Coastal Land Loss and the Mitigation–Adaptation Dilemma: Between Scylla and Charybdis

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ABSTRACT

Coastal land loss is an inevitable consequence of the confluence of three primary factors: population growth, vanishing wetlands, and rising sea levels. Society may either mitigate coastal land loss by engaging in human engineering projects that create technological solutions or restore natural processes that protect the coastal zone, or it may choose to adapt to coastal land loss by shifting development and other human and economic resources out of areas especially at risk for coastal land loss. This Article first details the primary threats to coastal lands. Next, the Article discusses two primary means of addressing coastal land loss—mitigation and adaptation—applying those terms slightly differently than they are used in the broader climate change context in order to focus more precisely on the coastal land loss phenomena and its solutions. Finally, the Article makes three normative claims for why policy-makers should approach coastal land loss mitigation in particular with caution: (1) uncertainty of mitigation's effectiveness—scientifically and institutionally; (2) the political expediency of choosing mitigation over adaptation; and (3) the fact that failure to adapt past land-use activities in the coastal zone has contributed to the need to adapt or mitigate today.

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I. INTRODUCTION: THE ANCIENT MYTH AND THE MODERN REALITY

> He runs on Scylla, wishing to avoid Charybdis.[1]
> Erasmus, *Adagia*

In Homer's epic *Odyssey*, the hero Odysseus faces a tragic choice. He must guide his men through a narrow strait and either pass close to Charybdis, a sea monster that spewed forth water three times per day with disastrous consequence, or pass close to Scylla, a monster on the coast with six snake-like heads filled with fangs and encircled with the heads of baying dogs around its

1. The idiom "between Scylla and Charybdis" means "between two equally perilous alternatives, neither of which can be passed without encountering and probably falling victim to the other." *Scylla Definition*, DICTIONARY.COM, http://dictionary.reference.com/browse/scylla (last visited Aug. 31, 2012).

waist.[2] Odysseus ultimately chose the latter fate, accepting the loss of some of his men by crashing into the coast, but calculating that he would lose far fewer men than if he challenged the raging sea. U.S. citizens and policy-makers face a similarly costly choice—that of either grappling directly with increasingly menacing and encroaching seas or undergoing the societally and economically disruptive, but potentially less devastating, transition to further inland. As the climate continues to change and sea levels continue to rise, the United States will continue to lose coastal land due to these "geologic" forces. At the same time, American citizens continue to flock to the coastal zone at a rate tracking the already high exponential rate of population growth.[3] Along with that growth comes increased residential, commercial, and industrial coastal-zone development and associated infrastructure improvements, resulting in what may be described as "artificial" coastal land loss, or "runaway land consumption,"[4] as land continues to be appropriated from its natural state by human activity. Though land development has certainly contributed to societal, economic, and technological advancement, when land development becomes wasteful of valuable ecosystem service and other functions provided by natural habitat, then those attributes of the land are lost and society is faced with great difficulty (if not impossibility) in recreating them. Consider the leveeing and diversion of the Mississippi River or the filling in of coastal wetlands. As these natural lands became increasingly developed and subject to human-made engineering projects, their functional provision of buffer from sea-level rise, protection from hurricane storm surge and provision of other forms of flood control, water filtration services, and habitat protection may certainly be considered a form of land loss.

In later times, Scylla was rationalized as a rocky shoal, an inescapable threat upon which those seeking to avoid Charybdis would inevitably crash. Indeed, due to population and development pressures, the U.S. coastline is becoming increasingly hardened

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2. *Scylla and Charybdis*, BRITANNICA ONLINE ENCYCLOPEDIA, http://www.britannica.com/EBchecked/topic/530331/Scylla-and-Charybdis (last visited Aug. 31, 2012).

3. KRISTEN M. CROSSETT ET AL., NAT'L OCEANIC & ATMOSPHERIC ADMIN., POPULATION TRENDS ALONG THE COASTAL UNITED STATES: 1980–2008 1 (2004), *available at* http://oceanservice.noaa.gov/programs/mb/pdfs/coastal_pop_trends_complete.pdf.

4. DANA BEACH, PEW OCEANS COMM'N, COASTAL SPRAWL: THE EFFECTS OF URBAN DESIGN ON AQUATIC ECOSYSTEMS IN THE UNITED STATES ii (2002), *available at* http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Protecting_ocean_life/env_pew_oceans_sprawl.pdf.

like the precipice of Scylla—whether it is the filling of coastal wetlands to provide a foundation for agricultural, industrial, or residential development; the very concrete structures and paved surfaces that comprise coastal development; or the sea walls, dams, levees, and other man-made artifices designed to keep the sea at bay. This hardening of the coast exacerbates coastal threats to human populations, potentially forcing them to make a painful choice to run even farther inland to higher ground. Similarly, Charybdis was later rationalized as a giant, destructive whirlpool—a reconceptualization bearing an almost prophetic semblance to the rising seas that now threaten U.S. coasts.

It is time for the myth of Scylla and Charybdis to be reconceptualized once more and in line with the potentially tragic modern reality, especially given its accurate metaphor of choosing between the perils of the sea and the threats looming on the coast. The modern choice regards how we allocate priority on either mitigation or adaptation as the primary response to coastal land loss—assuming, of course, that we do not wish to take the third option of doing nothing and allowing our ship to sink. With coastal land loss mitigation we have a choice to confront Charybdis in an attempt to keep the sea at bay: to design policies and invest billions of dollars to restore wetlands; to rebuild coastal lands and barrier islands through dredging and other large-scale engineering projects; or to create man-made structures such as sea walls and other mechanisms of tide and flood control, to name a few examples. With coastal land loss adaptation we have a choice to "run on Scylla" and endure the hardship of, first, slowing the rapid commercial and industrial land development and population boom in high risk areas of our coastal zone, and second, making a difficult transition from already existing development and infrastructure in these areas to higher ground inland.

Certainly these two options are not mutually exclusive, and as the Intergovernmental Panel on Climate Change has noted, policies aimed at both are necessary to manage climate change generally, and coastal land loss specifically.[5] Yet, the relative emphasis on either mitigation or adaptation (as a general matter and given the unique needs of particular geographic regions) will have drastic ramifications not only for the effectiveness of the coastal land loss response, but also for the amount and allocation of local, state, and federal financial resources. In other words, though both mitigation

5. RICHARD J.T. KLEIN ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATIONS AND VULNERABILITY 745 (M.L. Parry et al. eds., 2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter18.pdf.

and adaptation are likely to be used in different areas along the coast, a great risk lies in striking the balance between the two that places too much emphasis on one or the other. In particular, though coastal land loss mitigation may be the more appealing option in the short term, since society may be reticent to accept major changes to historical land use and settlement patterns in the coastal zone and may have a tendency to believe it can engineer its way out of any environmental crisis, mitigation efforts also pose the greatest risk if they fail. Though coastal land loss adaptation may be more difficult over the short term, it will succeed in moving society out of harm's way regardless of whether projected climate change-related threats to the coastal zone come to fruition to the degree projected. On the other hand, the change that will take place in the coastal zone due to climate change may be too great to effectively combat with attempted engineering projects or wetland restoration efforts aimed at keeping the sea at bay, potentially resulting in years of wasted effort and billions of dollars that would have been better utilized to shift societal infrastructure away from high-risk areas.

This Article in no way seeks to provide definitive solutions for striking the balance between coastal land loss adaptation and mitigation, either regarding how precisely the balance should be struck or where along different coastal regions coastal land loss adaptation would be preferable to mitigation and vice versa. Various regions of the U.S. and around the world face different coastal land loss challenges, depending on whether they are designated as a delta region, a rocky coast, or some other form of geologic intersection of land and sea. Given the complexities of choosing and designing coastal land loss mitigation or adaptation policies by region, this Article merely seeks to highlight some considerations for policy-makers and scientists when making those choices and designing coastal land loss policies. The Article does so by first, in Part II, describing the confluence of events that have given rise to coastal land loss, namely population growth, vanishing wetlands, and sea-level rise. Part III then discusses the mitigation and adaptation response options for coastal land loss, neither of which are optimal, but which are the most viable responses to inevitable climate change impacts. Part IV then makes a normative claim that we should approach coastal land loss mitigation with caution and, like Odysseus, have the courage to retreat from the rising tide by choosing adaptation when the long-term view would demand it in areas particularly vulnerable to coastal land loss. This normative claim of caution toward coastal land loss mitigation actions is based primarily on three considerations: (1) the uncertainty regarding the effectiveness of mitigation actions over the long term; (2) the tempting political expediency that may misguidedly drive policy-makers' choice to implement mitigation policies over adaptation; and (3) the fact that failure to *adapt* past land-use activities in the coastal zone has contributed to the need to adapt or mitigate today—lending support to the premise that adaptation now can avoid both costly mitigation policies as well as preempt the need to mitigate or adapt to coastal land loss in the future.

II. THE PERFECT STORM FOR COASTAL LAND LOSS: POPULATION GROWTH, VANISHING WETLANDS, AND RISING SEAS

Three primary phenomena have converged in the coastal zone to give rise to coastal land loss. These phenomena are so inextricably entwined that discussing them in isolation is difficult. Populations have increased in the coastal zone, exacerbating "artificial" land loss as commercial, industrial, and residential development replace coastal lands, coastal natural capital (such as wetlands), and the ecosystem services that those resources provide. In turn, rising populations have increased the need to protect human-made capital in the coastal zone, which has given rise to more dams, levees, sea walls and other structures that have starved the coast of sediment, replaced wetlands, and caused subsidence that accelerates sea-level rise—compounding "geologic" coastal land loss by further accelerating an already increasing rate of sea-level rise. The following sections briefly discuss these phenomena in turn.

A. Population Growth

The Low Elevation Coastal Zone (LECZ) is the contiguous area along the coast that is less than ten meters above sea level. Though this area covers only 2% of the world's land area, it contains 10% of the world's population and 13% of global urban population.[6] As a result of high populations in the coastal zone, "[b]oth urban disasters and environmental hot spots are already located disproportionately in low-lying coastal areas. Climate change will increase the risk of both."[7]

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6. Gordon McGranahan et al., *The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones*, 19 ENV'T & URBANIZATION 17, 17 (2007), *available at* http://sedac.ciesin.columbia.edu/gpw/docs/McGranahan2007.pdf.

