



1-1-2014

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Recommended Citation

Colleen R. Rush, *An Overflowing Global Tub: Why Rising Seas Are Spilling into the Streets and What the Government Can Do in Response*, 25 Vill. Envtl. L.J. 275 (2014).

Available at: <https://digitalcommons.law.villanova.edu/elj/vol25/iss1/9>

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AN OVERFLOWING GLOBAL TUB: WHY RISING SEAS ARE
SPILLING INTO THE STREETS AND WHAT THE
GOVERNMENT CAN DO IN RESPONSE

I. INTRODUCTION

For over thirty years, warnings from environmentalists about the dangers of rising sea levels have largely gone unheeded.¹ Many skeptics, including Chief Justice John Roberts, believe that the “actual loss of . . . coastal land from 20th-century global sea level increases . . . is pure conjecture.”² According to recent studies, however, rising sea levels are far from conjecture and are taking coastal lands at an alarming rate.³ Rising seas could potentially cause billions of dollars worth of damage over the coming decades, as evidenced by the fifty-one billion dollars of relief aid Congress provided for those affected by Hurricane Sandy.⁴ While Hurricane Sandy proved catastrophic for millions of people across the Eastern Seaboard, it may have convinced some critics of the veracity of the environmentalists’ warnings.⁵

1. See Samuel Pyeatt Menefee, “*Half Seas Over*”: *The Impact of Sea Level Rise on International Law and Policy*, 9 UCLA J. ENVTL. L. & POL’Y 175, 182 (1991) (explaining despite introduction of information on rising sea levels in 1980s, policies and decisions outside scientific community remained unchanged).

2. *Massachusetts v. EPA*, 549 U.S. 497, 542 (2007) (Roberts, C.J., dissenting) (reasoning Massachusetts did not show actual loss because it provided nothing to support contentions that rising sea levels are swallowing coastal land). For a further discussion of *Massachusetts v. EPA*, see *infra* notes 105-109.

3. See Suzanne Goldenberg, *US Coastal Cities in Danger as Sea Levels Rise Faster than Expected, Study Warns*, THE GUARDIAN (Nov. 27, 2012, 7:01 PM), <http://www.guardian.co.uk/environment/2012/nov/28/us-coastal-cities-sea-level-rise> (highlighting 2012 scientific evidence that sea levels are rising sixty percent faster than originally projected, and declaring environmentalists are succumbing to reality that this rise will be far worse than originally predicted).

4. Ben Strauss, Claudia Tebaldi, & Remik Ziemlinski, *Surging Seas: Sea Level Rise, Storms & Global Warming’s Threat to the US Coast*, CLIMATE CENTRAL, 5 (Mar. 14, 2012), available at <http://slr.s3.amazonaws.com/SurgingSeas.pdf> (emphasizing that rising sea levels pose threats to both coastal areas and national economic health because rising sea levels result in damage that is very costly to repair); see also John Rudolf, *Sandy Relief Passes House Despite Conservative Opposition*, HUFFINGTON POST (Jan. 15, 2013, 4:46 PM), http://www.huffingtonpost.com/2013/01/15/sandy-relief-measure-passes_n_2480328.html (reporting Congress’ decision to provide Hurricane Sandy victims with fifty-one billion dollars of federal relief for storm damage despite already high levels of federal debt).

5. Dan Vergano, *Sandy Revives Debate over Sea-Level Rise*, USA TODAY (Nov. 28, 2012, 2:50 PM), <http://www.usatoday.com/story/tech/2012/11/27/sandy-sea-level-rise/1730405/> (detailing how towns along Hurricane Sandy’s path are still trying to recover one-month later and how Hurricane Sandy’s negative and costly

In the United States, twenty-three of the twenty-five most densely populated counties are located along a coast.⁶ This population concentration in coastal areas puts much of the nation at risk of the dangers of rising sea levels, as more than half of the United States' population lives less than three-and-a-half feet above average high tide levels.⁷ The problem of rising sea levels is not just an issue in the United States, but is global in scale considering ten percent of the world's population lives in low-lying areas that are extremely vulnerable to even the smallest changes in sea levels.⁸ Over the past century, global sea levels rose approximately seven inches.⁹ Sea levels continue to rise at an increased rate and show no signs of slowing down.¹⁰ While the increase in sea levels of about an inch per decade may seem small, it is only a matter of time until one inch becomes "like the last inch of water that overflows a tub."¹¹

In *Massachusetts v. EPA*,¹² the Supreme Court directly recognized the harms associated with climate change and rising sea levels.¹³ Despite the Court's recognition of these harms, the government's actions often run contrary to working toward a climate

impact may be what turns skeptics to believe scientist's warnings about rising sea levels).

6. *Coastal Areas: Climate Impacts on Coastal Areas*, ENVTL. PROT. AGENCY, <http://www.epa.gov/climatechange/impacts-adaptation/coasts.html> (last updated Sept. 9, 2013) (showing individuals tend to reside in coastal areas).

7. Goldenberg, *supra* note 3 (providing information on vulnerability of many Americans to relatively small increases in sea levels).

8. Zane Gresham & Miles Imwalle, *Sea Level Rise: Regulatory Responses in San Francisco Bay and Across the Globe*, 43 NO. 3 ABA TRENDS 10, 10 (January/February 2012) (providing statistic on how global population may be affected by sea level rise).

9. Brad Plumer, *Can We Stop the Seas from Rising? Yes, but Less than You Think.*, WASH. POST (Nov. 1, 2012, 9:45 AM), <http://www.washingtonpost.com/blogs/wonkblog/wp/2012/11/01/can-we-stop-the-seas-from-rising-yes-but-less-than-you-think/> [hereinafter *Can We Stop the Seas from Rising*] (noting sea level increase since 1900).

10. Nat'l Oceanic and Atmospheric Admin.'s Nat'l Ocean Serv., *Frequently Asked Questions, IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, NOAA'S NAT'L OCEAN SERV., 1-2 (2007) [hereinafter *IPCC 2007*] available at <http://oceanservice.noaa.gov/education/pd/climate/factsheets/issea.pdf> (predicting sea levels will continue to rise at unprecedented rates).

11. Strauss et al., *supra* note 4, at 4 (analogizing incremental increases in rising sea level to filling up bathtub and how even small increases are sometimes too much).

12. 549 U.S. 497 (2007).

13. *Id.* at 521 (noting harms posed by global warming and recognizing severity of issue at hand).

change solution.¹⁴ For example, the United States chose not to be a party to the original Kyoto Protocol to reduce global emissions of greenhouse gases.¹⁵ The Senate rejected joining the treaty because it did not apply to developing and heavily polluting nations such as China and India.¹⁶ The federal government's reluctance to work toward a solution is also demonstrated by its developmental encouragement in some coastal areas that are most at risk from the dangers of rising sea levels.¹⁷ Individuals who build along the coast often sue the government for the regulatory taking of private property when rising sea levels consume their property.¹⁸ The threat of liability from these takings claims may ultimately "chill government willingness" to react to rising sea levels; however, it is imperative that the government establish a plan to combat the rising sea levels problem.¹⁹ Whether this plan entails hard structures such as sea walls or stronger emissions regulations, the government must respond to this increasingly present issue to prevent the global bathtub from spilling over.²⁰

This Comment examines the risks created by rising sea levels and solutions the United States government can implement to mitigate the potentially catastrophic results. Part II provides a background on the current state of sea levels, the reasons behind the recent increased rate of rising sea levels, and projections for future increases.²¹ Part III looks at the effect of rising sea levels, including

14. For a further discussion of *Massachusetts*, see *infra* notes 105-109. For a further discussion of the government's failure to address global warming and rising sea levels, see *infra* notes 140-144.

15. *Massachusetts*, 549 U.S. at 509 (establishing purpose of Kyoto Protocol).

16. *Id.* (explaining why U.S. did not ratify Kyoto Protocol). For a further discussion of the Kyoto Protocol, see *infra* notes 140-144.

17. Brad Plumer, *Sandy Shows the U.S. is Unprepared for Climate Disasters*, WASH. POST (Oct. 31, 2012, 8:50 AM), <http://www.washingtonpost.com/blogs/wonk-blog/wp/2012/10/31/why-the-united-states-is-so-unprepared-for-climate-disasters/> [hereinafter *Sandy Shows the U.S. is Unprepared for Climate Disasters*] (questioning government's decision to encourage building in areas that will undoubtedly face issues from rising sea levels).

