC thus has broad discretion in shaping its rules, its geographic jurisdiction is limited to all submerged lands, a strip of land 100 feet from the shoreline, and some limited jurisdiction over wetlands and salt ponds along the Bay. (BCDC 2008). Permits from the BCDC are required for any development activities that impact areas within the BCDC's jurisdiction. Under the law that established the BCDC, the entire San Francisco Bay is segmented, with some areas being designated as “priority use areas.” Within a priority use area, BCDC may only permit water-dependent uses. (BCDC 2008). In all other areas, the BCDC may only deny a permit on the

grounds that the proposed project fails to provide the maximum feasible public access to the shoreline. (BCDC 2008).

While the BCDC's landside jurisdiction is extraordinarily limited, it has led the way in encouraging municipalities along the Bay to take sea level rise into consideration and has exercised its authority to amend the Bay Plan to expressly require the consideration of climate change. Under amendments to the Bay Plan adopted on October 6, 2011, there are a number of new findings and policies that are designed to facilitate adaptation to sea level rise. (BCDC Res. No. 11-08). The Bay Plan's new findings emphasize the importance of enhancing the adaptive capacity and resilience of the Bay's ecosystem. The Bay Plan amendments also adopt the California Climate Adaptation Strategy's finding that state agencies should not plan, develop, or build any new infrastructure that will require significant protection from sea level rise. The new Bay Plan climate change policies require that a qualified engineer conduct a sea level rise risk assessment for any new project along the Bay shoreline. If the assessment determines that an area will be vulnerable to sea level rise, the only developments that the BCDC will approve are repairs to existing facilities, small projects that do not increase risks to public safety, infill developments and those new developments that can demonstrate they are designed to be "resilient to a midcentury sea level rise projection." (BCDC Res. No. 11-08). While the requirements to demonstrate resilience to a midcentury sea level rise project are not specified, BCDC officials have indicated that they believe there are few categories of developments that will meet this goal. In fact, in interviews one of the few examples that BCDC officials gave of communities that might meet this criterion were those communities that would be designed to float as the land upon which they are built becomes inundated. In addition, if a new development is projected to remain in place beyond mid-century, the developer must prepare an adaptive management plan to address long-term impacts that will arise as sea level rises. The new Bay Plan policies also call for the formulation of a regional strategy that will identify which areas should be defended from sea level rise and how they should be protected.

The BCDC's new rules thus take important steps towards shaping coastal development to both reduce the vulnerability of the built environment and to preserve important habitats and ecosystems. However, because of the BCDC's limited jurisdiction, it is difficult to project the impact that these rules will have on future developments along the Bay, particularly given competing climate and development priorities. A prime example of this conflict is the proposed Redwood City Saltworks development in Redwood City, California. The Redwood City Saltworks site consists of approximately 1,200 acres of land along the San Francisco Bay that was formerly part of Cargill's extensive salt production operations in the Bay. (Bishop 2009). In 2009, a developer submitted plans to develop a "mini-city" with up to 12,000 home sites on the property, which consists of low-lying and infill land. (Redwood City Saltworks 2009). The Saltworks Developers proposed a system of levees that could be raised in the future to accommodate up to 1.5 meters of sea level rise. (Redwood City Saltworks 2009). While it appears that the Redwood City Saltworks may have a difficult time demonstrating consistency with the Bay Plan climate change rules, there are a number of other forces that may lead to the ultimate approval of some portion of the development. Primary among these factors are considerations of available housing and California's obligations to mitigate greenhouse gas emissions under state legislation. The South Bay, where the Saltworks project would be located, experiences a chronic shortage of housing in relation to the number of jobs in the area.

(Redwood City Saltworks 2009; Calthorpe 2009). In addition, under California's Global Warming Solutions Act ("AB 32"), the state has an obligation to limit greenhouse gas emissions from the transportation sector.