7. *Id.* at 18 (citation omitted) (stating further that "[i]n particular, rising sea levels will increase the risk of floods, and stronger tropical storms may further increase the flood risk").

In 2003, approximately 153 million U.S. citizens, or 53% of the population, lived in coastal counties. Ten of the fifteen largest U.S. cities are in coastal counties,[8] and "23 of the 25 most densely populated U.S. counties are coastal."[9] Coastal counties, as a general matter, average 300 persons per square mile—far more than the national average of 98 persons per square mile.[10] As a result, over half of the U.S. population lives within the 17% of land that is coastal,[11] with some states maintaining over half of their population in the coastal zone. Louisiana, for example, is one of two states bordering the Gulf of Mexico with a majority of its population in coastal counties (or, more precisely, "parishes" in Louisiana).[12]

Not only are absolute population numbers in the coastal zone disproportionate to total U.S. population, but so too is the *rate* of population growth. Coastal population increased between 1980 and 2003 by 33 million,[13] accounting for nearly half of the United States' total population growth during that time period.[14] Stated differently, nearly half of the total U.S. population's growth occurred within 17% of its land, the coastal zone. Coastal population is expected to increase by another 27 million by 2017, accounting this time for *more than half* of the country's total population increase.[15] The rate of population growth in coastal counties outpacing that of the country as a whole creates a dramatic increase in population density along the coast, which, combined with the fast-growing coastal economy,[16] increases the rate at which coastal land is lost due to human activities (i.e., "artificial" coastal land loss).[17]

Permanent settlement, however, is not the only population pressure along the coast. The yearly influx of vacationers increases coastal stress even further, and "[w]ith more people comes the need for increased infrastructure," which leads to even more

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8. CROSSETT ET AL., *supra* note 3, at 1.
9. *Id.* at 7.
10. *Id.* Coastal counties also provide a key source of waterborne commerce, with seven of the ten leading ports in Gulf states and south Louisiana accounting for about 9% of waterborne commerce in principal U.S. ports. *Id.* at 18.
11. *Id.* at 6.
12. *Id.* at 18 (noting that the other state is Florida).
13. *Id.* at 1.
14. *See Population Estimates*, U.S. CENSUS BUREAU, http://www.census.gov/popest/data/historical/index.html (last updated May 22, 2012).
15. BEACH, *supra* note 4, at ii.
16. The median household income of coastal counties is approximately 17% higher than noncoastal counties. CROSSETT ET AL., *supra* note 3, at 12.
17. *Id.* at 1.

coastal land loss.[18] Furthermore, "[i]n the next few decades, coastal areas will also see a growing proportion of older Americans and an unprecedented number of Americans reaching retirement age."[19] Each of these factors contributes to a population boom along the coast.

Along with increased population comes a great deal of economic wealth and resources. In 2000, coastal counties contained 57% of civilian income, and income per square kilometer in these counties is more than eight times that of inland counties.[20] Furthermore, the level and growth rate of per capita income is strongly positively correlated with coastal proximity.[21] In 2000, coastal counties maintained per worker annual labor income that averaged approximately $41,000 versus approximately $31,000 in inland counties.[22] In addition, coastal counties maintain citizenry that are, on average, more educated than inland counties. Nearly 28% of adults in coastal counties in 2000 had at least a Bachelor's degree, compared to 22% of inland adults, while nearly 11% had a graduate degree, compared to 8% of inland adults.[23]

As if exponential population growth in and of itself did not stress coastal lands enough, the population growth rate and the accumulation of wealth in the coastal zone each reinforce a feedback loop whereby development pressures increase at rates that actually *outpace* population growth generally. For example, while a great degree of natural capital has been replaced by agricultural lands in the coastal zone, coastal counties in the United States are losing nearly 2,000 acres of farmland per day to urbanization and other development,[24] and "[s]ome large coastal metropolitan areas are consuming land ten times as fast as they are adding new residents."[25] In 1997, the amount of developed coastal acreage was 14%, but if current rates of land consumption continue unchecked, more than one-quarter of coastal acreage will be developed by 2025.[26] In fact, "[b]y most measures, human impacts to coastal ecosystems have grown faster than the rate of population growth. So, although population statistics paint an alarming picture

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18. *Id.*
19. *Id.*
20. Jordan Rappaport & Jeffrey D. Sachs, *The United States as a Coastal Nation*, 8 J. ECON. GROWTH 5, 5 (2003), *available at* http://mvs.ei.columbia.edu/sitefiles/file/about/director/documents/jeg0304.pdf.
21. *Id.* at 7.
22. *Id.* at 16.
23. *Id.*
24. CROSSETT ET AL., *supra* note 3, at 16.
25. BEACH, *supra* note 4, at ii.
26. *Id.*

for coastal management, they actually understate the magnitude of the challenge."[27] Developed land in the United States as a whole increased by 25 million acres (34%) between 1982 and 1997, which "means that more than one-fourth of all of the land converted from rural to urban and suburban uses since European settlement occurred in only 15 years."[28] Though developed land grew by 34%, corresponding population growth was only 15%, demonstrating that land consumption occurred at a rate "more than twice the underlying rate of population growth [, and] the mismatch between land development and population growth is widening. Between 1982 and 1992, land was developed at 1.8 times the rate of population growth. During the period between 1992 and 1997, that multiple had grown to 2.5."[29] One can imagine the result of stacking exponential land consumption on top of exponential population growth—coastal land that is being appropriated and "lost" at astonishing rates. As described by the Pew Oceans Commission:

> Between 2000 and 2025, the U.S. population is projected to grow by 22 percent. If the relationship between land use and population in the last decade continues, there will be 68 million more acres of developed land in the contiguous U.S. than there are today . . . . This newly developed acreage—equivalent to the land area of Wyoming—will almost match the amount of land developed from the founding of the country until 1983.[30]

In other words, "[i]f developed land were expanding at the same rate as population, coastal zone management would be a formidable task. With development vastly outstripping even the relatively high rate of population growth, the challenge is considerably greater."[31] Because more than half of this projected growth will occur within the coastal zone, the impact will be even greater along the coast. In 1982, 10% of coastal watersheds were developed, which increased to nearly 14% in 1997, and if trends continue, more than 25% of the country's coastal watersheds will be developed by 2025.[32]

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27. *Id.* at 2.
28. *Id.* at 4.
29. *Id.* (citations omitted).
30. *Id.*
31. *Id.* at 5.
32. *Id.* This can have profound impacts on coastal ecosystem health, because:

> When more than ten percent of the acreage of a watershed is covered in roads, parking lots, rooftops, and other impervious surfaces, the rivers and streams within the watershed become seriously degraded . . . . By

In short, "U.S. economic activity is overwhelmingly concentrated near its ocean and Great Lakes coasts," and this concentration is increasing.[33] Exponential population growth, combined with disproportionate economic growth and wealth accumulation in the coastal zone, combined with development impacts that increase exponentially and disproportionately with the underlying rate of population growth, make any choice between land loss mitigation or adaptation policies, and any attempt to actually implement them, exceedingly difficult. The investment needed to implement mitigation policies will continue to rise. As more people need protection from geologic land loss caused by the encroaching seas, there is also more wealth to protect in the form of residential and commercial development, jobs, and infrastructure tied directly to inland economic welfare. Furthermore, "artificial" coastal land loss is exacerbated by increasingly diminishing natural capital and associated ecosystem services.

As with mitigation, adaptation policies must grapple with the fact that there are more people to move out of coastal areas, more wealth accumulation and investment to forestall in order to prevent development of new areas, and increased economic and social inertia that make slowing down coastal zone growth in the first instance difficult, much less steering already anchored economic and social systems further inland. The irony is that while productivity factors have traditionally driven wealth accumulation in the coastal zone, quality of life considerations have played an increasing role—quality of life that will quickly degrade without making the difficult choice to adopt adaptation or mitigation measures.[34] The rapid reduction of natural capital increasingly recognized as crucial to human welfare, particularly the loss of coastal wetlands, is compounding the reduction in quality of life along the coastal zone.

> virtually every measure of ecosystem health, the streams, creeks, marshes, and rivers surrounded by hardened watersheds are less diverse, less stable, and less productive than those in natural watersheds. If the percentage of the coast that is developed rises sharply (from 14 percent to 25 percent) over the next 25 years, these studies point to an irreversible decline in coastal aquatic ecosystem health.

Id. at 7.

33. Rappaport & Sachs, *supra* note 20, at 7.

34. *Id.*

B. Vanishing Wetlands

Over the last century, development has claimed over half of all wetlands in North America.[35] The loss of important ecosystem services provided by wetlands can "make urban settlements more prone to disaster, amplifying the risks of climate change."[36] Wetlands provide a wide variety of ecosystem services important to both human well-being and the maintenance of coastal land—not only the physical maintenance of coastal land, but also the maintenance of its functionality. Wetlands provide a variety of services. Wetlands act as a key buffer system that protects against storm surge caused by hurricanes and other weather events; dissipate and absorb flood waters and stormwater runoff—thus protecting local communities and saving municipalities flood control expenditures; act as an anchor for preserving coastal lands by dispersing coast-building sediment and forestalling coastal erosion; provide water filtration services that clean coastal waters; act as a major carbon sink that helps regulate the climate; and provide habitat for coastal species, among a variety of other services.

Vanishing wetlands are directly tied to rising sea levels as well as increasing populations and associated development. As described by scholars:

> Water drains more rapidly from built-over land, increasing peak flows and flood risks . . . . In many parts of the world, developers have drained wetlands . . . removing a buffer against tidal floods. Particularly in delta regions, land compaction, subsidence due to groundwater withdrawal and reductions in the rate of sediment deposition (due to water regulation) can lead, in effect, to sea-level rise, increasing flood risk (as well as creating various other problems).[37]

In some U.S. states—Louisiana, for example—the disappearance of wetlands has indeed compounded coastal land loss and has further synergized with rising sea levels to exacerbate disaster events that have become seared into the collective national

35. David Moreno-Mateos et al., *Structural and Functional Loss in Restored Wetland Ecosystems*, 10 PLOS BIOLOGY 1, 1 (2012), *available at* http://www.plosbiology.org/article/info%3Adoi%2F10.1371%2Fjournal.pbio.1001247 (follow "PDF" hyperlink).