18. Robin Kundis Craig, *Public Trust and Public Necessity Defenses to Takings Liability for Sea Level Rise Responses on the Gulf Coast*, 26 J. LAND USE & ENVTL. L. 395, 398 (Spring 2011) (recognizing possibility that rising sea levels may lead to increase in regulatory takings claims brought by individuals against U.S. government). For a further discussion of regulatory takings claims, see *infra* notes 145-161.

19. Craig, *supra* note 18, at 398 (posing possibility that threat of litigation may lead to government inaction with respect to rising sea levels).

20. For a further discussion of actions the government could take in response to rising sea levels, see *infra* notes 162-212 and accompanying text.

21. For a further discussion of the cause of rising sea levels and projections for the future, see *infra* notes 25-73 and accompanying text.

its impact on tropical storms, surges, and the potential devastation that could occur.²² Part IV follows by examining the law's response to the cause of rising sea levels and the potential for constitutional takings claims as a result of land loss.²³ Finally, Part V considers potential solutions to the issue of rising sea levels and what should be done to lessen the devastating effects of a sea level rise on present and future generations.²⁴

II. SEA LEVELS ON THE RISE

According to a study by the National Oceanic and Atmospheric Administration, global sea levels rose between five and nine inches during the twentieth century.²⁵ This abrupt rise followed a relatively stable history of little change in sea levels from 0 AD to 1900.²⁶ Even more alarming than the rise in global sea levels during the twentieth century is the discovery that the average global sea level rise during the past fifteen years was double that of the last century.²⁷ Although many accept the notion that global sea levels are rising, "satellite and hydrographic observations show that sea level is not rising uniformly across the world."²⁸ For example, in coastal Louisiana, sea levels rose by at least eight inches over the last fifty years, an amount slightly greater than double the global rate.²⁹ Sea levels are also increasing faster in the mid-Atlantic region, at a rate of about .1 to .2 inches per year above the global average.³⁰

22. For a further discussion of the effects of rising sea levels including storm surges and hurricane development, see *infra* notes 74-119 and accompanying text.

23. For a further discussion of the law's response to rising sea levels, see *infra* notes 120-161 and accompanying text.

24. For a further discussion of the possible solutions to lessen the effects of rising sea levels, see *infra* notes 162-212 and accompanying text.

25. Gresham & Imwalle, *supra* note 8, at 10 (providing accepted range of sea level increase seen during twentieth century).

26. *IPCC 2007*, *supra* note 10, at 1-2 (detailing why steadily increasing sea levels are concerning).

27. Craig, *supra* note 18, at 396 (identifying drastic changes in sea levels apparent in last fifteen years).

28. *IPCC 2007*, *supra* note 10, at 1 (indicating additional problem that sea levels are not rising uniformly and noting difficulty in helping areas facing challenges resulting from sea level rise).

29. *Coastal Areas*, *supra* note 6 (offering example of drastic fluctuation in sea level compared to global rate).

30. *Id.* (providing examples of areas where sea levels are not rising according to general global rates).

Sea levels are rising as a result of two forces: thermal expansion and land ice melt.³¹ While environmentalists originally attributed rising sea levels mostly to thermal expansion, they recently shifted their theory to reflect that thermal expansion and land ice melt “each account for about half of the observed sea level rise.”³² This increased ice melt leads to greater uncertainty when predicting how high sea levels will rise, with potential amounts for the end of the century ranging anywhere from seven inches to four feet.³³ Whatever the ultimate sea level, the reasonable conclusion is that additional water from both thermal expansion and ice melt has the world quickly approaching its maximum capacity for land-based water storage.³⁴

A. Causes of Rising Sea Levels: Global Warming Strikes Again

Although it is impossible to understand exactly how much thermal expansion and land ice melt contribute individually to rising sea levels, environmentalists agree that these two phenomena are both attributable to the same source: global warming.³⁵ While higher temperatures in North America from 1900 to 1949 were likely due to natural climate variation, a report by the Climate Change Science Program concluded that “changes between 1950 and 1999 were unlikely to be due only to natural climate variations.”³⁶ Temperature changes resulting from global warming

31. Craig, *supra* note 18, at 396 (stating two accepted reasons for sea level rise and connecting thermal expansion and land ice melt to increasing average global temperatures).

32. IPCC 2007, *supra* note 10, at 1 (explaining shift in environmentalists' theory for sea level rise).

33. Craig, *supra* note 18, at 396 (indicating difficulty in predicting how high sea levels will rise because of uncertainties over melting ice caps); see also *Sea Level Rise: New York Projections & Impacts*, N.Y. DEP'T OF ENVTL. CONSERVATION, <http://www.dec.ny.gov/energy/45202.html> (last visited Nov. 6, 2013) (examining 2007 study by IPCC, which did not take into account rapid melt of land-based ice and still predicted that sea levels will likely rise between seven and twenty-three inches by 2100); Brad Plumer, *Which Cities Get Hit Hardest by Rising Sea Levels?*, WASH. POST (Oct. 13, 2011, 9:50 AM), http://www.washingtonpost.com/blogs/wonkblog/post/which-cities-get-screwed-by-rising-sea-levels/2011/10/13/gIQAPZrNhL_blog.html [hereinafter *Which Cities Get Hit Hardest by Rising Sea Levels?*] (stating many scientists predict ice caps will melt at rates causing sea levels to rise three to four feet by 2100).

34. IPCC 2007, *supra* note 10, at 1-2 (hinting that no matter what rate sea levels rise, sea levels are getting dangerously close to natural limits without causing extreme amounts of damage).

35. Craig, *supra* note 18, at 396 (explaining that both thermal expansion, causing existing sea waters to expand, and land ice melt, adding additional water to global water supply, stem from global warming).

36. Robert L. Glicksman, *Global Climate Change and the Risks to Coastal Areas from Hurricanes and Rising Sea Levels: The Costs of Doing Nothing*, 52 LOY. L. REV.

cause sea levels to rise as ocean water temperatures increase and land ice melts away.³⁷

1. Thermal Expansion

Thermal expansion occurs when increased air temperatures heat ocean waters, thereby expanding the ocean's volume.³⁸ As a result of global warming, environmentalists expect coastal waters to continue to warm by as much as eight degrees Fahrenheit during the twenty-first century.³⁹ With this rise in temperature, the seawater will increase in volume and inevitably lead to higher sea levels.⁴⁰ According to a 2007 study by the Intergovernmental Panel on Climate Change (IPCC), global warming alone could raise sea levels worldwide by almost two feet over the next century.⁴¹ Global warming not only leads to coastal flooding and land loss, but it also puts many ecosystems at risk because certain species are incapable of surviving at elevated temperatures.⁴² As a result, thermal expansion provides a dangerous source of sea level rise that threatens coastal states across the globe, even without the companion threat of rapid ice melt.⁴³

1127, 1131 (Winter 2006) (concluding large amounts of climate change could not simply be attributable to natural changes, but resulted from some sort of global warming).

37. Craig, *supra* note 18, at 396 (explaining why increased temperatures from global warming are causing unprecedented rise in sea levels).

38. *Id.* (explaining thermal expansion process).

39. *Coastal Areas*, *supra* note 6 (predicting higher ocean temperatures within this century).

40. See Bob Weber, *Greenlandic, Antarctic Ice Sheets Contributing More to Sea Level Rise: Study*, CTV NEWS (Nov. 29, 2012), <http://winnipeg.ctvnews.ca/greenlandic-antarctic-ice-sheets-contributing-more-to-sea-level-rise-study-1.1059369> (stating that part of sea level rise is attributable to increase in water volume that results from higher ocean temperatures).

41. Vergano, *supra* note 5 (summarizing IPCC's estimated impact on sea levels from thermal expansion alone).

42. *Coastal Areas*, *supra* note 6 (discussing additional impacts that could result as sea temperatures continue to rise).