Because of all of these considerations, broader environmental concerns, and public expectations regarding the future of the Saltworks site as open space, the proposed project was quite controversial. In response to the significant number of comments received during the City's initial scoping process conducted as part of its review of the Saltworks Proposal, the project developer formally withdrew its application in May of 2012. (DMB 2012). In so doing, the developer announced its intention to come back with a smaller scale of development, which will focus on areas already zoned for possible urban expansion. As a result, it appears likely that the revised proposal will fall outside of BCDC's jurisdiction.

Although the revised Saltworks plan may not fall within BCDC's jurisdiction, it provides a number of important lessons for the future implementation of BCDC's climate change policies. Even if BCDC were to object to a proposed development on the grounds that it is inconsistent with the climate change policies in the Bay Plan, it does not appear to have the authority to stop such development. Even so, the BCDC's new climate change rules were opposed by developers on the grounds that they may reduce property values if Californians become concerned that their properties will be lost to inundation. (Bland 2011). At most, it appears that a BCDC denial could force redesign of a development so that it does not fall under BCDC's jurisdiction. However, if BCDC's calls for regional planning are heeded, a subsequent regional plan may dictate that areas like the Saltworks site be left in their natural state or be available only for developments that can be removed when the land is inundated. In the short run, the BCDC's new climate change policies are a key example of a fundamental mismatch between the scope of authority of a political institution and its will to act. Recognizing this, BCDC has positioned itself as an educator that seeks to influence governance and development at the local level. BCDC has undertaken extensive efforts to educate local governments on the risks and impacts of sea level rise and has created a number of studies and projects to develop examples of the implementation of sea level rise adaptation in the Bay. (BCDC 2010). These efforts have been significant, decision makers around the Bay report that both they and their constituents were not aware of nor concerned about the impacts of sea level rise prior to BCDC's education and outreach efforts. Using a series of inundation maps, BCDC has succeeded in making sea level rise real and battling the public inability to perceive of risks. While these efforts alone are not likely enough to entirely reshape development along the Bay's shoreline, they have been a significant factor in raising consciousness about the threat of inundation due to sea level rise.

A different story is playing out along California's ocean coasts as the newest chapter of conflicts between coastal property owners and public access advocates unfolds. Much of California's coastline consists of soft mudstone bluffs that are prone to erosion, and as a result, the Coastal Commission is often presented with applications to introduce new armoring along the coast, turning the natural bluffs into concrete. Under the Coastal Act, the Coastal Commission has original jurisdiction over all seawall permits, but must make sure that any development is consistent with the community's approved local coastal plan. Under the Coastal Act, the Coastal Commission has two conflicting mandates that come into play in evaluating whether the Commission can promote managed retreat and prevent the armoring of the coast, which has significant consequences for both environmental quality and public beach access. First section

30233 creates a general prohibition against armoring the coast. (Cal. Pub. Res. Code § 30233). In contrast, section 30235 of the Coastal Act states creates a right to armor for any property that is considered to be “in danger.” (Cal. Pub. Res. Code § 30235). While the history of the Coastal Act suggests that this provision was intended to prevent a taking of the property rights of those owners whose homes existed when the Coastal Act was passed in 1976, the Coastal Commission has generally interpreted section 30235 more broadly.

The most recent controversy over the permitting of seawalls along California’s coast has arisen in Solana Beach. Solana Beach is a 1.7 mile-long beachside community located 20 miles north of San Diego. Single family homes have been built in Solana Beach on bluffs overlooking the beach; seawalls protect these bluff-top homes from erosion and preserve property values.

The Coastal Act requires local governments with jurisdiction over “coastal zone” lands to adopt a Local Coastal Program (LCP) that has been certified by the California Coastal Commission (“Commission”). (Cal. Pub. Res. Code § 30500). A LCP has two parts: a Land Use Plan (LUP) and a Local Implementation Plan (LIP). The LUP is a general policy document that sets forth policies for coastal development and has the force of law. The LIP is the collection of implementing ordinances that carry out LUP policies.