36. McGranahan et al., *supra* note 6, at 18. Other resources, such as coastal forests and coral reefs, are similarly imperiled. Roughly one-third of coastal mangrove forests and one-fifth of coral reefs have disappeared. *Id.* at 19.

37. *Id.* at 19.

consciousness—Hurricane Katrina being a recent example, causing by some estimates $108 billion in damages.[38] The loss of wetlands has had particular implications for gulf hurricanes and resulting severe-flood events, leading to ever-increasing economic and human costs. Hurricane Katrina demonstrated that low-lying coastal lands, for instance, "are already vulnerable to erosion, flooding, storm surges, and tsunamis; and poor development planning has placed trillions of dollars' worth of building and infrastructure directly in the path of these threats."[39]

Coastal Louisiana is a complex ecosystem created by 7,000 years of sediment deposition from the Mississippi River.[40] Even so, Louisiana is losing 6,600 acres of coastal wetlands per year.[41] Some of this loss is naturally occurring, but "the real culprits are human-made"[42] and include commercial and residential development, levees, navigational channels, and oil-and-gas infrastructure. The overland flow of storm surge can be stifled by healthy marshes and cypress swamps, and natural waterways facilitate sediment and nutrient exchange. In contrast, storm surge is uninhibited when flowing through deep man-made navigation channels, which in turn results in the need to construct and maintain even more man-made flood control devices.[43] In addition to inhibiting sediment and nutrient exchange with the landscape, navigation channels further provide a pathway for salt water to move inland and destroy inland cypress swamps and freshwater marshes.[44]

Conversion of natural wetlands to pastures, agricultural lands, and cities has resulted in the need for higher levees and larger pumps for flood protection and has further eliminated the natural process of soil accretion, which, when combined with sea-level rise and increased subsidence, causes the landscape to eventually

38. RICHARD D. KNABB ET AL., NAT'L HURRICANE CTR., TROPICAL CYCLE REPORT: HURRICANE KATRINA 13 (2005), *available at* http://www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf.

39. Christophe A.G. Tulou et al., *Climate Change and the Marine Environment*, *in* OCEAN AND COASTAL LAW AND POLICY 571, 578 (Donald C. Baur, Tim Eichenberg & Michael Sutton eds., 2008).

40. COASTAL LA. ECOSYSTEM ASSESSMENT & RESTORATION, REDUCING FLOOD DAMAGE IN COASTAL LOUISIANA: COMMUNITIES, CULTURE & COMMERCE 2 (2006) [hereinafter CLEAR], *available at* http://www.clear.lsu.edu/pdfs/clear_newsletter_20081016112354.pdf.

41. ROBERT R. M. VERCHICK, FACING CATASTROPHE: ENVIRONMENTAL ACTION FOR A POST-KATRINA WORLD 19 (2010).

42. *Id.*

43. CLEAR, *supra* note 40, at 2.

44. *Id.*

sink below the water level.[45] Prior to levee construction, natural flooding from rivers and bays provided the important function of adding sediment and organic matter through the process of accretion, which allows land elevation to remain stable in the face of sea-level rise and soil subsidence.[46] Levees disrupt the delivery of these sediments, and removing water from the soil increases subsidence, reduces accretion, and requires ever increasing levee height and pump capacity as "land continues to sink [and] the sea level rises."[47]

Ultimately, human development activities in coastal Louisiana have "accelerate[d] coastal land loss by reducing the natural flow of the [Mississippi] [R]iver's freshwater and sediment to wetland areas, where the lost land would then naturally be replenished."[48] Instead of maintaining and replenishing wetlands, the sediment empties into the Gulf as far as the outer continental shelf where it cannot form important barrier islands.[49] As these barrier islands erode, storm surges and wave impacts threaten commercial infrastructure farther and farther inland, again leading to the need to build more levees, larger levees, and more robust pumping systems.[50] So, it is not only commercial and residential coastal development that cause disaster related to wetland loss, but also the very human-made structures meant to prevent coastal land loss and associated disasters in the first instance. As scholars have described: "Unintended consequences of flood protection measures [and] individual public work projects have increased risks to natural resources [and] human settlements resulting in a more dangerous place to live [and] work."[51] Indeed, had more natural wetlands been maintained along coastal Louisiana, they could have prevented much of Katrina's storm surge damage. Other coastal states face a similarly staggering amount of wetland loss. For example, in only the last 15 years, 84,000 acres of wetlands have

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45. *Id.* Coastal wetland forests are also at risk. Much of Louisiana's cypress forests, for example, are expected to be entirely wiped out over the next 20 years if current conditions remain and projections come to fruition. COASTAL PROT. & RESTORATION AUTH. OF LA., DRAFT JAN. 2012: LOUISIANA'S COMPREHENSIVE MASTER PLAN FOR A SUSTAINABLE COAST 159 (Jan. 12, 2012) [hereinafter DRAFT MASTER PLAN] (unpublished draft) (on file with the Louisiana Law Review).
46. CLEAR, *supra* note 40, at 2.
47. *Id.*
48. VERCHICK, *supra* note 41, at 19.
49. *Id.*
50. CLEAR, *supra* note 40, at 2.
51. *Id.* at 3.

been converted to urban development in Florida—a rate of 5,600 acres per year.[52]

Despite the increasing rate of destruction of coastal wetlands, state and federal governments have largely failed to formulate a plan for curbing their destruction, restoring them, or designing policies to encourage a shift in development activities to farther inland. After Hurricane Georges barely missed New Orleans in 1998, a $14 billion wetlands restoration plan was formulated, but Congress and the Bush administration did not act on the proposal.[53] Following another near miss from Hurricane Ivan, one Louisiana administrator observed, "What is it going to take for Congress and the president to realize this is not just another project? . . . Would we have had to get hit by the big one? Who wants to wait for that? Surely it shouldn't have to take loss of life, [should] it?"[54] Only one year later, Hurricane Katrina killed at least 1,800 people and cost over $108 billion in damages.[55] As discussed below, it is unclear whether wetlands restoration is a surefire, long-term answer to addressing coastal land loss, and it seems clear that a history of poor development planning contributed to Katrina's human and economic costs. Even so, some might argue that the $14 billion wetlands restoration cost is a bargain compared to the $108 billion in damages wrought by Katrina. The economic costs of not curbing destruction of existing wetlands, guiding current and future development away from rapidly eroding coastal lands and rising sea levels, or restoring wetlands will only increase, since hurricanes are expected to become both more frequent and more intense as climate change contributes to warmer oceans.[56] Ultimately, vanishing wetlands synergize with rising populations and rising sea levels to compound coastal land loss.

C. Rising Seas

Rising sea level is perhaps the most obvious threat to coastal lands—it is the Charybdis from which we must either flee by adapting or fight by mitigating to the extent possible. Indeed, as Odysseus perceived regarding the dangers of Charybdis, scholars

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52. Matthew Waite & Craig Pittman, *Katrina Offers Lesson on Wetlands Protection*, TAMPA BAY TIMES, Sept. 5, 2005, http://www.sptimes.com/2005/09/05/Worldandnation/Katrina_offers_lesson.shtml.

53. *Id.*

54. *Id.*

55. KNABB ET AL., *supra* note 38, at 12–13.

56. Tulou et al., *supra* note 39, at 578. More frequent and intense category four and five storms have occurred over the past 30 years, a trend "directly linked to increases in sea-surface temperatures." *Id.*

have argued that climate change, the source of more rapid sea-level rise in the recent past and in the future, is nothing more than "a slow-moving disaster."[57] Unlike most disasters, however, the harmful land loss threats of sea-level rise are not immediately obvious, because its observable impacts play out incrementally over human lifetimes. This makes sea-level rise arguably even more dangerous than other threats to coastal lands, at least in the sense of spurring human action. The full magnitude of harm is apparent only when temporally aggregated over periods of time exceeding any one generation's lifespan. Thus, forging collective action among individuals, policy-makers, and governments to avoid the disaster is especially difficult. As Professor Buzbee described: "A sudden disaster or perceived crisis is often essential to rouse the populace and give politicians reasons to take on issues of harms caused by industry and the process of real estate development."[58] While sea-level rise may exacerbate sudden disaster events like floods, it is otherwise by definition not "sudden," thus masking the perceived crisis.

Though sea level rose .17 meters over the past century, a rate of roughly 1.7 mm/year,[59] satellite imagery demonstrates that the rate increased to 3.1 mm/year between 1993 and 2003.[60] In other words, the rate of sea-level rise is accelerating. Because this increased rate corresponds with increases in atmospheric concentrations of greenhouse gases and temperatures over the same time period, the future impact of a changing climate on sea levels is highly variable and uncertain. A recent report found that "[p]rojections of sea-level rise for the twenty-first century vary widely, ranging from several centimeters to more than a meter."[61] Even so, these estimates may be revised upward given the continued rise in global temperatures and the rapid loss of arctic and Antarctic ice sheets.[62] Ultimately, "warming and sea level rise will continue for more than a millennium, even if carbon dioxide concentrations are stabilized, due to the long time required to remove this gas from the atmosphere."[63] This dire warning has critical implications for coastal land loss, because "rising sea levels . . . will ensure increased

57. JOSH EAGLE, COASTAL LAW 33 (2011).

58. William W. Buzbee, *Urban Sprawl, Federalism, and the Problem of Institutional Complexity*, 68 FORDHAM L. REV. 57, 129–30 (1999).

59. Tulou et al., *supra* note 39, at 575.

60. *Id.*

61. U.S. CLIMATE CHANGE SCI. PROGRAM, COASTAL SENSITIVITY TO SEA-LEVEL RISE: A FOCUS ON THE MID-ATLANTIC REGION IX (2009), *available at* http://www.climatescience.gov/Library/sap/sap4-1/final-report/sap4-1-final-report-all.pdf.