43. See *Sea Level Rise*, *supra* note 33 (providing projection figures for sea level rise with only thermal expansion, and then also with rapid ice melt scenario). Although scientists are unsure about the impact ice melt will have on future sea levels, they do not seem to dispute that thermal expansion will continue to have an evident effect on sea level rise. See Craig, *supra* note 18, at 397 (declaring that despite uncertainties about land ice melt, scientists predict global average sea levels will increase by two feet or more by 2100). In giving its predictions for sea level rise in two regions of New York, the New York State Sea Level Rise Task Force (SLRTF) provided estimations based on just model-based probabilities of greenhouse gas emissions leading to overall higher temperatures, as well as estimations of sea level rise with rapid ice-melt scenario based on acceleration of recent rates of land ice melt. *Sea Level Rise*, *supra* note 33 (giving projections of future sea level amounts that are almost guaranteed with thermal expansion compared to esti-

2. *Land and Sea Ice Melt*

While the effect of thermal expansion on rising sea levels is well understood, the effects of land ice melt on sea levels remains less certain.⁴⁴ Like its effect on ocean water temperature, global warming severely impacts land ice, “attacking glaciers and polar ice sheets, pouring meltwater and icebergs into the sea.”⁴⁵ Ice sheet reduction occurs in both hemispheres, as Antarctica and Greenland are both losing ice at a pace three times that in the 1990s.⁴⁶ Greenland’s land ice melt rate is particularly frightening, as it “has gone from [fifty-five] billion tons a year in the 1990s to nearly 290 billion tons a year recently.”⁴⁷ If this excessive melt rate continues and “the entire Greenland ice sheet melts, as it may do, global sea levels are expected to rise by about seven meters,” or roughly twenty-three feet.⁴⁸

Increasing the dangers of this excessive ice melt rate is the fact that current methods of dealing with ice melt may not provide nations with the information they need to put proper policies and protections in place.⁴⁹ While the IPCC initially “assumed that Antarctica [would] gain enough (ice) mass to compensate for Greenland ice loss,” new studies show “the ice sheets in [both] Greenland and Antarctica are increasingly losing mass.”⁵⁰ Contrary to IPCC projections, there is no counterbalance to the loss of either ice

mats that are predicted due to ice melt). While projections considering both thermal expansion and rapid ice melt are obviously higher, the projected amounts of sea level increase due to thermal expansion alone are no doubt threatening to everyday life in those areas. *Id.*

44. See Craig, *supra* note 18, at 396 (recognizing thermal expansion and land ice melt both impact sea levels, but questioning how much land ice melt will impact future sea level rise).

45. Strauss et al., *supra* note 4, at 3 (explaining effect global warming has on land ice and how this effect leads to increased sea levels).

46. Miguel Llanos, *Antarctica, Greenland Ice Definitely Melting into Sea, and Speeding Up, Experts Warn*, NBC NEWS (Nov. 29, 2012, 3:27 PM), http://worldnews.nbcnews.com/_news/2012/11/29/15518574-antarctica-greenland-ice-definitely-melting-into-sea-and-speeding-up-experts-warn?lite&ocid=msnhp&pos=1 [hereinafter *Antarctica, Greenland Ice*] (highlighting that land ice melt is not concentrating in any one area and is speeding up at unprecedented rates).

47. *Id.* (providing astounding figures on Greenland’s current ice melt rate).

48. Glicksman, *supra* note 36, at 1139 (warning that if Greenland continues to melt at its current pace, oceans will rise at unprecedented rates).

49. Miguel Llanos, *Sea Level Rose 60 Percent Faster Than UN Projections, Study Finds*, NBC NEWS (Nov. 28, 2012, 2:05 PM), http://worldnews.nbcnews.com/_news/2012/11/28/15512957-sea-level-rose-60-percent-faster-than-un-projections-study-finds?lite [hereinafter *Sea Level Rose 60 Percent*] (asserting United Nations’ projections may be too conservative).

50. *Id.* (internal quotation marks omitted) (highlighting IPCC’s incorrect assumptions, which result in much lower projections for sea level increase than actually experienced).

sheet.⁵¹ As a result, the loss of ice from these sheets contributes to rising sea levels even more than originally projected.⁵²

In addition to the loss of land ice, there is evidence that increased air temperatures lead to decreased sea ice.⁵³ Over the past thirty years, summer sea ice declined at a rate of about forty percent and lost significant volume, which now exists as seawater.⁵⁴ Sea ice levels around the North Pole are currently at “a new record low” as a consequence of the loss of sea ice of “an area bigger than the United States.”⁵⁵ At this rate, researchers predict the world is “on track to see an ice-free summer by 2030.”⁵⁶ This sea ice loss poses additional threats by means of thermal expansion because sea ice melting exposes more of the ocean to sunlight, thus leading to darker ocean surfaces that absorb sunlight and warm the region even further.⁵⁷

B. Predictions for the Future: A Grim Outlook

As the world continues to experience higher temperatures leading to greater thermal expansion and ice melt, future sea level predictions are troubling.⁵⁸ In 2007, the IPCC estimated sea levels will rise between seven and twenty-three inches this century, creating “worsen[ed] coastal flooding and erosion during storm

51. See Weber, *supra* note 40 (explaining how IPCC projections can be so incorrect).

52. *Id.* (noting that because land ice is melting faster than expected it is adding to increasing sea levels more than originally projected).

53. See Glicksman, *supra* note 36, at 1137 (providing result of Arctic Council's 2004 report, which found that annual sea ice declined by about eight percent since 1974). The report further predicts “[s]ummer sea ice may completely disappear by the end of the century.” *Id.*

54. See Brad Plumer, *Arctic Sea Ice Hit a Record Low in 2012. Here's Why It Matters.*, WASH. POST (Aug. 28, 2012, 1:38 PM), <http://www.washingtonpost.com/blogs/wonkblog/wp/2012/08/28/arctic-sea-ice-just-hit-a-record-low-heres-why-it-matters/> [hereinafter *Arctic Sea Ice Hit a Record Low*] (reasoning that Arctic sea ice is shrinking each year, and if it continues at this pace, it will soon disappear during summer months).

55. Weber, *supra* note 40 (internal quotation marks omitted) (explaining United Nations weather agency's conclusions that 2012's loss from March to September was 11.83 million square kilometers).

56. *Arctic Sea Ice Hit a Record Low*, *supra* note 54 (predicting potential consequences of increased temperatures on current and foreseeable future levels of sea ice).

57. *Id.* (concluding that ice-free summers present risks in form of loss of ice-mass that turns into sea water, and thermal expansion, which results from waters previously covered by ice becoming exposed to warming sunlight).

58. See *Antarctica, Greenland Ice*, *supra* note 46 (expressing experts' fears that further warming will accelerate polar melt and lead to unimagined sea level rise, yielding catastrophic results).

surges.”⁵⁹ This prediction is likely inaccurate, however, considering sea levels rose at a rate sixty-percent faster than the IPCC’s projected rate for 1993 to 2011.⁶⁰ Environmentalists look at this excessively low past prediction and infer “that IPCC sea-level projections for the future may also be biased low.”⁶¹

Although many environmentalists stress this IPCC projection is low, some courts and agencies remain unwilling to recognize the excessive dangers of any sea level rise higher than the IPCC’s projection.⁶² In *Ballona Wetlands Land Trust v. City of Los Angeles*,⁶³ Ballona Wetlands Land Trust (Trust) challenged a revised environmental impact report for a proposed coastal project.⁶⁴ The Trust cautioned against taking on projects in coastal areas, citing a paper by the California Climate Change Center that noted the risks of such projects to inhabitants of coastal areas.⁶⁵ Entitled “The Impacts of Sea-Level Rise on the California Coast,” the paper warned developers of the risks of “a significant sea level rise . . . as a result of global climate change.”⁶⁶ In response, the City of Los Angeles stated that the paper’s sea level projection “represented an extreme worst case scenario, relied on a faulty methodology, and overstated the flood risk.”⁶⁷ Providing a report from an engineer rather than an environmentalist, the city claimed that the IPCC’s significantly lower projection provided a “more reliable estimate[] of sea level rise,” than the Trust’s projection.⁶⁸ Finding for the city, the court

59. See *Sea Level Rise 60 Percent*, *supra* note 49 (indicating current estimates by IPCC for twenty-first century sea level rise and noting that even this modest estimate would have devastating results).

60. *Id.* (noting previous estimates for sea level rise from 1993 to 2011 were extremely off-base).