On March 7, 2012, the Commission certified, with heavy modifications, a LUP the City of Solana Beach submitted in October 2011. The Commission’s amended LUP provides, among other things, that “[a]ll permits for bluff retention devices shall expire after 20 years.” (City of Solana Beach Local Coastal Plan, Feb. 27, 2013, Policy 4.55).<sup>1</sup> Thereafter, the owner must apply for a new permit, which may be granted depending on factors such as “changed geologic site conditions relative to sea level rise and the age, condition, and economic life of [the] principal structure including whether it was an existing structure on January 1, 1977 (prior to implementation of the Coastal Act).” As a condition of the application, the owner must record a deed restriction waiving “any future right that may exist [under the Coastal Act] to new or additional bluff retention devices.” (City of Solana Beach Local Coastal Plan, Feb. 27, 2013; Policy 4.19).

However, on August, 15, 2013, the Commission approved a permit for a seawall for the Land’s End development that marks a significant departure from the 20 year seawall permit sunset included in the Solana Beach LUP. Rather than stating that the permit shall expire at the end of 20 years and limiting the ability of the property owner to renew the permit, the Land’s End permit provides that permittee may apply for an amendment to its coastal development permit to extend the life of its seawall. (California Coastal Commission Permit No. Th17a 2013). In adopting this provision, the Coastal Commission asserted that section 30235’s right to protect structures that are “in danger” supersedes any contrary provisions in LUPs, including the seawall permit sunset in the Solana Beach LUP. While the motivations behind the Coastal Commission’s decision are not altogether clear, the permittee submitted documentation to the Commission suggesting that the application of the sunset clause would constitute a regulatory

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<sup>1</sup> The LUP is available at [http://www.ci.solana-beach.ca.us/index.asp?SEC=CC37BEAA-17D1-46B7-9DF6-F0C3F305CCFC&DE=4CD0C8ED-DD66-4B4C-906C-4BF26BD4711C&Type=B\\_BASIC](http://www.ci.solana-beach.ca.us/index.asp?SEC=CC37BEAA-17D1-46B7-9DF6-F0C3F305CCFC&DE=4CD0C8ED-DD66-4B4C-906C-4BF26BD4711C&Type=B_BASIC).



taking. (California Coastal Commission 2013). Thus, it seems that the Commission's fear of takings liability may be an important factor limiting its ability to promote coastal retreat.

### **North Carolina**

In North Carolina, the ocean and estuarine coastlines are jointly managed under the Coastal Area Management Act ("CAMA"). CAMA delegates authority over coastal management to the North Carolina Division of Coastal Management ("DCM") and grants permitting authority to the Coastal Resources Commission ("CRC"). Under CAMA, the CRC is responsible for creating the minimum requirements for land use planning, while local governments are charged with the development of land use plans, which must be approved by the CRC. (N.C. Gen. Stat. § 113A). The CRC also has direct jurisdiction over all permitting in designated Areas of Environmental Concern ("AEC"). (15A N.C. Admin. Code § 07J). The AECs under CAMA are estuarine and ocean ecosystems, ocean hazard systems, public water supplies, and natural and cultural resource areas. (N.C. Gen. Stat. § 113A).

In 1979 the CRC instituted a ban on hardened shorelines along North Carolina's ocean coast. (Mabry 2009). This ban has since been codified into law, and expressly forbids permanent armoring of the coastline. (N.C. Gen. Stat. § 113A). However, North Carolina has always provided for the use of "temporary erosion control structures," or the placement of sand bags for limited periods of time to respond to erosion threats. Under the current rules, a permit may be granted for the placement of sandbags for up to two years for structures smaller than 5,000 square feet and up to five years for larger structures. (15A N.C. Admin Code § 07H). The rules require that sandbags be removed at the end of the permitted period unless the community is actively pursuing beach nourishment, the sand bags have become covered by sand and dune vegetation is established, or the property owner obtains a variance from the CRC. (N.C. Admin. Code § 07H). While the rules expressly provide that sand bags must be removed, it is often the case that once sand bags have been placed, coastal property owners become dependent upon the sand bags to protect their homes, and removal becomes difficult if not impossible. As of 2009, DCM estimated that there were 320 sandbagged structures along the North Carolina coast. (Allegood 2009; McGrath 2008).