62. Tulou et al., *supra* note 39, at 575.

63. *Id.* at 576.

damage along increasingly developed shorelines"[64] as rising seas "inundate low areas and increase flooding, coastal erosion, wetland loss, and saltwater intrusion into estuaries and freshwater aquifers."[65] Furthermore, rising "sea levels interact with tides and storms to create more destructive impacts, as extreme high water levels occur with more frequency."[66]

Approximately 58,000 square kilometers of coastline along the Atlantic seaboard and Gulf of Mexico are less than 1.5 meters above sea level, with more than 80% of this coastline in Louisiana, Florida, Texas, and North Carolina. North Carolina alone maintains as much land within one meter of sea level as the Netherlands.[67] Indeed, "Atlantic and Gulf Coast shorelines are especially vulnerable to long term sea-level rise . . . . [T]he slope of these areas is so gentle that a small rise in sea level produces a large inland shift of the shoreline."[68] Approximately 1,600 square kilometers of land in 85 eastern seaboard counties lie less than a meter above current sea levels, potentially threatening approximately 4,800 kilometers of roads and 388,000 people.[69] Over the next 50 years, coastal erosion is estimated to threaten nearly 87,000 homes along U.S. coasts.[70]

In the City of Boston, sea levels could rise up to a meter over the next 100 years, and even best-case estimates of sea-level rise and climate change could leave "Massachusetts General Hospital, the Public Garden, the Esplanade, and MIT in a pool of water after a strong storm surge in the harbor."[71] Flood damage in Boston would be around $57 billion over the next 100 years, $26 billion more than would occur without sea-level rise impacts.[72] On the other side of the country in California, a mere .3 meter rise in sea level would cause what were once 100-year storm surge flood events to become *ten*-year events.[73] Similarly, in San Diego, a no-sea-level-rise scenario would result in approximately ten extreme weather events between 2070–2100, but "[o]ver the same time period there would be approximately 330 extreme events with a

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64. *Id.* at 578.
65. U.S. CLIMATE CHANGE SCI. PROGRAM, *supra* note 61, at IX.
66. Tulou et al., *supra* note 39, at 578.
67. *Id.*
68. EAGLE, *supra* note 57, at 27.
69. *Id.*
70. Tulou et al., *supra* note 39, at 578–79.
71. Susan Milligan, *Study Predicts City Flood Threat Due to Warming*, BOS. GLOBE, Feb. 15, 2005, at A1, *available at* http://www.boston.com/news/local/articles/2005/02/15/study_predicts_city_flood_threat_due_to_warming/.
72. *Id.*
73. Tulou et al., *supra* note 39, at 578.

rise in sea level of twenty centimeters, 2,300 extreme events with a rise of forty centimeters, and almost 19,000 events with a rise of eighty centimeters."[74]

These brief examples merely demonstrate that mitigation and adaptation policies aimed at coastal land loss and associated disasters must inevitably grapple with the consequences of sea-level rise because:

> Sea levels rising at exponential rates (over geologic time scales) will meet head-on with a rush of humans heading at exponential rates right into the face of the disaster—an ironic scenario that demonstrates the circular nature of human psychology related to disasters. Humans exacerbate climate change through carbon emissions, and as a result sea levels rise; then humans move in disproportionate numbers into areas likely to be inundated by rising sea levels; then society expects a system of disaster law and policy to alleviate their difficulties *after* disaster strikes.[75]

Despite the negative land-use policy impacts caused by this type of collective psychological inertia, governments are beginning the process of preparing for rising seas. The Coastal Protection and Restoration Authority of Louisiana (CPRA), for example, issued a recent report finding that "Louisiana is particularly sensitive to sea-level rise due to the unique geology of the State's Delta and Chenier Plains" and that the State must "integrate up-to-date sea-level rise data into planning and engineering activities to anticipate coastal land loss patterns, protect coastal communities and adequately design restoration projects."[76] Rising sea levels in

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74. *Id.*

75. *See* Blake Hudson, *Reconstituting Land-Use Federalism to Address Transitory and Perpetual Disasters: The Bimodal Federalism Framework*, 2011 B.Y.U. L. REV. 1991, 2010–11 (2011) (emphasis added). Governments, of course, share the blame for this psychological predisposition. As Professor Barnhizer has noted in the context of floodplain development:

> [Governments] continue to expend hundreds of millions of dollars annually to repair repeated and foreseeable damage to unwise and unsustainable private development and public infrastructure and facilities. Instead of limiting flood-plain development, those policies and practices continue to maintain development against rising sea levels, climate change, extreme weather phenomena, and erosion.

Daniel D. Barnhizer, *Givings Recapture: Funding Public Acquisition of Private Property Interests on the Coasts*, 27 HARV. ENVTL. L. REV. 295, 296 (2003).

76. KRISTIN DEMARCO ET AL., COASTAL PROT. & RESTORATION AUTH. OF LA., RECOMMENDATIONS FOR ANTICIPATING SEA-LEVEL RISE IMPACTS ON LOUISIANA COASTAL RESOURCES DURING PROJECT PLANNING AND DESIGN: SUMMARY OF THE TECHNICAL REPORT FOR COASTAL MANAGERS 1 (2012),

Louisiana are "exposing lowland areas to more frequent events of saltwater intrusion, flooding, and rapid shoreline erosion, magnifying the negative effects of coastal storms and storm surge."[77] These effects are especially acute in Louisiana because it has some of the world's highest rates of soil subsidence, given the historically dynamic nature of the Mississippi Delta that makes up the eastern two-thirds of the state's coastline.[78] Furthermore, not only is sea-level rise accelerating globally across the board, but in Louisiana some areas are experiencing rates up to 58% greater than other areas, demonstrating the regional variability with which sea level can rise.[79] The CPRA technical report recommended the assumption of a Gulf sea-level rise of one meter by 2100, or, the high end of the projections noted at the beginning of this section.

Ultimately, while populations rapidly rise and coastal wetlands and other ecosystem services are rapidly lost to human development, sea levels will slowly continue to rise. Yet, despite sea-level rise's methodical nature—and indeed perhaps *because* of it—it will have potentially the most profound interjurisdictional and nationwide impacts. These impacts will synergize with other disasters like hurricanes and flood events to wreak havoc on the human-built coastal environment and the ever-increasing populations that live in coastal areas—especially in the absence of innovative and responsible coastal land loss mitigation and adaptation responses.

III. CAUGHT IN A DOUBLE BIND: THE MITIGATION–ADAPTATION DILEMMA

[W]e understand that trying to maintain the status quo is not only futile, it is a recipe for disaster.[80]

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available at http://www.lacpra.org/assets/docs/LACES/20120124_Executive_Summary_for_SLR_PaperNEW.pdf.

77. *Id.*

78. Mark Schleifstein, *Louisiana Officials Establish Formula for Anticipating Sea-Level Rise*, THE TIMES-PICAYUNE (Feb. 7, 2012, 9:30 PM), http://www.nola.com/environment/index.ssf/2012/02/louisiana_officials_establish.html?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%253A+StatelineorgRss-Environment+%2528Stateline.org+RSS+-+Environment%2529.

79. DEMARCO ET AL., *supra* note 76, at 4.

80. COASTAL PROT. & RESTORATION AUTH. OF LA., LOUISIANA'S COMPREHENSIVE MASTER PLAN FOR A SUSTAINABLE COAST 24 (2012) [hereinafter 2012 LOUISIANA COASTAL MASTER PLAN], *available at* http://www.lacpra.org/assets/docs/2012%20Master%20Plan/Final%20Plan/2012%20Coastal%20Master%20Plan.pdf.

Given that population growth, vanishing wetlands, and sea-level rise are causing coastal land loss at an alarming rate, mitigation or adaptation measures will be an inevitable reality in coastal zones of the future—whether through proactive policy-making or by force of nature if society is ultimately driven from encroaching seas. Indeed, coastal governments are realizing that "[r]educing the risk of disasters related to climate change in coastal settlements will require a combination of mitigation, migration[,] and settlement modification,"[81] the latter two approaches of which might be characterized simply as "adaptation."

Before proceeding with a discussion of these two measures, a point of clarification should be made. This Article uses the terms *mitigation* and *adaptation* in a slightly different manner than they are used in the climate change context generally. Coastal land loss *mitigation*, as used herein, includes actions that seek to forestall or mitigate land loss through wetland restoration, river diversion to renourish coastlands and restore the natural accretion of land, barrier island restoration, dam and levee building, and so on. Each of these actions is typically considered "adaptation" in the climate change context generally, with scholars and policy-makers accepting that climate-change impacts will occur and pursuing mechanisms for adapting to those changes. In addition, this use of mitigation is divergent from general understandings of *climate change mitigation*, where scholars and policy-makers focus on reducing greenhouse gas emissions and atmospheric concentrations to halt or reverse anthropogenic global warming. Coastal land loss *adaptation*, as used in this Article, means accepting that certain coastal lands will be lost to subsidence or rising sea levels, pursuing adaptation policies by moving out of areas likely to be lost, and otherwise adjusting land-use planning to avoid new development in those areas projected to be inundated. Adjustment in the use of these terms, and divergence from how they are used in the climate change context more generally, allows for more precise focus on the coastal land loss phenomenon and its solutions. Both coastal land loss mitigation and adaptation are briefly described in this section.

A. Mitigation: Facing Charybdis, a Louisiana Case Study

Addressing land-use activities associated with the broader issue of climate change mitigation might include policies aimed at, for example, fostering urban design that builds settlements more compactly in order to reduce carbon emissions from transportation

81. McGranahan et al., *supra* note 6, at 17.

and other local activities.[82] Mitigation of coastal land loss specifically, on the other hand, would entail a variety of projects aimed at building coastal land and keeping the sea at bay. A recent example of coastal land loss mitigation policy is the State of Louisiana's *Comprehensive Master Plan for a Sustainable Coast* (Master Plan). The Master Plan is aimed at investing $50 billion over upcoming decades to restore the Louisiana coast and at mitigating coastal land loss by fighting the encroaching sea—metaphorically taking on Charybdis with full force. After Hurricanes Katrina and Rita pummeled the Louisiana coast, the Louisiana Legislature created the Coastal Protection and Restoration Authority of Louisiana (CPRA), referenced above, which was "required [to] develop a plan for a safe and sustainable coast."[83] The Master Plan resulted from CPRA's efforts and is intended to establish a strategy for protecting a state whose importance to the U.S.'s natural resources and economy cannot be overstated.