61. *Id.* (internal quotation marks omitted) (providing logical rationale for why experts are hesitant to agree with IPCC’s current projections because past projections were overwhelmingly incorrect).

62. See *Ballona Wetlands Land Trust v. City of L.A.*, 134 Cal. Rptr. 3d 194, 209 (Cal. Ct. App. 2011) (holding IPCC provides reliable sea level rise estimates, and that projects considering future sea level rise should use IPCC estimates, rather than other higher estimates, for projected future levels).

63. 134 Cal. Rptr. 3d 194 (Cal. Ct. App. 2011).

64. *Id.* (presenting objections to coastal projects due to negative environmental impacts including inundations of coastal areas).

65. *Id.* at 206 (detailing study used to prove defendants’ environmental impact report for proposed coastal development project had flawed projections).

66. See *id.* (highlighting evidence from environmental report indicating flooding associated with sea level rise).

67. *Id.* (relating defendant’s reply to contention that sea level rise is occurring at rates that would directly impact project in question).

68. *Ballona*, 134 Cal. Rptr. 3d at 206 (specifying process used by defendant to undermine plaintiff’s credited assertion that sea levels are rising at significant rates due to global warming).

concluded that the IPCC projections provided an adequate estimate of sea level rise for the environmental impact report and subsequently permitted the coastal development.⁶⁹

Other courts faced with the issue of rising sea levels should recognize, contrary to the result in *Ballona*, that the IPCC's prediction for the coming century may be excessively low because it does not factor in a possible ice melt acceleration.⁷⁰ The general opinion of environmentalists is that sea level rise over the next century is going to be far worse than indicated by the IPCC's projections.⁷¹ The IPCC's excessively conservative projections pose serious implications for coastal areas around the United States where water levels are increasing at rates higher than the global average.⁷² Without accurately estimating the actual figures for potential sea level increases, these areas will be unprepared for the imminent danger that lies ahead.⁷³

III. SEA LEVELS CHANGING THE WORLD AS WE KNOW IT

Because so many people in the United States and throughout the world live in low-lying coastal areas, the potential for widespread damage from sea level rise poses a considerable threat.⁷⁴ Although the exact rate of sea level rise is uncertain, the risks it poses are more predictable.⁷⁵ In the United States alone, well over "\$7 trillion in assets [may be] vulnerable to severe coastal flooding by 2070."⁷⁶ In Maryland, Virginia, and North Carolina, for example, a one-and-a-half foot rise "would mean the periodic swamping of

69. *Id.* at 209 (concluding IPCC provided sufficient basis to make determinations for environmental impact reports).

70. *See Antarctica, Greenland Ice, supra* note 46 (explaining that IPCC projections, which do not consider recently drastic increases in ice melt, may be extremely off-base and provide predictions that are much lower than what may actually occur).

71. Goldenberg, *supra* note 3 (reiterating conclusions drawn by experts who believe that IPCC projections are incorrect).

72. *Id.* (setting forth potential dangers to areas known as "hotspots" where sea levels increase at rates twice that of most other areas and lead to situations where these areas are unprepared).

73. *See id.* (indicating that preparation by coastal areas for increased sea levels will not be adequate because IPCC estimates used by coastal areas are too low).

74. *See Sea Level Rise, supra* note 33 (identifying serious threat to coastal communities and natural resources posed by rising sea levels both worldwide and domestically in coastal areas such as New York City). For a further discussion of the tendency of both U.S. citizens and people across the globe to live in coastal areas, see *supra* notes 6 and 8 and accompanying text.

75. *Which Cities Get Hit Hardest by Rising Sea Levels?, supra* note 33 (recognizing that although future sea levels are uncertain, risks are known).

76. *Id.* (providing statistics from Organisation for Economic Co-operation and Development's 2007 study reporting that Miami, New York City, Newark, New

more than 400 miles of major roads and highways, 150 miles of railroad, and one-third of the land base of the . . . major ports.”⁷⁷ Rising sea levels may also destroy coastal ecosystems anywhere from New York City to New Orleans.⁷⁸ Both the Eastern Seaboard and the Gulf Coast experience high erosion levels.⁷⁹ In these areas, rising sea levels consume coastal wetlands that otherwise protect nearby cities, exposing those areas to increased damage from more intense hurricanes.⁸⁰

As the dangers of coastal flooding and ecosystem destruction increase with rising sea levels, threats from hurricanes and storm surges also increase.⁸¹ Evidenced by the catastrophic damage caused by hurricanes Katrina and Sandy, these storms have the potential to destroy coastal areas and cause loss of life, property, and economic stability from which recovery is extremely difficult, if not impossible.⁸² Hurricane storm surges are especially dangerous be-

Orleans, and Virginia Beach are extremely vulnerable to coastal flooding and have seven trillion dollars in combined assets exposed to flood damage).

77. Steve Nash, *Waterworld*, THE NEW REPUBLIC (Sept. 24, 2010), <http://www.tnr.com/article/environment-energy/magazine/77388/waterworld> (setting forth possible consequences of rising sea levels, which would impact every day activities that many do not consider to be at risk from rising sea levels).

78. See *Sea Level Rise*, *supra* note 33 (addressing Union of Concerned Scientists’ 2007 *Northeast Climate Impacts Assessment*); see also Glicksman, *supra* note 36, at 1141 (highlighting increased dangers to New Orleans area from rising sea levels). The Union of Concerned Scientists’ study stated that as sea levels rise, risks of severe floods increase, beaches suffer increased erosion, salt-water can infiltrate surface waters and aquifers, and transportation, septic, sewage, and water treatment systems become at risk from flooding and erosion. *Sea Level Rise*, *supra* note 33.

79. Gresham & Imwalle, *supra* note 8, at 11 (stating rates at which these areas are losing land due to rising sea levels).

80. Glicksman, *supra* note 36, at 1141 (indicating IPCC projections for rising sea levels could lead to elimination of as much as forty-three percent of coastal wetlands, which would cause coastal cities to lose much needed natural protection from hurricanes).

81. See *Sandy Shows the U.S. is Unprepared for Climate Disasters*, *supra* note 17 (noting that as sea levels rise, storm surges and dangers from storms will become more severe).

82. See Glicksman, *supra* note 36, at 1156 (relaying devastating effects of Hurricane Katrina’s 2005 landfall); see also Michael Gormley, *Flood Walls For Subways: New York Commission’s Report Urges Safeguards Against Storms Like Sandy*, HUFFINGTON POST (Jan. 12, 2013, 1:06 AM), http://www.huffingtonpost.com/2013/01/12/flood-walls-for-subways-new-york-commission-sandy_n_2463007.html (discussing Sandy’s unprecedented effects, causing at least 120 deaths and leading to New York’s Governor Andrew Cuomo request for sixty billion dollars in federal relief funds for that state alone). Hurricane Katrina caused the deaths of more than 1,300 people, displaced more than one million people from their homes, and caused \$125 billion in economic damage, of which only \$45 billion was insured. Glicksman, *supra* note 36, at 1156 (indicating devastating effects of Hurricane Katrina).

cause they “flood low-lying areas, damage property, disrupt transportation systems, destroy habitat[s], and threaten human health and safety.”⁸³ Compounding the catastrophic effects of hurricanes and storm surges with the already significant dangers of rising sea levels creates a situation where heavily populated areas across the globe could disappear altogether.⁸⁴

A. Hurricanes Become More Dangerous

Although there is currently a debate over the relationship between global climate change and hurricane activity, scientists generally believe “[s]ea level rise is raising the launch pad for storms and high tides.”⁸⁵ In *Comer v. Murphy Oil*,⁸⁶ property owners sued numerous oil, coal, electric, and chemical companies alleging these companies’ activities caused global warming, which “led to high sea surface temperatures and sea level rise that fueled Hurricane Katrina,” thereby damaging claimants’ property.⁸⁷ The property owners further argued that these companies should be held strictly liable because “their actions . . . increased and will continue to increase the risk of more intense tropical cyclones and other storms, as well as sea level rise (through melting of glacial ice and thermal expansion) in the immediate future.”⁸⁸ In analyzing this claim, the District Court for the Southern District of Mississippi stated “plaintiffs must show that the defendants’ emissions caused or contributed to the specific damages they suffered during Hurricane Katrina.”⁸⁹ The court further reasoned that:

At most, the plaintiffs can argue that the types of emissions released by the defendants, when combined with

83. *Coastal Areas: Climate Impacts on Coastal Areas*, *supra* note 6 (noting dangerous consequences of storm surges).