Because sandbag installations can pose a major threat to public safety and significantly impair public beach access, the CRC voted to issue an order requiring the removal of all non-conforming sandbag installations in July 2008. (CRC 2008). The order required the removal of all sandbag installations more than 5 years old, and the CRC thought this could result in the removal of sandbags at more than 250 sites. (Interview with CRC member). Seeing the order as an imminent threat to their property, a number of coastal homeowners went to the North Carolina legislature to voice their objections to the order. As a result, in May 2009, the legislature passed a one-year moratorium on enforcement of the CRC order and directed the CRC to conduct a study on the efficacy of terminal groins as erosion control devices. (N.C. Senate Bill 998).

Because North Carolina's coast tends to have a dominant longshore flow, there is a possibility that the placement of structures perpendicular to the coast (terminal groins) will capture sediment and rebuild the beaches. Released in March 2010, the Terminal Groin Study concluded that there is a significant and positive result, defined as halting erosion or causing accretion of sediments, within the first mile of shoreline from the terminal groin, and only mild increased

erosion on the side opposite the terminal groin. (NCDENR et al. 2010). In its review of these results, the CRC concluded that the impacts of terminal groins amount to mere “noise” in the context of other inlet management activities occurring in the study areas. (CRC 2010). Determining that the results of the Terminal Groin Study were inconclusive but recognizing the need to respond to the mandate of the legislature, the CRC concluded that the use of terminal groins should only be considered where all other options including relocation of threatened structures are deemed impracticable. (CRC 2010). After issuing its findings on the Terminal Groin Study, the CRC unanimously ordered the DCM to resume enforcement activities against non-conforming sandbags. (CRC 2010b).

However, facing continuing difficulties in enforcing its sand bag rules, the CRC adopted a series of revisions to these rules in February 2013. (CRC 2013). Under the revised rules, sandbags may be used as follows: (1) for two years to protect buildings 5,000 square feet or smaller; (2) for five years to protect buildings larger than 5,000 square feet; (3) for five years to protect properties located in a community that is actively pursuing a beach nourishment project; (4) for eight years for properties located in an Inlet Hazard Area adjacent to an inlet for which a community is actively pursuing an inlet relocation project. (DCM 2013). In addition, the rule revisions provide that existing sandbags in Inlet Hazard Areas can receive eight-year permit extension provided the structure protected by the sandbags is still imminently threatened. (DCM 2013).

In 2012, North Carolina’s General Assembly enacted House Bill 819 (“Bill”), which provided that the state’s Coastal Resources Commission (“CRC”) and the Division of Coastal Management of the Department of Environment and Natural Resources “shall not define rates of sea-level change for regulatory purposes prior to July 1, 2016;” however, counties, municipalities, and local governments were not prohibited from defining rates of sea-level change for regulatory purposes. (N.C. GEN. STAT. § 113A-107.1(c) (2012)). The Bill requires the CRC’s Science Panel to deliver a five-year update to their 2010 report, “North Carolina Sea Level Rise Assessment,” no later than March 31, 2015. (2012) (N.C. Sess. Laws 202 § 2(b)). Furthermore, the Science Panel’s 2015 report must describe the limitations and assumptions of its models; address the full range of sea-level change hypotheses, including falling sea levels and decelerating sea rise; compare determinations of sea level based on historical calculations versus predictive models; and calculate sea level rise for at least four different regions of the coast, rather than using a single rate of sea level rise for the entire state. (N.C. Sess. Laws 202 § 2(c)). The 2015 report be available to the public for comment by December 31, 2015, and presented to the General Assembly Environmental Review Commission with these comments no later than March 1, 2016. (N.C. Sess. Laws 202 § 2(c)). Finally, the Bill provides that the CRC “shall not deny a development permit for the replacement of a single-family or duplex residential dwelling with a total floor area greater than 5,000 square feet” based on failure to meet ocean hazard setback requirements, if the dwelling was built prior to August 11, 2009, and meets other minimum setback requirements. (N.C. Sess. Laws 202 § 3(a)). The CRC responded to this final provision by adopting a rule amendment at its July 2013 meeting. (CRC 2013b).