In 2006, Louisiana alone accounted for 27% of the country's crude oil, 15% of its natural gas, 30% of commercial fisheries, and 21% of waterborne commerce, with coastal Louisiana maintaining the country's largest port complex.[84] This coastal ecosystem protects 90% of the country's outer continental shelf oil and gas and 26% of the commercial fisheries landings in the United States.[85] Yet, since the 1930s, Louisiana has lost over 1.2 million acres of coastal land, and over the next 50 years Louisiana may lose another 1.1 million acres, threatening not only the two million people who live in south Louisiana and a variety of resources crucial to Louisiana's well-being, but also the well-being of the country.[86] For example, the Hackberry salt domes house one of just four Strategic Petroleum Reserves in the country, potentially holding 228 million barrels of crude oil, while Louisiana Highway 1 connects the nation to Port Fourchon, which supplies 18% of the country's oil. The loss of the highway could potentially cost the country over $7 billion.[87] Each of these areas is increasingly threatened by "[c]oastal land loss [that] has placed these economic

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82. Elisabeth M. Hamin & Nicole Gurran, *Urban Form and Climate Change: Balancing Adaptation and Mitigation in the U.S. and Australia*, 33 HABITAT INT'L 238, 240 (2009), *available at* http://archone.tamu.edu/epsru/Course_Readings/Ldev671MARS689/LDEV671_Readings/Hamin_urbanform_habinternational.pdf.

83. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 24.

84. CLEAR, *supra* note 40, at 1.

85. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 20.

86. DRAFT MASTER PLAN, *supra* note 45, at 14.

87. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 19.

and natural resources at increased risk of loss due to the intense effects of waves and storm surges from hurricanes."[88] Expected annual flood damages over the next 50 years could increase by a magnitude of ten, averaging up to a coast-wide average of as much as $23 billion per year.[89] Even commercial fishing has been negatively impacted by coastal land loss. Though likely due to a confluence of factors, it is worth noting that the total number of Louisiana commercial fishing licenses has declined proportionally with the loss of coastal land over the last 25 years, dropping from nearly 30,000 in 1987 to a little over 10,000 in 2010.[90] This corresponds with the loss of nearly half a million acres of coastal land over the same time period.[91]

The Master Plan aims to halt coastal land loss, to protect these resources, and to restore coastal lands by utilizing complex modeling that accounts for a variety of coastal land loss factors and risks, including sea-level rise, subsidence, storm intensity and frequency, river discharge and sediment load, marsh collapse, and potential levee and floodwall failure.[92] Most mitigation measures within the Plan are matters of human engineering aimed at either creating manmade structures to manage land loss or restoring natural processes to do so. These include projects aimed at protective levee building, bank stabilization, barrier island restoration, channel realignment, hydrologic restoration, marsh creation, bioengineered oyster barrier reef creation, ridge restoration, shoreline protection projects, and sediment diversion[93] (using up to 50% of the Mississippi River's peak flow).[94] These measures will involve the construction of numerous types of structures, such as earthen levees, concrete walls, and floodgates, as well as increased pump use,[95] and would, for instance, allow gates to divert sediment and freshwater through currently impenetrable levees to feed and replenish marshy terrain, theoretically mimicking the natural flood events of the river before the levees were put into place. The 25 land-building restoration

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88. CLEAR, *supra* note 40, at 1.

89. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 16.

90. DRAFT MASTER PLAN, *supra* note 45, at 89. Of course, a variety of other factors can contribute to a drop in commercial fishing licenses, such as declining fisheries or vessel buyback and other programs that take fishers out of the market. Nonetheless, there is a dramatic correlation between coastal land loss in Louisiana in particular and a drop in commercial licenses.

91. *Id.*

92. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 83–92.

93. *Id.* at 66.

94. *Id.* at 33.

95. *Id.* at 70.

projects that the plan projects to be most successful are comprised of three primary types: channel realignment, marsh creation, and sediment diversion projects.[96] Nonstructural projects, on the other hand, involve flood-proofing residential and commercial properties, increasing the elevation of residential properties, and voluntary acquisition of residential properties[97]—leaving ambitious structural engineering projects as the plan's primary focus. Interestingly, the draft Master Plan asserted that only 3% of the nonstructural projects suggested would involve voluntary acquisition,[98] but the final Master Plan is noncommittal regarding the role of voluntary acquisitions.[99]

The financial expenditures projected to implement the plan are equally ambitious, including an approximately \$24 billion investment in sediment diversion and marsh creation, \$10 billion for structural protections, \$10 billion for nonstructural protections, \$2 billion for barrier island creation, \$1 billion for hydrologic restoration, and \$3 billion for miscellaneous restoration projects, bringing the total budget to around \$50 billion.[100] The plan justifies these expenditures by finding, for instance, that an investment of \$25 billion in increased flood protection could prevent \$100 billion to \$220 billion in direct asset damage to individuals, communities, and industry over the next 50 years.[101] The Master Plan actually projects that if the state takes the recommended actions, then by 2042 Louisiana will begin to *gain* land annually for the first time since the 1930s.[102]

Ultimately, mitigation measures like those outlined in the Louisiana Master Plan may have the potential to undo some of the past human contributions to coastal land loss while also harnessing human ingenuity to both forestall further land losses and actually build land over time. Yet, these measures do not come without associated risk and uncertainty, in the form of complex and speculative scientific, economic, and, as discussed below, legal and political projections. Coastal land loss adaptation, on the other

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96. *Id.* at 106.
97. *Id.* at 72.
98. DRAFT MASTER PLAN, *supra* note 45, at 65.
99. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 72.
100. *Id.* at 34. The Master Plan looks to a variety of potential funding sources, including the Gulf of Mexico Energy Security Act, the Energy and Water Act (Corps funding), the Coastal Wetlands Planning Protection and Restoration Act, the Deepwater Horizon Natural Resources Damage Assessment, the Deepwater Horizon Clean Water Act Penalties, Carbon and Nutrient Credits, Future State Funding, and Louisiana's Coastal Protection and Restoration Fund. *Id.* at 93.
101. *Id.* at 140–41.
102. *Id.* at 29.

hand, while being more certain in approach and outcome (i.e., if people move away from the coast, they will most certainly avoid inevitable land losses), carries with it its own difficulties—primarily, that of forging the political will and societal fortitude to make the harder choice over shorter time frames to adapt by retreating from harm's way.

B. Adaptation: Running on Scylla

As noted earlier, adaptation to climate change in the general sense "seeks to adjust the built and social environment to minimize the negative outcomes of now-unavoidable climate change"[103] and might very well include some of the coastal land loss *mitigation* measures described above. Coastal land loss adaptation, on the other hand, involves shifts in population patterns that give rise to fundamental changes in existing and future infrastructure, the protection of riverine and coastal floodplains and wetlands from development, and increased preservation of ecosystems to act as species corridors and other natural capital reservoirs as coastal ecosystems are lost to sea-level rise[104]—it means running on Scylla, the rocky shoal, farther inland. So in the face of "natural" coastal land loss via sea-level rise, land loss adaptation means reigning in "artificial" land loss to human development even further, in order to remove the populace from lands likely to be lost and provide more natural land to act as a buffer between rising seas and human habitation that has moved farther inland. These adaptation measures "require significant land to undertake, often through the provision of open space used for . . . stormwater management, sea level rise planning, or for migration corridors"[105] and may require "a dramatic reduction in available areas for new development and redevelopment" within existing communities.[106] These types of actions would occur by the establishment of "policy framework[s] for re-situating land uses that may become unsafe or unsuitable in the future due to climate change," by "[i]dentify[ing] and reserv[ing] locations for relocation of major infrastructure,"[107] and by "[a]ctively plan[ning] ahead for settlement reorientation or design."[108]

103. Hamin & Gurran, *supra* note 82, at 238.
104. *Id.* at 241.
105. *Id.*
106. *Id.* at 242.
107. *Id.* at 243.
108. *Id.* at 244.

Obviously, there are "difficulties inherent in shifting the direction of population movements and adapting to increasing risk," and "[m]igration away from lowest elevation coastal zones will be important, but can also be costly and difficult to implement without causing severe disruptions. Modification of the prevailing forms of coastal settlement, so as to protect local residents, will also be needed."[109] Indeed, scholars note that "[t]he risks to human settlements could be reduced if people and enterprises could be encouraged to move away from the coast, or at least from the most risk-prone coastal locations."[110] Even so, "current population movements are in the opposite direction[,] [and] [g]iven the character of urban development, and that the factors driving coastward movement are still poorly understood, turning these flows around is likely to be slow, costly or both."[111] Nonetheless, preventative action regarding the placement of *new* settlements in areas either likely to be lost or that will be needed in the future as a buffer for settlement farther inland is a much cheaper and more practical approach to adapting to coastal land loss.[112] In other words, though shifting current development and infrastructure will undoubtedly be difficult, an approach that can be more easily controlled is deterring the populace's continued flock to the coast and continued development of previously undeveloped lands on the coast.

As scholars have noted, because so much coastal land has already been developed, "most of the easier options for shifting settlement patterns, and modifying them so that they are better adapted to the risks of climate change, will have been foreclosed."[113] As a result, any option that remains is difficult to choose. Scholars have argued that "[p]redicted weather-related events like sea level rise, increased storm events, and extreme heat waves imply an urgent need for new approaches to settlement design to enable human and non-human species to adapt to these increased risks."[114] Unfortunately, not enough attention has been paid to mechanisms for adapting settlement to the land-use related impacts of climate change, with most focus being on mitigating impacts. This is almost certainly because modern society has yet to face an environmental problem on a scale that it has been unable to address or combat with the right legal and policy tools; or, rather, on a scale that has

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109. McGranahan et al., *supra* note 6, at 17.
110. *Id.* at 20.
111. *Id.*
112. *Id.* at 21.
113. *Id.* at 35.
114. Hamin & Gurran, *supra* note 82, at 238.

foreclosed the ability to "mitigate" in some way. Indeed, "[i]n some cases mitigation and adaptation are complementary[,] but in other cases these policy goals may conflict."[115] Such is often the case when choosing between: (1) not developing coastal land at all or moving society out of those areas, and (2) building human-made structures or attempting to restore natural processes through human engineering.