84. *Can We Stop the Seas from Rising*, *supra* note 9 (concluding that if emissions continue to go unchecked, areas such as South Florida, New Orleans, Shanghai, the Netherlands, and Bangladesh will be completely underwater by 2300).

85. Strauss et al., *supra* note 4, at 4 (explaining severe storms bring high water levels that are indicative of future permanent heights); *see also* Glicksman, *supra* note 36, at 1155 (indicating it is unlikely that conclusions regarding global warming’s effect on hurricane activity will be drawn anytime soon).

86. 839 F. Supp. 2d 849 (S.D. Miss. 2012).

87. *Id.* at 854 (noting plaintiffs’ claim against defendants for public and private nuisance, trespass, and negligence resulting from damage to property caused by Hurricane Katrina).

88. *Id.* (providing plaintiffs’ alternative claim that even if defendants are not directly responsible, their general actions put plaintiffs at greater risk of harm, and defendants therefore need to compensate plaintiffs).

89. *Id.* at 862 (setting forth necessary requirements for plaintiffs to have standing).

similar emissions released over an extended period of time by innumerable manmade and naturally-occurring sources encompassing the entire planet, may have contributed to global warming, which caused sea temperatures to rise, which in turn caused glaciers and icebergs to melt, which caused sea levels to rise, which may have strengthened Hurricane Katrina, which damaged the plaintiffs' property.⁹⁰

Because the court found this causal connection too tenuous, it held the property owners' injuries from Hurricane Katrina and the alleged rise in sea level did not give them standing to pursue the claim against these companies.⁹¹ Although the property owners in *Comer* were unsuccessful, the court did not rule out the plausibility of a connection between sea level rise and higher hurricane intensity.⁹²

Following the court's analysis in *Comer*, there is an increasing consensus that rising sea surface temperatures, which lead to higher sea levels, "may well be causing hurricanes to become more intense over time."⁹³ Elevated water temperatures may result in a five to ten percent increase in wind speeds, and experts predict even this slight increase will double the annual cost of damage from hurricanes in the United States.⁹⁴ Hurricane Katrina's landfall in 2005 resulted in more than 1,300 deaths and "displaced more than a million people from their homes."⁹⁵ In 2012, Hurricane Sandy's

90. *Id.* at 861 (setting forth causal chain provided by plaintiffs to prove they had standing). The court recognized the EPA's findings that "greenhouse gases contribute to global warming, which in turn creates a danger for rising sea levels and extreme weather events," but it stated that this itself does not provide adequate support to prove the damage to the plaintiffs' property is fairly traceable to defendants' emissions. *Id.* at 860-61.

91. *Comer*, 839 F. Supp. 2d at 862 (explaining why court denied plaintiffs standing in this case).

92. *Id.* at 864 (reasoning that requiring fact finder to make determinations about dangers from emissions would be nearly impossible without making policy determinations, which are reserved for legislators and agencies). The court explained that Congress designated the EPA to determine effects of emissions, and that courts lack the scientific knowledge necessary to make decisions on relationships between emissions and environmental events, such as increased hurricane intensity as a result of rising sea levels. *See id.*

93. Glicksman, *supra* note 36, at 1139-40 (identifying perceived connection between rising sea temperatures and hurricane activity).

94. *See id.* at 1145 (explaining how increasing water temperatures, which result in thermal expansion and thus rising sea levels, increase hurricanes' intensity by means of higher wind speeds which produce more damage).

95. *Id.* at 1155 (relaying Hurricane Katrina's deadly and unimaginable effects).

assault on the Eastern Seaboard resulted in more than 120 deaths, submerged thousands of homes, and knocked out electricity to over two million households.⁹⁶ As sea levels continue to rise and storms continue to intensify, a “Hurricane Sandy” that arrives in 2100 could be truly catastrophic.⁹⁷

B. Storm Surges

Hurricane Sandy was such a devastating storm partially because it produced an extremely strong storm surge in a vastly populated region.⁹⁸ A storm surge occurs when a large amount of seawater is pushed onshore by the storm’s strong winds and low atmospheric pressure.⁹⁹ Hurricanes in the Atlantic Ocean can already produce storm surges of up to sixteen feet above normal tide levels, and in the Gulf of Mexico, Hurricane Katrina produced a storm surge twenty-five to twenty-eight feet above normal tide levels.¹⁰⁰ The risks posed by storm surges are not only apparent during massive storms such as Sandy and Katrina, but also during smaller storms.¹⁰¹ With rising sea levels, storm surges threaten more and more people, as “scientists predict that a one-half meter rise in sea level would place six times more people at risk from storm surges.”¹⁰²

96. Gormley, *supra* note 82 (identifying some of Hurricane Sandy’s devastating consequences).

97. See Michael D. Lemonick, *Sandy’s Storm Surge Explained and Why It Matters*, CLIMATE CENTRAL (Oct. 29, 2012), <http://www.climatecentral.org/news/hurricane-sandys-storm-surge-explained-and-why-it-matters-15182> (asserting sea level rise greatly increases threats from storms such as Hurricane Sandy).

98. See Vergano, *supra* note 5 (recognizing impact of Hurricane Sandy’s storm surge, which resulted from warmer sea temperatures, and referencing locations such as Lower Manhattan, where Sandy’s storm surge of fourteen feet produced debilitating consequences).

99. Lemonick, *supra* note 97 (explaining that storm surges come as great amounts of water spread out in wide areas in front of storms, resulting in widespread flooding even before storms make landfall). Included within a storm surge is the added “fact that water can’t drain back off into the ocean because there’s more water pushing from behind.” *Id.*

100. Nash, *supra* note 77 (providing 2010 data that Atlantic hurricanes can potentially produce storm surges of sixteen feet); see also *Storm Surge Overview*, NATIONAL HURRICANE CENTER, <http://www.nhc.noaa.gov/surge> (last modified June 3, 2013) (highlighting notable surge events and detailing high surge levels associated with Hurricane Katrina).

101. Brad Plumer, *Yes, Hurricane Sandy is a Good Reason to Worry About Climate Change*, WASH. POST (Oct. 29, 2012, 3:34 PM), <http://www.washingtonpost.com/blogs/wonkblog/wp/2012/10/29/yes-hurricane-sandy-is-a-good-reason-to-worry-about-climate-change/> [hereinafter *Yes, Hurricane Sandy is a Good Reason to Worry About Climate Change*] (noting storm surges are not just connected to hurricanes, but can accompany smaller storms).

102. Marc R. Poirier, *A Very Clear Blue Line: Behavior Economics, Public Choice, Public Art and Sea Level Rise*, 16 SOUTHEASTERN ENVTL. L.J. 83, 90 (Fall 2007) (relay-

Rising sea levels dramatically increase the potential of flooding from storm surges and add to overall water mass, as a single cubic yard of water weighs nearly a ton.¹⁰³ As sea levels continue to rise and additional “cubic yards[] . . . of ocean mov[e] inexorably onto land in a pulse that could last a day or more, the crushing force involved [in these storm surges] is nearly impossible to imagine.”¹⁰⁴

C. What Could Disappear?

In *Massachusetts*, the Supreme Court directly recognized a loss of Massachusetts’ coastal land as a consequence of global warming and rising sea levels.¹⁰⁵ In that case, the Commonwealth of Massachusetts, local governments, and environmental organizations challenged the Environmental Protection Agency’s (EPA) decision to refrain from regulating motor vehicle emissions known to increase global warming.¹⁰⁶ The Court noted that Massachusetts owns a substantial portion of coastal property, and that “[i]f sea levels continue to rise as predicted . . . a significant fraction of coastal property will be ‘either permanently lost through inundation or temporarily lost through periodic storm surge and flooding events.’”¹⁰⁷ Because of this direct harm through property loss, the Court found “the rise in sea levels associated with global warming has already harmed and will continue to harm Massachusetts,” and

ing scientific prediction that sea level rise of one-half meter would pose storm surge risks to millions of additional people).