In early 2013, the Government Reorganization and Efficiency Act (“GREA”) was introduced in the General Assembly. (S.B. 10, 2013 Gen. Assemb., (N.C. 2013)). The North Carolina Senate’s version of the GREA reduces the number of Commission members from 15 to 13; it

requires 9 members to be appointed by the governor, and another 4 members to be selected by the General Assembly. (S.B. 10 § 2.1(a)). It ends the terms of all Commission members who served as of January 1, 2013, while exempting the terms of four members from expiring until June 30, 2014. Finally, the Senate bill clarifies conflict of interest rules, prohibiting members from deriving a significant portion of their income from land development or real estate and requiring all Commission members to be residents of North Carolina and live or own property in coastal areas. Taken together, these provisions end the terms holdover Commission members from previous administrations and allow the party currently controlling the governorship to appoint a majority of the Commission's members. The GREA passed the Senate on February 7, 2013; it passed the House on March 4, 2013. *Id.* Since that time it has been in a conference committee, where House and Senate representatives agree on a bill's final form.<sup>2</sup>

Overall, the North Carolina example demonstrates the influence of stakeholders on coastal adaptation governance. As written, North Carolina's policy against oceanfront hardening combined with the high rates of erosion experienced on the Outer Banks should constitute a de facto policy of retreat. If enforced as written, the sand bag rules would have granted property owners a time limited right to remain on their properties once threatened by erosion but ultimately would have forced them to give way to encroaching seas. Thus, on paper the no oceanfront hardening policy is a theoretical example of efficient adaptation to sea level rise: property owners with notice of the policy can assume the risk of loss and put coastal properties to their highest economic use until the moment when sea level rise and erosion dictate that they must move. However, in practice, the DCM's inability to enforce the sand bag restrictions and the legislature's demand that terminal groins be considered demonstrate that near-term stakeholder demands can frustrate the implementation of adaptation policies. Furthermore, it is interesting to note that the results of the Terminal Groin Study do not even make it clear that terminal groins are a technically possible option to reduce vulnerability to coastal erosion and sea level rise. However, terminal groins are still considered a policy option because of their popularity with a group of coastal property owners seeking protection for their homes. Along North Carolina's Outer Banks, erosion is a daily concern that every property owner must contend with. However, the persistence of sandbags and proposed modifications to the rules governing their use serve to underscore property owner's established expectations that the government will protect them from the impacts of natural hazards. Thus, the evolution of North Carolina's policies related to the placement of sand bags and construction of terminal groins may make planning for sea level rise more difficult in future because coastal property owners may continue to expect support in defending their properties from encroaching seas. Further, the legislature's recent action on sea level rise and planning and reconstituting the CRC demonstrates the political significance of adaptation to sea level rise.

## **Texas**

Texas is a state of sharp contrasts with regard to the management of the ocean and estuarine coasts. On the ocean coast, Texas has one of the most progressive laws to move people out of harm's way in response to erosion and rising seas. In contrast, on the estuarine side, there is very little zoning or other land use controls at the state level that shape coastal development to reduce

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<sup>2</sup> The GREA's procedural history is available at <http://www.ncga.state.nc.us/gascripts/BillLookUp/BillLookUp.pl?Session=2013&BillID=S10>

vulnerability to sea level rise. Because of naturally high erosion rates, the Texas coast already loses over 235 acres of land along the Gulf Coast, bays, and estuaries each year. (GLO 2009).