In the end, adaptation provides a recipe arguably more simple than mitigation for addressing coastal land loss, though one that is just as difficult (and in the short term, likely more difficult) than mitigation to implement—creating policies aimed at steering new and existing development away from areas likely to be lost, and then as areas become lost or increasingly under threat of loss, retreating to higher ground. This has the potential, over the long term, to be far less risky and less costly than investing billions in mitigating land loss in areas likely to become inundated regardless of mitigation efforts. And indeed, mitigation policy-makers acknowledge that a balance of mitigation and adaptation approaches is necessary. Louisiana's Master Plan, for example, implicitly contemplates, through the omission of protection measures for various areas of the Louisiana coast, that some areas simply cannot be saved, and retreating from those areas while investing in mitigation efforts elsewhere would be wiser. The risk lies in striking the appropriate balance between mitigation and adaptation. The next Part discusses three reasons why, like Odysseus, policy-makers should consider avoiding Charybdis and running on Scylla under circumstances where the short-term lure of mitigation may be appealing but over the longer view would be likely to fail—thus tipping the balance in favor of adaptation in those areas.

IV. CHOOSING TO RUN ON SCYLLA: ADAPTING TO THE RISING TIDE AND APPROACHING MITIGATION WITH CAUTION

Change is upon us. We can either embrace it or become victims of the challenges we face.[116]

A. Uncertainty of Mitigation's Effectiveness—Scientifically and Institutionally

There are two primary forms of uncertainty regarding coastal land loss mitigation, each of which should cause us to approach mitigation with caution. The first is scientific uncertainty regarding

115. *Id.*
116. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 38.

the efficacy of wetland restoration, sediment diversion, and other human engineering efforts to restore "natural" processes, as well as modeling projections of sea-level rise and coastal land subsidence. The Louisiana Master Plan, for example, highlights the need to maintain realistic and "clear expectations" for mitigation efforts, stating that "we cannot recreate the coast of the 20th Century. Instead, we must seek to fashion a new landscape that will support viable natural and human communities into the future."[117] Along with those expectations comes recognition of the profound uncertainties of projecting the viability of mitigation projects:

> Although our protection and restoration efforts must be based on sound and robust science, we must also acknowledge that substantial uncertainties remain . . . . For example, we do not know with certainty the rate of sea level rise we can expect over the life of a restoration project, nor can we fully predict all ecological responses to actions such as sediment diversions.[118]

Take wetland restoration, for instance. In North America alone within the last 20 years, more than $70 billion has been spent restoring over seven million acres of wetlands.[119] Though wetlands restoration has become a "booming business,"[120] some scientists have argued that restoring wetlands often "fall[s] short of returning wetlands to their former biological complexity and functioning."[121] These scientists have found that "current restoration practice fails to recover original levels of wetland ecosystem functions, even after many decades. If restoration as currently practiced is used to justify further degradation, global loss of wetland ecosystem function and structure will spread."[122] More directly, scientists assert that "current restoration practice and wetland mitigation policies will maintain and likely accelerate the global loss of wetland ecosystem functions,"[123] and that

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117. *Id.* at 44.
118. *Id.* at 45.
119. Moreno-Mateos et al., *supra* note 35, at 1.
120. Rachel Nuwer, *Not All Wetlands Are Created Equal*, N.Y. TIMES (Jan. 24, 2012, 5:00 PM), http://green.blogs.nytimes.com/2012/01/24/not-all-wetlands-are-created-equal/.
121. *Id. See also* Moreno-Mateos et al., *supra* note 35.
122. Moreno-Mateos et al., *supra* note 35, at 1.
123. *Id.* at 2. In other words, "ecosystem services may not be fully recovered even when wetlands appear to be biologically restored. If markets for ecosystem services and mitigation offsets from restored or created wetlands are used to justify further wetland degradation, net loss of global wetland services will continue and likely accelerate." *Id.* at 6 (citation omitted). Carbon storage capacity in particular is significantly degraded in restored wetlands. *Id.* at 3.

> [i]f we keep degrading or destroying wetlands, for example through the use of mitigation banks, it is going to take centuries to recover the carbon we are losing. . . . [P]reserve the wetland, don't degrade the wetland. . . . [C]urrent thinking holds that many ecosystems just reach an alternative state that is different, and you never will recover the original.[124]

Much of the uncertainty around wetland restoration involves further uncertainties surrounding the primary synergistic relationship that is crucial to restoring wetlands in a delta system like that of the Mississippi—namely, the synergy between sediment diversion, subsidence, and sea-level rise. As noted earlier, levees and dams along the Mississippi River have caused sediment that once renourished and built land over time to be channeled and conveyed beyond the outer continental shelf where it cannot build land. This has led to subsidence, which combines with sea-level rise to amplify coastal land loss. The first layer of uncertainty regards rates of subsidence. As CPRA observed: "Subsidence is a significant driver of relative sea-level rise in . . . Louisiana . . . . While rates of subsidence are highly variable across the Louisiana coastal zone, our understanding of the exact rates of subsidence at the local level is very limited."[125] In addition, a second layer of uncertainty regards sea-level rise—Louisiana officials have noted that "there has been very little work done to predict the specific change in the Gulf of Mexico water surface for the rest of this century" and that without such study, "anticipated sea-level changes in the Gulf of Mexico must be primarily extrapolated from satellite altimetry or tide gauges, which can be less reliable due to the limited period of record."[126] As a result, any sediment diversion and wetland restoration projects aimed at combating subsidence and sea-level rise is fraught with compounded uncertainties. Indeed, opponents to coastal wetland restoration, like that outlined in the Louisiana Master Plan, claim that experimental sediment diversions that have been in place for at least a decade have failed to rebuild land and combat subsidence,

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124. Jeremy Hance, *Protecting Original Wetlands Far Preferable to Restoration*, MONGABAY.COM (Jan. 26, 2012), http://news.mongabay.com/2012/0126-hance_wetlands_restoration.html?utm_campaign=General+news&utm_medium=Twitter&utm_source=SNS.analytics (citation omitted).
125. DEMARCO ET AL., *supra* note 76, at 6 (citation omitted).
126. *Id.* at 4–5.

and while scientists have shown improvements in those areas, land has not rebuilt at rates initially predicted.[127]

Importantly, though "restoring wetlands remains a controversial strategy,"[128] the largest portion of money designated by the Louisiana Master Plan—nearly $20 billion—is authorized for coastal wetland restoration.[129] Policy-makers should seriously consider foregoing costly, short-term (geologically speaking) restoration expenditures under circumstances in which the return on investment is highly uncertain. Obviously, some projects may be more efficacious than others, but it remains that while mitigation via restoration may be appealing to the collective societal psychology of believing that we can engineer our way out of any environmental challenge, it may not be as realistic or effective over the long term as adapting land-use patterns to retreat from rising seas. In other words, we should avoid saddling the taxpayer of today with costs of mitigation projects that are likely to fail and therefore saddle future generations with continued disappearance of coastal lands.

The second form of coastal land loss mitigation uncertainty is institutional and includes both political and legal considerations. One of the difficulties in designing policies aimed at both coastal land loss mitigation and adaptation is achieving the appropriate level of input at each level of government. While politics can complicate policy design on one hand, principles of constitutional law further compound the issue on the other. The federal government currently maintains no regulatory inputs into a variety of land-use activities that have critical implications for coastal land loss—primarily regarding direct land-use planning that determines both the intensity and extent of coastal development.[130] This

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127. Mark Fischetti, *New Orleans Protection Plan Will Rely on Wetlands to Hold Back Hurricanes*, SCIENTIFIC AMERICAN (Jan. 26, 2012), http://blogs.scientificamerican.com/observations/2012/01/26/new-orleans-protection-plan-will-rely-on-wetlands-to-hold-back-hurricanes/.

128. *Id.*

129. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 34.

130. The federal government does maintain the ability to forestall coastal wetland filling through its 404 permitting program under the Clean Water Act. 33 U.S.C. § 1344 (2006). Even so, and though the Corps receives an average of over 80,000 permit requests annually,

> only about [9%] are required to go through a "detailed evaluation for an individual permit;" most are approved through a nationwide or region-specific permit. Of the [9%] that have to file for an individual permit, less than 0.3[%] are denied. In Louisiana between 1988 and 1996, [99%] of all permit applications were granted, including [92%] in flood disaster areas.

situation is largely due to the institutional inertia of jurisprudence declaring that land-use regulation is the "quintessential state and local power" under the Constitution.[131] Even though state and local governments maintain this quintessential role, they are doing little to curb coastal land loss and the destruction of coastal ecosystem services from human development activities, and indeed their interests in promoting economic growth in their respective jurisdictions run counter to preserving coastal lands or forestalling coastal development today to combat coastal land loss in the future. Consider a contrast between Louisiana and North Carolina. While Louisiana has developed a plan to prepare for sea-level rise, and has projected a one-meter rise in sea levels by the end of the century, the North Carolina State Legislature has passed a statute[132] that caps sea-level rise projections at eight inches, forbidding sea-level rise modeling that accounts for climate change and instead basing the projection on only linear data from the past—an outright rejection of their own state-appointed board of scientists who projected a one-meter rise.[133] This has led some

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Brandee Ketchum, Note, *Like the Swamp Thing: Something Ambiguous Rises From the Hidden Depths of Murky Waters—The Supreme Court's Treatment of Murky Wet Land in* Rapanos v. United States, 68 LA. L. REV. 983, 1011–12 (2008) (footnotes omitted). Additionally, the EPA only exercised its power to veto Corps wetland permit issuance eleven times between 1972 and 2007. CRAIG PITTMAN & MATTHEW WAITE, PAVING PARADISE: FLORIDA'S VANISHING WETLANDS AND THE FAILURE OF NO NET LOSS 167 (2009).