103. Strauss et al., *supra* note 4, at 4 (recognizing impact that rising sea levels have on risk of damage resulting from storm surges); see also Lemonick, *supra* note 97 (indicating weight of water that moves onshore with surge).

104. Lemonick, *supra* note 97 (attempting to explain effects of storm surges where overwhelming amounts of water force way onshore).

105. See *Massachusetts v. EPA*, 549 U.S. 497, 519 (2007) (reasoning that because Massachusetts owns a great deal of territory claimed to be affected, it has sufficient stake to warrant regulation). The Supreme Court, noting the connection between emission levels and global warming, which leads to increased sea levels and coastal land loss, concluded the “EPA’s steadfast refusal to regulate greenhouse gas emissions presents a risk of harm to Massachusetts that is both ‘actual’ and ‘imminent.’” *Id.* at 521 (citing *Lujan v. Defenders of Wildlife*, 504 U.S. 555, 560 (1992)).

106. *Id.* at 498 (summarizing petitioners’ claim that EPA’s Clean Air Act provides for regulation of these emissions). In response to the petitioners’ claims, the EPA argued that its decision not to regulate motor vehicle emissions is insignificant in the scope of global warming, “and that there is no realistic possibility that the relief sought would mitigate global climate change and remedy petitioners’ injuries.” *Id.* at 499. The Court rejected the EPA’s argument on the basis that the risk of harm would be reduced to some extent if the EPA regulated these emissions. *Id.* at 526.

107. *Id.* at 522-23 (quoting one of petitioners’ unchallenged affidavits explaining how severity of harm to Massachusetts from global warming is increasing as seas continue to rise).

held the EPA must work to reduce that risk effectively.¹⁰⁸ Addressing the EPA's failure to regulate certain emissions, the Court warned of the risk of catastrophic harm that could result from rising sea levels associated with global warming.¹⁰⁹

While the Supreme Court found the risk of loss of Massachusetts' coastal land to be "remote, [but] nevertheless real," other states and nations may be at risk of a harsher, more proximate loss.¹¹⁰ In North America, a three-foot rise could drown many coastal wetlands, flood New York City annually, and inundate a significant portion of New Orleans.¹¹¹ From a global perspective, a rise in sea levels of just three feet would lead to the destruction of some small island nations and severely threaten low-lying cities including London, Venice, and Tokyo.¹¹² As sea levels rise, the possibility of a large storm surge increases, exposing low-lying areas to further destructive flooding that could decimate these areas altogether.¹¹³

The average shoreline is currently eroding at a rate of two to three feet per year along the East Coast and at a rate exceeding four feet per year along the Gulf Coast.¹¹⁴ Losing these coastal areas means the loss of coastal wetlands, which exacerbates the risk of damage to many coastal cities.¹¹⁵ In Norfolk, Virginia, home of the world's largest naval base, a two-foot rise in sea levels would effec-

108. *Id.* at 526 (noting rising sea levels already harmed and will continue to harm Massachusetts unless something is done to stop rising sea levels).

109. *See id.* (recognizing risks posed by rising sea levels are real and can be reduced if EPA complies with petitioners' request for regulation of these emissions).

110. *Massachusetts*, 549 U.S. at 526 (maintaining that although risk of coastal land loss is remote, it should be considered).

111. *See Poirier*, *supra* note 102, at 90 (identifying risks posed to North America's coastal wetlands which currently serve as protective barriers from coastal storms); *see also Glicksman*, *supra* note 36, at 1140-41 (explaining potential dangers from sea level rise pose significant threats to New York and catastrophic threats to New Orleans).

112. *See Poirier*, *supra* note 102, at 89-90 (relaying consequences of relatively slight increases in sea levels which could have disastrous consequences for many individuals in multiple nations).

113. *See Yes, Hurricane Sandy is a Good Reason to Worry About Climate Change*, *supra* note 101 (noting that as sea levels rise, storms and subsequent flooding that were once considered freak events are now casual occurrences).

114. Gresham & Imwalle, *supra* note 8, at 11 (noting current rates of erosion plaguing coastal communities).

115. *See Glicksman*, *supra* note 36, at 1141 (indicating that rising sea levels could eliminate forty-three percent of North America's coastal wetlands). Because these coastal wetlands serve as protective barriers for many cities, the loss of wetlands exposes cities to even more potential damage from hurricanes. *Id.*

tively inundate low-lying parts of the city.¹¹⁶ A three-foot rise in sea level in Miami would “likely put all of Miami Beach underwater and turn downtown Miami into an island, channeled off from the rest of Florida.”¹¹⁷ In New York City, a four-foot rise would put thirty-four percent of the city’s 6,300 miles of streets and highways in the flood-risk zone.¹¹⁸ Finally, and most destructively, a five-foot rise in sea level has the potential to flood eighty-eight percent of New Orleans, effectively wiping the city off the map.¹¹⁹

IV. THE LAW’S RESPONSE

Although the government is aware of the threats of rising sea levels, including the potential destruction of cities such as New York City, New Orleans, and Miami, it is doing little to respond to these risks.¹²⁰ Instead of working to minimize coastal cities’ exposure to rising sea levels, “government policies are encouraging development in the areas most vulnerable to sea-level rise.”¹²¹ In Miami, Florida’s government is “racing to subsidize new developments along the coast, through state-run insurance and funding for coastal protection,” while nationwide, the federal government is “*encouraging construction* on coastal property that’s most at risk from sea-level rise.”¹²² As illustrated by Chief Justice Roberts’ dissent in

116. Jennifer Weeks, *Whatever You Call It, Sea Level Rises in Virginia*, SCI. AM. (Aug. 21, 2012), <http://www.scientificamerican.com/article.cfm?id=whatever-you-call-it-sea-level-rises-in-virginia> (highlighting that continued rising sea levels threaten coastal cities with increased flooding). City maps of Norfolk currently show that the entire city would be submerged by a Category Three Hurricane. *Id.*

117. *Which Cities Get Hit Hardest by Rising Sea Levels?*, *supra* note 33 (giving results of Organisation for Economic Co-operation and Development’s 2011 report and noting report ranks Miami as world’s ninth most vulnerable city to coastal flooding).

118. *Yes, Hurricane Sandy is a Good Reason to Worry About Climate Change*, *supra* note 101 (discussing level of risk posed to New York City by increasing sea levels). Currently, only eleven percent of the city’s streets are considered to be in flood-risk zones. *Id.*

119. *What Could Disappear*, N.Y. TIMES, <http://www.nytimes.com/interactive/2012/11/24/opinion/sunday/what-could-disappear.html> (last updated Nov. 24, 2012) (providing interactive maps of major U.S. cities that would be permanently flooded if sea levels increase by five, twelve, and twenty-four feet unless cities receive engineered protection).

120. *See Which Cities Get Hit Hardest by Rising Sea Levels?*, *supra* note 33 (discussing that while many nations are taking prudent steps to guard against future flooding, U.S. officials are slow in adapting and are actually making things worse).

121. Nash, *supra* note 77 (citing 2009 study in Environmental Research Letters showing that sixty percent of Atlantic coastline is zoned for additional development, while only ten percent is set aside for preservation).

122. *Which Cities Get Hit Hardest by Rising Sea Levels?*, *supra* note 33 (questioning Florida’s actions of encouraging development in areas that are almost sure to fall victim to rising sea levels); *see also* *Sandy Shows the U.S. is Unprepared for*

Massachusetts, some government officials are still unwilling to acknowledge that sea level rise causes particularly significant and concerning coastland loss.¹²³ Although Congress recognizes the need to prepare for sea level rise, it provides little guidance on how this should be done.¹²⁴ By not fully combating the effects of rising sea levels, the government is creating problems for itself both in the way of regulatory takings claims, and ultimately, the destruction of valuable coastal communities.¹²⁵

A. Corresponding Environmental Legislation, or Lack Thereof

Despite the many possible methods of dealing with rising sea levels, governmental implementation of protective measures is lacking, as “no one seems to agree on whether [the politics of sea level rise are] a local, state, or federal responsibility.”¹²⁶ Partially because of the debate surrounding climate change within the government, Congress largely delegated regulation of rising sea levels to agencies and state governments.¹²⁷ In delegating this responsibility, Congress claims it is working to encourage and assist the states in implementing management programs to “minimize the loss of life

Climate Disasters, *supra* note 17 (analyzing Hurricane Sandy’s impact on getting government actors to make note of climate change, but recognizing that in many areas governments are acting like sea levels are not rising).