In 1959, after the state Supreme Court held that the dry sand beach in private property, the Texas legislature passed the Open Beaches Act. The Open Beaches Act states that the public has free, unrestricted access to the dry sand beach up to the first line of vegetation along any portion of the coast where this right has been acquired through customary use of the beach or other prescribed legal mechanisms. (Tex. Nat. Res. Code § 61). The Open Beaches Act protects the public's right of access by restricting the construction of any obstruction, barrier, or restraint that interferes with public access. Further, the Act acknowledges the natural migration of the Texas shoreline by declaring that any structure that comes to interfere with the public beach may be subject to an order of removal. (Tex. Nat. Res. Code § 61). With respect to coastal development, the Open Beaches Act is administered together with the Dune Protection Act through the Beach and Dune Rules. The Beach and Dune Rules require local governments to develop dune protection plans that must be approved by the GLO and prohibit construction activities that may effect the public beach unless the developer receives a permit. (31 Tex. Admin. Code § 15.4(s)). Through its system of rules the Texas Open Beaches Act codified and reinforced the public's long-standing expectation that the dry sand beaches in Texas are freely accessible by the public. The Open Beaches Act is also notable because in the name of protecting the public right of access, it adopts an express policy of retreat as shorelines move.

The case of *Severance v. Patterson* is an important example of how the legal system can be used to frustrate coastal adaptation activities, even over the objections of local residents. *Severance* involves a challenge to the Texas Open Beaches Act brought by a resident of California who owned vacation and rental properties in along the Galveston Coast. As explained below, Ms. Severance's challenge and the consequences that followed were objectionable to the majority of Texans, including fellow coastal property owners.

For many years, the Texas General Land Office ("GLO") has struggled to figure out how to exercise its authority to order the removal of homes that come to lie on the public beach after storm events. After a particularly severe storm in 2004, the GLO issued a two year moratorium on enforcement under the Open Beaches Act in order to determine how to exercise its authority to seek removals. (GLO 2004). In 2005 while the enforcement moratorium was still in effect, Carol Severance, a California resident, purchased several properties that were subject to the enforcement moratorium. (*Severance v. Patterson*, 485 F. Supp. 2d 793 (2007)). Although an enforcement moratorium was in effect, Ms. Severance would have been required to sign a statutorily-required notice that the properties were along the beach and could be subject to removal under the Open Beaches Act if they interfered with the public beach. Shortly after Ms. Severance purchased her properties, Hurricane Rita hit Galveston, causing her homes to further encroach upon the public beach. When the enforcement moratorium expired in 2006, Ms. Severance received notice letters informing her that her homes were subject to potential removal actions under the Open Beaches Act and offering her a payment to voluntarily remove them. Upon receiving these letters, Ms. Severance filed claims in the federal district court alleging that her constitutional rights would be violated by the enforcement of the Open Beaches Act against her. (485 F. Supp. 2d 793 (S.D. Tex. 2007)). The District Court found that because there had been no enforcement action against her, it was too early for Ms. Severance to bring suit. Ms.

Severance appealed to the Fifth Circuit, which found that one of her claims could not yet be heard, but concluded that to decide the second claim, it needed to ask the Texas Supreme Court to issue an opinion on certain questions related to the Open Beaches Act. (566 F.3d 490 (5<sup>th</sup> Cir. 2009)). In particular, the Fifth Circuit asked the Supreme Court of Texas whether the state recognized a rolling beach easement, giving the state the right to order the removal of Ms. Severance's houses, and if so whether it was created by the Open Beaches Act.