131. State governments regulate land use under their authority to exercise the "police power" for protection of the "general welfare." *See generally* Mugler v. Kansas, 123 U.S. 623 (1887). Scholars have recognized that "[t]he weight of legal and political opinion holds that this allocation of power in [the U.S.] leaves the states in charge of regulating how private land is used," JOHN R. NOLON, PATRICIA E. SALKIN & MORTON GITELMAN, LAND USE AND COMMUNITY DEVELOPMENT 17 (7th ed. 2008), and that "[l]and use law has always been a creature of state and local law," Marci A. Hamilton, *Federalism and the Public Good: The True Story Behind the Religious Land Use and Institutionalized Persons Act*, 78 IND. L.J. 311, 335 (2003). The U.S. Supreme Court has further recognized that "[r]egulation of land use . . . is a quintessential state and local power." Rapanos v. United States, 547 U.S. 715, 738 (2006). *See also* Fed. Energy Regulatory Comm'n v. Miss., 456 U.S. 742, 768 n.30 (1982) ("[R]egulation of land use is perhaps *the quintessential* state activity." (emphasis added)). It is true that the Coastal Zone Management Act allows some level of federal influence on coasts. It remains, however, a very weak approach and is a voluntary program (to avoid federalism concerns) without significant prescriptive dictates. *See* Hudson, *supra* note 75, at 2034, 2052–54.

132. Act of July 3, 2012, 2012 N.C. Sess. Laws 202.

133. Wade Rawlins, *North Carolina Lawmakers Reject Sea Level Rise Predictions*, REUTERS (July 12, 2012), http://www.reuters.com/article/2012/07/03/us-usa-northcarolina-idUSBRE86217I20120703. *See also* Scott Huler, *NC*

commentators to declare that North Carolina has considered "making sea level rise illegal."[134] Furthermore, it is not only states that politically and legally make a successful, coordinated land loss response uncertain. The federal government is complicit in facilitating human settlement patterns within the coastal zone, as its National Flood Insurance Program subsidizes poor development in areas at risk for coastal land loss.[135]

Absent coordination, either among state and local governments or provided by a higher-level authority, such as the federal government, governments around the country may very well continue to ignore the artificial and natural threats to coastal lands, especially because they have incentives to grow their individual economies, to increase the tax base by attracting more residents, and to create job opportunities in order to maintain and continue to grow the population and the economy. At the very least, even if governments formulate plans, they may tip the scale toward mitigation over adaptation when long-term prudence would call for the opposite result. Ultimately, the collective inaction or miscalculations of the federal government and the disparate and numerous subnational governments damages the shared coastal land resource.[136]

While horizontal coordination uncertainties exist regarding political and legal actions across different levels of government, such as the various states, there are also uncertainties regarding the vertical coordination between the state and federal governments, as well as between state governments, local governments, and private property owners. For example, the initial draft of the Louisiana Master Plan absolved the State of responsibility for potentially important aspects of coastal restoration, stating, for example, that "it is the state's policy that funding for federally authorized navigation channels is the sole responsibility of the federal government"[137] and that "[f]unding for those projects should come at full federal expense."[138] By the final draft, the language had been changed to: "For purposes of this plan, we assumed that funding of these projects would be the responsibility of the federal

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Considers Making Sea Level Rise Illegal, SCIENTIFIC AMERICAN (May 30, 2012), http://blogs.scientificamerican.com/plugged-in/2012/05/30/nc-makes-sea-level-rise-illegal/.

134. Huler, *supra* note 133.

135. *See* Hudson, *supra* note 75, at 2004.

136. *See* Blake Hudson, *Federal Constitutions: The Keystone of Nested Commons Governance*, 63 ALA. L. REV. (forthcoming 2012).

137. DRAFT MASTER PLAN, *supra* note 45, at 62.

138. *Id.* at 141.

government."[139] The State does assert that it will "work to secure federal funding for projects shown to be important to the overall coastal strategy,"[140] but uncertainty is inherent regarding whether the federal government will in fact be willing or able to do so.

Similarly, the state and federal governments are wrangling over policy constraints relevant to wetland restoration. The Master Plan's success depends heavily upon the successful use of sediment to restore and rebuild coastal wetlands, especially because it has allocated $24 billion for the task. Though dredged sediment is normally dumped in upland disposal sites or in the Gulf, since 2009 the State of Louisiana has required private parties who plan to dredge more than 25,000 cubic yards of sediment to place the dredged material in a coastal restoration project or pay a fee.[141] Yet, federalism rears its ugly head once again and places large quantities of sediment beyond the project's reach. In order to maintain navigation channels, the Corps of Engineers dredges sediment along the coast in greater amounts than any other entity in Louisiana (58 million cubic yards per year), and very little of this is diverted to wetlands.[142] The Corps claims, according to the Master Plan, that its authorizations and budget do not allow the beneficial use of this dredged material for restoration projects.[143] Thus, this is a complication that will need to be addressed, though exactly how it will be resolved is unclear since the State absolves itself of any funding related to navigation channel maintenance handled by the federal government.

Not only do entities up the chain, such as the federal government, foster uncertain political and legal outcomes, but so too do entities "down the chain," such as local governments and private property owners. The nonstructural solutions to coastal land loss in Louisiana, as described in the Master Plan, are dependent upon amending the regulatory requirements of local land-use planning, building codes, flood damage prevention ordinances, and risk reduction project funding.[144] The Master Plan describes the problem of "induced risk," whereby structural solutions to protect from hurricane and flood damage "encourage unwise development in high risk areas."[145] Induced risk has been the norm in the past along the Louisiana coast, even though it "increases overall levels of risk and diminishes the effectiveness of

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139. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 69.
140. *Id.* at 155.
141. *Id.* at 174.
142. *Id.*
143. *Id.*
144. *Id.* at 158.
145. *Id.* at 159.

the protection structures themselves."[146] As a result, the Master Plan asserts that "wetland areas inside the hurricane protection system need to remain intact and undeveloped. Land use ordinances that contain nonstructural risk reduction measures . . . can ensure that our coastal investments bring maximum benefits while providing for economic growth."[147] This aspirational language establishes no mechanism for guaranteeing that these steps will actually be taken, at the state or subnational government levels, adding yet another layer of uncertainty as to whether all levels of government will take the necessary political and legal actions to successfully implement mitigation goals.

In addition to political and legal uncertainty, the Master Plan acknowledges that 80% of the coast is privately owned and that "[t]he rights of these landowners, including mineral rights, must be acknowledged" as coastal projects are designed.[148] As a result, "landowners should be partners with the state as projects are planned, designed, constructed, and operated."[149] While this sounds good in theory, in practice, relying on the cooperation of so many private property owners turns what would otherwise be an uncertainty into a certainty—states are *certain* to have difficulties procuring the necessary cooperation of private property owners to the degree that may be needed to have successful mitigation policies.

Ultimately, in the mitigation context, uncertainty exists regarding the scientific projections that the mitigation policy relies upon, particularly in the areas of wetland restoration, sediment diversion, subsidence, and sea-level rise. Uncertainty also exists regarding the coordination and implementation of needed legal and political actions by the federal government, state and local governments, and private property owners. These compounded uncertainties should caution against relying too heavily on mitigation efforts in areas where, over the long-term view, adaptation would provide far more certainty. In these areas, policy-makers should design policies that move society away from coastal lands likely to be lost, so the impacts of future coastal land loss on society will be reduced. To be clear, this is not to argue that coastal mitigation projects are uniformly poor policies, or even that certain short-term benefits gained by coastal restoration are not worthwhile investments. A wide variety of coastal restoration projects, including those that "protect vital coastal and marine habitat, restore species

146. *Id.*
147. *Id.*
148. *Id.* at 167.
149. *Id.*

that keep coastal systems healthy, remove invasive species, create shellfish spawning sanctuaries and re-establish water flows to estuaries,"[150] may very well be successful. The same may be said for certain sediment diversion and wetland restoration projects. Similarly, tipping the scale too far in favor of coastal land loss adaptation may cause society to lose valuable economic and environmental benefits provided by the coast that may very well have turned out to be "fixable" and sustainable over the long term. Yet, as discussed in the next section, this Part is primarily concerned with the scale being tipped too far toward mitigation because it is the most politically expedient choice—a situation that distorts assessment of which approach is actually more appropriate.

B. The Political Expediency of Choosing Mitigation over Adaptation

The second reason to proceed with caution regarding coastal land loss mitigation policies is the tempting political expediency that may drive policy choices to implement coastal land loss mitigation over adaptation. A stark example of the political appeal for mitigation policies is the Louisiana Master Plan poll determining that 89% of Louisianans "believe that [Louisiana's] coast is very important" and that 85% of Louisianans "believe it is smart to invest dollars in risk reduction and coastal restoration."[151] Importantly, the Master Plan notes that "[p]eople were not willing to give up on the coast, nor were they willing to write off areas at risk."[152] This demonstrates the intuitive appeal to a legislator for proposing and supporting mitigation policies aimed at restoring and saving the coast, especially if the public sees adaptation policies as "writing off" areas at risk.

Contrast these results with a recent study undertaken by the National Oceanic and Atmospheric Administration and the Sea Grant institutions of Texas, Louisiana, Florida, Mississippi, and Alabama. When polled about climate change generally, only about 42% of coastal Louisianans said they were "very concerned,"[153] while only 46% said that the effect of climate change on their local

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150. Mark Tercek, *Coastal Restoration: A Smart Investment*, HUFFPOST GREEN (Feb. 22, 2012, 1:44 PM), http://www.huffingtonpost.com/mark-tercek/coastal-restoration_b_1292642.html.

151. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 51.