123. See *Massachusetts v. EPA*, 549 U.S. 497, 535 (2007) (Roberts, C.J., dissenting) (reasoning that because there is no sound inference of actual loss on behalf of petitioners, their claim of actual loss of Massachusetts coastal land is pure conjecture). Justices Scalia, Thomas, and Alito joined Chief Justice Roberts in his dissent. *Id.* For a further discussion of *Massachusetts*, see *supra* notes 105-109.

124. See 16 U.S.C. § 1451(1) (2012) (providing that coastal states must anticipate and plan for rising sea levels, but setting forth no requirements or suggestions of how to do so).

125. See Joseph L. Sax, *Some Unorthodox Thoughts About Rising Sea Levels, Beach Erosion, and Property Rights*, 11 VT. J. ENVTL. L. 641 (Spring 2010) (noting many claims dealing with rising sea levels arise as regulatory takings claims). For a further discussion of how these coastal communities may be impacted by rising sea levels, see *supra* notes 111-119 and accompanying text.

126. Nash, *supra* note 77 (explaining why sea levels continue to rise without adequate protections put in place). For a further discussion of the ways to deal with rising sea levels, see *infra* notes 162-212.

127. See Sarah Crean, *Storm Surge: An Interview With Climate Change Expert Klaus Jacob On NYC’s Post-Sandy Future*, GOTHAM GAZETTE (Jan. 17, 2013), <http://www.gothamgazette.com/index.php/topics/environment/4149-storm-surge-an-interview-with-climate-change-expert-klaus-jacob-about-nycs-post-sandy-future> (noting present congressional debate over climate change’s existence); see also 16 U.S.C. § 1452(2)(B) (illustrating congressional policy that states should be encouraged to exercise their responsibilities effectively in coastal zones to minimize harms in areas likely to be affected by sea level rise).

and property caused by improper development . . . in areas likely to be affected by or vulnerable to sea level rise.”¹²⁸

Although the potentially devastating effects of rising sea levels generally remain unaddressed by the federal government through lack of legislation, many regulatory agencies are noticing the consequences and starting to take action.¹²⁹ Until recently, however, agency programs were largely ineffective in providing measures to combat the dangers of rising sea levels, and many development projects continued to take place in coastal areas.¹³⁰ For example, in 2009, the Federal Emergency Management Agency (FEMA) “encourage[d] high-risk coastal development by subsidizing flood insurance for property owners” without considering whether any of these projects planned for sea level rise.¹³¹ In response to the devastation from Hurricane Sandy, however, FEMA began “the process of putting out so-called Advisory Base Flood Elevation maps,” which require every new or modified building in flood-prone areas conform to higher elevations or implement other protective measures.¹³² By forcing FEMA to enact these changes, “[Hurricane] Sandy did what Congress didn’t do” to combat the effects of rising sea levels.¹³³

Even before Hurricane Sandy inspired FEMA’s recent recognition of the need to consider rising sea levels, many agencies acted based on Congress’ general directive for coastal states to anticipate and plan for substantial sea level rise.¹³⁴ For example, the San Francisco Bay Conservation and Development Commission (BCDC), which is composed of “representatives of the California

128. 16 U.S.C. § 1452(2)(B) (setting forth basis of congressional policy leading to state implementation of programs designed to combat negative effects of rising sea levels).

129. See Gresham & Imwalle, *supra* note 8, at 10 (highlighting positive response from regulatory agencies to rising sea levels).

130. For a further discussion of the ways the government ignores issues of rising sea levels, see *supra* notes 120 and 125 and accompanying text.

131. Nash, *supra* note 77 (criticizing FEMA policy which encouraged coastal development without taking into consideration potentially devastating consequences of sea level rise on these projects).

132. Crean, *supra* note 127 (explaining FEMA’s effective changes in recognition of Hurricane Sandy’s paralyzing impacts to coastal areas where FEMA previously encouraged development).

133. *Id.* (concluding that without Hurricane Sandy, FEMA’s regulations would have remained unchanged and inadequate with respect to considerations of sea level rise).

134. See 16 U.S.C. § 1451 (2012) (finding global warming potentially causes substantial sea level rise and stressing importance of coastal areas planning for sea level rise). For a further discussion of agency action regarding protections from sea level rise taken prior to Hurricane Sandy regarding protections from sea level rise, see *infra* notes 135-139 and accompanying text.

State Senate and Assembly, various municipalities and counties, as well as representatives of the federal Environmental Protection Agency and the Army Corps of Engineers, the State Lands Commission and State Water Resources Control Board,” is recognized as the United States agency furthest along in the effort to lessen the impact of rising sea levels.¹³⁵ After extensive hearings and negotiations, the BCDC introduced the Bay Plan Amendment (Amendment) in 2011, which requires “shoreline projects to anticipate and plan for sea level rise.”¹³⁶ Under the Amendment, the BCDC will assess shoreline development projects on a case-by-case basis until officials develop a regional strategy.¹³⁷ This assessment will include consideration of a proposed project’s flood risk, resilient design, public benefits, and capacity to adapt to climate change.¹³⁸ To realize the benefits of amendments designed to deal with rising sea levels, the federal government must collaborate with state and local governments to establish comprehensive regional plans.¹³⁹

Although governmental agencies across the country are starting to take compelling action to combat the effects of rising sea levels, the federal government has yet to ratify the Kyoto Protocol and commit to stopping global warming and resulting rising sea levels.¹⁴⁰ Adopted in 1997, the Kyoto Protocol is an international agreement “which commits its Parties by setting internationally binding emission reduction targets.”¹⁴¹ Although the United States

135. Gresham & Imwalle, *supra* note 8, at 10 (noting composure of BCDC and identifying its position regarding regulation of rising sea levels).

136. *Id.* (discussing lengthy process BCDC engaged in resulting in Amendment which requires shoreline projects to consider coastal effects of rising sea levels).

137. *Id.* (highlighting process set forth by Amendment, which prevents projects that harm coastal protections or that take place in areas at risk of rising sea levels). The BCDC recognized that without action to protect the San Francisco Bay coastlines, “sea level rise could threaten 270,000 residents and an estimated \$62 billion in shoreline development” by 2100. *Id.*

138. *Id.* (identifying considerations taken into account by BCDC when making its assessment of whether certain coastline developments should take place).

139. *Id.* at 11 (asserting Congress and other government officials must act to implement comprehensive policies regarding sea level rise in order for any plans or programs taken on by independent organizations or agencies to have full effect).

140. See Gresham & Imwalle, *supra* note 8, at 10 (indicating BCDC was among initial agencies to adopt programs addressing rising sea levels and recognizing that more and more agencies are beginning to implement similar policies); see also Irene !Hoaëš, *Namibia: What Is the Future of Kyoto Protocol?*, ALLAFRICA (Dec. 5, 2012), <http://allafrica.com/stories/201212051374.html> (highlighting that although U.S. officials participated in initial negotiations, United States never officially ratified Kyoto Protocol’s policies).