On November 5, 2010, the Texas Supreme Court issued its opinion in *Severance*. (345 S.W.3d 18 (Tex. 2010)). The Court found that the rolling beach easement in Texas does not cross property lines. (345 S.W.3d 18 (Tex. 2010)). Applied to Ms. Severance, this holding meant that the public had no right to access the dry sand beach on which her homes stood, because the public's original easement covered dry sand beach that had become submerged due to erosion. Because the Texas Constitution prohibits the spending of public funds to increase the value of private property, the impacts of the Severance holding were immediately felt. A beach nourishment project that had been planned for West Galveston was cancelled even though all of the construction equipment was already in place because the GLO could not be sure that the renourished dry sand beaches would be public. (White 2010b). In addition, the Galveston County Park Board ceased its cleanup activities on dry sand beaches, announcing that it could not spend taxpayer dollars to maintain private properties. (Rice 2011). As a result of these events, a request from Land Commissioner Patterson, and general public outcry, the Texas Supreme Court agreed to reconsider its decision. On reconsideration, the Court upheld its prior decision that public beach easements do not migrate. (370 S.W. 3d 705 (Tex. 2012)).

While the ultimate outcome of *Severance v. Patterson* is of great legal significance in determining the extent of the public beach and the reach of the GLO's enforcement authority, several developments while the case was pending are of equal significance in understanding potential responses to sea level rise and the future of the open beach along Texas' shoreline. First, in September of 2008, the GLO adopted emergency rule provisions in its Beach and Dune Rules, providing for limited rebuilding of homes that have come to interfere with the public beach as the result of storm events. Under the rules, homes that are less than 50% damaged and do not harm public health and safety may be rebuilt under certain conditions. (31 Tex. Admin. Code § 15.13). This change in the rules suggests that the GLO recognizes the impracticality of removing every home that rests on the public beach after a storm. In fact, in interviews, GLO officials report that the evolution of GLO's enforcement policy to be more permissive of rebuilding likely signals the end of the truly open beach in Texas. If enforcement is limited to only those cases where a home presents a genuine threat to public health and safety, the state will have a much more difficult time obtaining judicially-ordered removals. This dynamic tends to suggest that property owner interests may prevail over generalized public rights in shaping adaptation to sea level rise.

The second major development was the public response to the *Severance* case, both while it was pending and after the Supreme Court of Texas issued its opinion. Just days before the Supreme Court of Texas issued its opinion, Texans overwhelmingly passed a measure making the public right to access the open beaches a part of the State's Constitution. (Office of the Secretary of State 2009). Since the *Severance* opinion was issued, public reaction has been equally unfavorable, as highlighted in Land Commissioner's letter supporting reconsideration where he emphasized to the Supreme Court of Texas that the holding upset Texan's long-established

expectations regarding their right to access the beach. (Patterson 2011). These developments are particularly interesting because they suggest that despite Texas' strong pro-property rights culture, cultural values for open public beach access will prevail in Texas. At this time, it is not clear how the public demand for continued open beach access will interact with the GLO's apparent policy to ease enforcement against homes that have come to lie on the public beach.

Finally, since Hurricane Ike, several major engineering projects to rebuild the Galveston Coastline and protect against future storm surges have been considered. These projects range from the straightforward beach nourishment that was cancelled after the *Severance* opinion was issued to the so-called "Ike Dike." The Ike Dike is a proposal to extend the seawall that currently defends downtown Galveston more than 50 miles and to install floodgates at the major inlets. (Casselmann 2009). In theory, the Ike Dike would protect against future storm surges in two ways: the seawall would provide some protection to coastal property owners and the closure of the floodgates would prevent the flow of storm surge into Galveston Bay. While the Ike Dike proposal has enjoyed popularity among coastal property owners, it is not clear that the project, which would include a 17 foot high seawall would enjoy public support. While the both the public and coastal property owners favor beach nourishment, to date Galveston property owners have been unable to organize themselves to obtain the access dedications the GLO demands to ensure the constitutionality of publicly-funded nourishment in Texas. (White 2010a). Therefore, the future feasibility of coastal engineering and nourishment projects as tools to adapt to sea level rise remains unclear.