152. *Id.*

153. KIRBY GOIDEL ET AL., NAT'L OCEANIC & ATMOSPHERIC ADMIN., TEX. SEA GRANT, LA. SEA GRANT, FLA. SEA GRANT & MISS.–ALA. SEA GRANT CONSORTIUM, 2012 GULF COAST CLIMATE CHANGE SURVEY: EXECUTIVE SUMMARY 11 (2012), *available at* http://www.southernclimate.org/documents/resources/Climate_change_perception_survey_summary_NOAA_Sea_Grant_2012.pdf.

community would be "very or somewhat negative."[154] Around 35% said climate change would be neither negative nor positive, and approximately 18% actually said that the effects of climate change would be positive.[155] So, though regionally Louisianans want to address the problems *caused* by climate change—accelerated coastal land loss—many fail to make the connection between land loss and climate change as one of the key drivers of the problem. Furthermore, the number of Louisianans statewide who are very concerned with climate change and who think its effects would be negative may well be lower than 42% and 46% respectively because those numbers only reflect coastal residents' opinions—the NOAA and Sea Grant report found that coastal residents are more likely to believe climate change is happening than noncoastal residents.[156] Finally, while 89% of Louisianans statewide support coastal land loss mitigation policies, only around 66% of coastal residents support incentives to relocate from threatened areas, only 69% support limiting the types of structures built in high-risk areas, and only 29% support raising insurance rates for high-risk areas[157]—each of which are key aspects of land loss adaptation.

These numbers present a glimpse into how well-received might be the legislator who says, "We need to dramatically rethink and restructure how and where we undertake new development, and we need to transition current infrastructure to lower risk areas." Given the long time scales, relative to human lifespans, that a policy-maker's decision takes to be proven "correct" or "incorrect," one might say it would *always* be in the legislator's best interest to propose mitigation over adaptation. The upside political and governance benefits are large, as the populace gets what it wants (though the populace may not be fully informed about what it needs), and any political downside is small because the policy-maker is not likely to be around to witness the negative ramifications if mitigation policies ultimately fail in the future. Yet, none of these governance and political considerations provides any *qualitative* indication about whether either adaptation or mitigation policies are indeed the best option for a given area, which is, of course, what should drive decision-making, rather than political expediency.

In addition to the effect that citizens' opinions on threats to their *regional* coastal interests can have on policy-makers' choices—a phenomena that acts as a type of endowment effect for

154. *Id.* at 9.
155. *Id.*
156. *Id.* at 18.
157. *Id.* at 16.

residents in states with important coastal resources—two other political considerations should cause policy-makers to approach mitigation cautiously. The first is simply the inertia that a mitigation policy gains once implemented. Once mitigation is relied upon to fortify coasts through large-scale engineering projects, with equally large-scale and corresponding economic investments, a preference arises to maintain that solution in perpetuity. Once billions of dollars are invested in levees, dams, seawalls, realigned channels, and wetland restoration, subsequent policy decisions are predisposed to protect those investments through even more mitigation measures. This acts as yet another distorting influence on the objective choice between adaptation and mitigation, as it becomes even more difficult to change course toward adaptation by letting those investments disappear.

The second additional political consideration involves the basic political incentives that the U.S. economic system provides. The desire to develop in floodplains to grow local and national economies is one reason current mitigation measures, such as levees, have been implemented in the first instance, giving rise to political pressure to maintain those measures. For example, recently Bay St. Louis, Mississippi officials attempted to remove markers along the interstate demarking the high-water flood mark reached during Hurricane Katrina.[158] As noted earlier, the extent of Katrina's destruction was due in great part to the commercial development of floodplains that destroyed natural wetland buffer systems. This resulted in floodwaters in Bay St. Louis that actually reached the overhead span where Interstate 10 crossed *over* another highway.[159] Even so, one Bay St. Louis councilmember stated that "the markers are detrimental to attracting businesses that might want to relocate [in the area], especially on undeveloped property around the interstate . . . ."[160] In fact, "[s]ome city leaders envision the interstate property as a magnet that will pull in restaurants, motels, and big-box retailers."[161] Though these commercial establishments may very well be under water during the next major hurricane, local government officials and economic development interests are politically predisposed to forego a needed adaptation policy for the sake of achieving the short-term economic benefits that a mitigation policy may achieve.

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158. Associated Press, *Bay St. Louis Officials Oppose Hurricane Katrina High-Water Markers on Highway*, NOLA.COM (July 23, 2011, 9:00 PM), http://www.nola.com/katrina/index.ssf/2011/07/bay_st_louis_officials_oppose.html.
159. *Id.*
160. *Id.*
161. *Id.*

Ultimately, political expediency based upon regional endowment, policy inertia, and economic development considerations distort the coastal land loss mitigation versus adaptation choice. As a result, policy makers should take those distortions into account and objectively assess their policy choices based on scientific and other tangible considerations, rather than merely political expediency.

C. Failure to Adapt Past Land-Use Activities in the Coastal Zone has Contributed to the Need to Adapt or Mitigate Today

The third and final reason why we should approach mitigation policies cautiously is the fact that failure to adapt past land-use activities in the coastal zone is one reason that mitigation and adaptation policies are now needed, lending support to the argument that adaptation now can avoid both costly mitigation policies, as well as preempt the need to adapt or mitigate in the future. Anecdotally, I recently purchased a home on Highland Road in Baton Rouge, Louisiana. The road is named "Highland" because historically it was the ridge where the natural floodplain of the Mississippi ended. As a result, people adapted to the natural circumstances by building their homes on the ridge—perhaps the ultimate form of adaptive, self-insuring land-use planning, achieved at low cost and with minimal effort (relative to building elsewhere, at least). This approach to development, however, has long since disappeared, as people now live in a world of levees and other structural solutions that places residential and commercial development within floodplains abutting structures that then must be maintained in perpetuity. As a result, society must make the difficult cost–benefit choice to flood one city because it would cause less damage than flooding another city—which happened recently along the Mississippi River.[162] In other words, society is forced to mitigate flood damages because it failed to adapt long ago, choosing instead to develop in floodplains and to store a massive amount of energy behind levees ever-increasing in bulk. While such measures may be an option to bail out communities that undertake poor land-use planning along a river, it simply will not be a choice for combatting constant, irreversible, and relatively geographically uniform sea-level rise in the coastal zone.

Indeed, in the coastal zone we have exacerbated vanishing wetlands and rising seas by refusing in the past to adapt to their

162. Major General Michael Walsh as told to Bruce Grierson, *How I Contained the Mississippi*, DISCOVER MAG., Apr. 2012, at 18, *available at* http://discovermagazine.com/2012/apr/14-how-i-contained-the-mississippi.

existence and to structure society around them. Instead, we have replaced natural capital with human-built capital, and then invested untold economic resources into mitigating risks that we ourselves created. The irony of a recent Article titled "New Orleans Protection Plan Will Rely on Wetlands to Hold Back Hurricanes"[163] is that, of course, Katrina's damages were exacerbated because of the prior removal of wetlands through development activities. Though "[d]ecades ago the delta had thick, robust marshes and swamps that began behind the barrier islands and ran back for miles and miles to where towns and cities had sprouted,"[164] those sprouting cities expanded and replaced these natural systems with development. The Louisiana Master Plan itself specifically acknowledges the role that manmade levees and floodgates have had in channeling the Mississippi River into the Gulf and starving the coastal ecosystem of fresh water and sediment, while oil and gas canal dredging has weakened marshes and allowed salt water infiltration—all of this compounded by sea-level rise, subsidence, and storms.[165] The Master Plan acknowledges that "[o]ur current coastal crisis is due in large part to *past decisions that have altered the natural processes of the coast. Both protection and restoration projects can support or impede these processes*."[166]

With regard to the Mississippi River, the Master Plan acknowledges the inherent trade-off when human development and natural systems collide, which is an unavoidable aspect of coastal land loss mitigation policies:

> Since the late 1930s, the Mississippi River has been controlled by federally built levees. By reducing river flood risks and providing reliable navigation, the levees *have allowed communities throughout the river's watershed to thrive*. But the levees have also *deprived Louisiana's wetlands of the sediment and fresh water that once built and sustained them*. One of the many severe effects of this land loss disaster has been an increase in hurricane based flooding risk to communities. We must allow more river water and sediment to spread across the delta if we are to provide a sustainable future for the ecosystem, navigation, industry, and communities.[167]

163. *See* Fischetti, *supra* note 127.
164. *Id.*
165. 2012 LOUISIANA COASTAL MASTER PLAN, *supra* note 80, at 18.
166. *Id.* at 153 (emphasis added).
167. *Id.* at 168 (emphasis added).

This statement might be paraphrased: "We have mitigated in the past, and therefore must continue mitigating in the future to protect past land-use patterns." An adaptation approach, on the other hand, uncouples significant anthropogenic impacts on natural systems in the coastal zone and does not attempt to extend artificial wetlands further—though reestablishment of wetlands that development has replaced may present an adaptive approach. Rather, adaptation prevents development from encroaching on natural coastal barriers already intact. Had this approach been taken in the past, adaptation or mitigation policies would be less necessary today. While adaptation policies may presently create significant economic and social difficulties, future residents of the coastal zone may very well prefer that we adapt where necessary, rather than continue a cycle of perpetually mitigating risks that we ourselves create.

V. Conclusion

Coastal land loss is an inevitable environmental challenge that society must face in a changing climate. Even so, society maintains legal and policy tools to address it, in the form of coastal land loss mitigation and adaptation. Many current environmental problems are caused by a failure to engage in policy-making that foregoes short-term interests for long-term societal well-being. So too may be the case if society fails to strike the appropriate balance between coastal land loss mitigation and adaptation policies. In many ways, mitigation is an unknown quantity compared with adaptation. We know that adaptation can and will be disruptive, and for the most part, we can pinpoint just how disruptive in real time based upon known data points. We also know exactly what measures will be necessary to allow a retreat from harm's way, and we can choose just how far removed we want to be from high-risk coastal land loss areas. Mitigation, on the other hand, is fraught with uncertainty, and its viability and desirability is further distorted by a variety of political and economic considerations. Finally, a failure to err on the side of adaptation in the past has given rise to many current coastal land loss problems.

Ultimately, a balance of adaptation and mitigation will necessarily be part of our response to coastal land loss. As we weigh those respective options, however, we should do so honestly, with consideration to future generations, and with an accounting of costs and benefits over long time scales—because in some circumstances it may very well be better to run on Scylla to avoid Charybdis.