The *Severance* case illustrates a number of important themes in evaluating sea level rise adaptation governance. First, as seen in many other cases, the objections of private property owners can shape enforcement policy and ultimately move states away from actions that would promote adaptation to sea level rise. These actions may be the result of a fear of legal claims, such as the *Severance* case itself, or of a more general fear of the political infeasibility of removing large numbers of homes after storm events, as is the case with the Beach and Dune Emergency Rules. Second, the *Severance* case illustrates that the public may place a high value on their right to access the beach. While this value is often easily ignored as a more abstract concern when coastal decision makers are faced with individual property owners who may be more vocal in defending their interests, *Severance* demonstrates that there is a tipping point at which cultural values associated with beach access may become so threatened that the public will act collectively to assert their interests. Furthermore, support for the Ike Dike proposal appears to be lacking in part due to public concerns about the impact on the beaches and beach access. Therefore, even if an engineering solution to sea level rise and increased storm surge is technically available, it may not be practical due to unacceptable impacts to high valued resources.

Finally, *Severance* raises the ability of individuals outside of a particular culture to impose their values upon a state and thereby upset long-standing compromises related to coastal management and adaptation. Prior to the *Severance* case, there were certainly legal challenges to particular applications of the Open Beaches Act, but in general all Texans, including beachfront property owners, recognized the Texan cultural value associated with public access to the beaches. Ms. Severance's claim evoked strong reactions from many Texans who feared that she was trying to "Californize" the Texas coast, limiting public access to the dry sand beaches. Land

Commissioner Patterson explicitly declared that the Supreme Court of Texas was permitting such “Californization” to happen when it found in Ms. Severance’s favor. (Patterson 2011). Should Ms. Severance again prevail in the Supreme Court of Texas and ultimately in the Fifth Circuit, her victory would profoundly change both the nature of coastal management and public beach access in Texas.

## Conclusions

To date the outcomes of efforts aiming to reduce vulnerability to sea level rise by preventing or removing development in vulnerable areas has had no relationship to the structure of governmental authority over development in the coastal zone. It is the action of political and economic factors, rather than the structure of legal authorities that will shape adaptation responses. As the North Carolina example demonstrates, sometimes adaptation options may remain on the table due to political popularity even though they have not been technically proven. In contrast, some areas will reject known engineering solutions to respond to sea level rise because of the importance of other values, including the preservation of ecosystem function, called for in the San Francisco BCDC Bay Plan amendments.

Ultimately, adaptation to sea level rise will involve a mix of approaches, defending some areas while permitting others to become submerged as sea level rise. While such decisions will turn, in part, on what is technically possible, to a greater extent they will be driven by cultural values and political considerations that determine what is worth saving. Management options to adapt to sea level rise range widely, and all parties involved in adaptation planning should recognize the need for ongoing dialogues to determine which adaptive actions are appropriate in a given circumstance. While hardened defense structures may be appropriate to defend critical infrastructure, such as major airports and ports, allowing the migration of natural coastal defenses, such as wetlands, may be the optimal strategy to reduce vulnerability to sea level rise. Where feasible, such retreat options provide the benefits of both physically moving populations out of harms way and preserving the natural defenses provides by dune and wetland systems. Therefore, if adaptation governance can be managed to make it possible, permitting the natural migration of coastal ecosystems is likely to be the most efficient option to facilitate adaptation to sea level rise. It should be noted that even if a retreat option is selected, it will still pose major infrastructure and engineering challenges that must be considered. For example, communities must consider matters such as how to build roads that can serve the coast today but that can be gradually moved or elevated to respond to sea level rise.

Given the gradual nature of the changes but their large magnitude over time, sea level rise presents one of the greatest coastal governance challenges ever encountered. In order to facilitate successful adaptation governance, coastal governments and the technical community must work to understand technically available adaptation options and build the adaptive capacity of their governance systems by conducting public education and outreach to facilitate adaptation decision making. Without such dialogue, adaptation decisions will be ad hoc and reactive, likely resulting in substantial economic and ecosystem losses.

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