141. *Kyoto Protocol*, UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://unfccc.int/kyoto_protocol/items/2830.php (last visited Nov. 6,

participated in negotiations of the Kyoto Protocol and signed the agreement, it did not ratify the treaty.¹⁴² It therefore is not bound to follow the mandatory greenhouse gas emission limits set for industrialized nations.¹⁴³ Given the causal connection between greenhouse gas emissions and rising air temperatures, which ultimately cause sea levels to rise, the federal government's disregard of the Kyoto Protocol shows it is not committed to limiting the impact of rising sea levels.¹⁴⁴

B. Regulatory Takings Claims

The federal government's encouragement of development in areas vulnerable to rising sea levels, together with its failure to abide by the emissions standards set forth under the Kyoto Protocol, puts many coastal properties at risk of land loss from rising sea levels.¹⁴⁵ With the substantial and continual increase in sea levels, property owners are eager to act to protect their land, both physically and lawfully.¹⁴⁶ States, as property owners themselves, also have an interest in protecting their rights to occupy and make use

2013) (providing Kyoto Protocol background). On December 8, 2012, the Kyoto Protocol's Parties adopted the "Doha Amendment to the Kyoto Protocol," which commits Parties to reduce greenhouse gas emissions from January 1, 2013 to December 31, 2020. *Id.* The Doha Amendment also confirmed the Parties' decision "to work toward adopting a universal climate change agreement" which would take effect in 2020. See Tim Profeta, *Weaker Kyoto Protocol Extended at International Climate Negotiations*, NAT'L GEOGRAPHIC (Dec. 13, 2012), <http://newswatch.nationalgeographic.com/2012/12/13/weaker-kyoto-protocol-extended-at-international-climate-negotiations> (addressing Kyoto Protocol's current state and what future action needs to be taken). This universal climate change agreement would set emissions goals for all nations, rather than just the "handful of industrialized nations" provided for in the Kyoto Protocol. *Id.* This general application of emission standards to all countries may improve the potential for U.S. ratification since one reason the Senate chose not to ratify the Kyoto Protocol was that it did not apply to "developing and heavily polluting nations such as China and India." See *Massachusetts v. EPA*, 549 U.S. 497, 509 (2007) (explaining why Senate did not ratify Kyoto Protocol).

142. See Glicksman, *supra* note 36, at 1159-60 (summarizing extent of U.S. participation in negotiations to reduce greenhouse gas emissions under Kyoto Protocol and discussing its decision not to ratify treaty). The United States, which is "responsible for about one quarter of total fossil fuel-derived CO₂ emissions," and Australia are the only two major industrialized nations that have not ratified the Kyoto Protocol. *Id.*

143. See *id.* at 1160 (explaining ramifications of United States' decision not to ratify Kyoto Protocol).

144. For a further discussion of how greenhouse gas emissions cause global warming and thereby rising sea levels, see *supra* notes 35-57 and accompanying text.

145. See Sax, *supra* note 125, at 641 (explaining that when issues arise with migrating oceans, they are often posed as regulatory takings claims).

146. *Id.* at 642 (noting when sea levels continue to rise and storms wipe away beach areas, landowners are anxious to protect their property rights).

of the foreshore area between high tide and low tide.¹⁴⁷ The high tide mark of this foreshore area serves as the property line between states' land and neighboring private property owners.¹⁴⁸ As sea levels continue to rise, this property line drifts up, taking away land belonging to private owners and often providing the foundation for takings claims under the Fifth and Fourteenth Amendments to the Constitution.¹⁴⁹ The issue with these takings claims, however, is it is ultimately the sea, and not the government, taking private property, and it is doing so in a way that could substantially and negatively impact long-term public welfare.¹⁵⁰

As recognized in *Massachusetts*, coastal states "own [] a substantial portion of the state's coastal property," and therefore, like private property owners, states have a particularized injury in the land loss that results from rising sea levels.¹⁵¹ As a property owner, a state is eligible to assert its property rights to the foreshore area with the same vigor as any other proprietor who experiences a loss of land.¹⁵² Unlike standard regulatory taking claims where the state is "simply diminishing some pre-existing entitlement that regulated parties . . . enjoyed," claims involving the ocean cause losses to the state equal to those of other property owners and require the state to safeguard its own rights.¹⁵³ As such, "[t]raditional common law rules do not fit contemporary circumstances" because the state's increased right to public ownership and use of the foreshore now

147. *Id.* at 641-43 (explaining seaward of high-tide mark is state government property and detailing state's interest in safe-guarding its existing rights to this land).

148. *Id.* at 641 (addressing how property lines are determined in coastal areas).

149. *Id.* at 641-43 (recognizing that as oceans migrate landward, land established as foreshore migrates into property once owned by private individuals). If the government addressed the problem of rising sea levels and the ocean maintained a generally stable level, private landowners' interests could peacefully coexist with the states' rights to the foreshore. *Id.* at 642. *See also* Craig, *supra* note 18, at 399 (acknowledging governments may not take private property for public use without compensation under Fifth and Fourteenth Amendments).

150. Craig, *supra* note 18, at 435 (addressing why sea level rise is particularly contentious with regard to regulatory takings claims).

151. *Massachusetts v. EPA*, 549 U.S. 497, 522 (2007) (internal quotation marks omitted) (recognizing rising sea levels are not just taking away property from private landowners, but also from state and general public).

152. *See* Sax, *supra* note 125, at 643 (explaining states are victims of land loss resulting from rising sea levels and recognizing that states are entitled to equivalent methods of recovery as those of private land owners).

153. *Id.* (explaining that rising sea levels cause as much loss to states' rights to foreshore areas as they do to rights of individual property owners, and arguing states should receive similar treatment as individual proprietors).

conflicts with upland private owner's defense against rising waters.¹⁵⁴

To address the regulatory takings issue affecting land belonging to both private property owners and states, the federal government must adopt new policies.¹⁵⁵ The consequences of rising sea levels create a "historically distinct situation that is not a good factual fit with the 'background' rules."¹⁵⁶ For example, a traditional public-trust-doctrine-based defense allows the government to assert that the concept of a migratory foreshore area protects public interests and cannot constitute a taking.¹⁵⁷ Although this is an adequate defense, it puts the land-owning government's property rights ahead of private landowners' property rights when theoretically, as neighboring property owners, the two should be treated equally.¹⁵⁸ To prevent this seemingly unfair result, the government needs to implement a "balancing approach that seeks an accommodation sensitive to the fact that both [private owners and the state] have a legitimate interest and are innocent victims of a phenomenon beyond their control."¹⁵⁹ Standard regulatory takings claims asserted by private property owners and countered by the government's public necessity defense do not effectively account for dramatically rising sea levels.¹⁶⁰ Therefore, the law is currently unprepared to respond to regulatory takings claims resulting from rising sea levels,

154. *Id.* at 645 (explaining public use of foreshore areas was not as important in previous eras as it is today). When courts established common law on this topic, the risk of migratory boundaries that moved upward with sea levels was not as threatening to upland owners as this migration is today. *Id.*

155. *Id.* (suggesting how governments should attempt to combat rising sea levels).

156. *Id.* (contending rising sea levels create new kinds of issues that traditional remedies for property loss, such as regulatory takings claims, were not designed to address).

157. *See* Craig, *supra* note 18, at 404 (asserting public trust doctrine provides applicable backdrop for government assertions that public foreshore areas migrate with sea levels).

158. *See* Sax, *supra* note 125, at 643 (declaring governmental interests in coastal areas are identical to those of neighboring private proprietors). Additionally, protective measures are inadequate "where protection of one property interest threatens to swallow the other." *Id.* at 647.

159. *Id.* at 646 (maintaining that to be fair to both parties involved, interests of one cannot take precedent to points where other's interest is completely disregarded). There are two legitimate, pre-existing property rights, and instead of looking at them as mutually exclusive, the property rights of both the state and the individual should be reasonably accommodated. *Id.* at 647.

160. *Id.* at 647 (expressing that constant regulatory takings declarations by private property owners which are then countered by traditional doctrinal uses do not fit well with current issues stemming from property loss resulting from rising sea levels).

and it must adjust to protect the pre-existing rights of both private individuals and public interests in coastal property.¹⁶¹

V. HOW TO STOP THE SEAS FROM SPILLING OVER: A GOVERNMENTAL COMPROMISE

Despite agency action to limit the threats from rising sea levels, the United States is still years behind other nations when it comes to protecting its shorelines from these dangers.¹⁶² While many coastal cities throughout the world have extensive barriers in place to protect against rising sea levels, cities such as New York are completely exposed to the sea without any sort of protection.¹⁶³ Although addressing sea level rise is a task of utmost importance for legislators in the coming decades, the government is at a stand still because responsive actions are extremely expensive and differing opinions exist as to whether regulation of emissions, implementation of hard structures, or strategic retreat is the proper response.¹⁶⁴ As sea levels continue to rise and the amount of necessary protection increases, even “[s]mall changes in sea levels in certain places mean very big changes in the kind of protection of infrastructure [cities] need to have in place.”¹⁶⁵ Even though no particular solution is perfect, the past practice of waiting for catastrophes to occur before building better structures is no longer a

161. *See id.* at 643-45 (indicating current policies that are in place to deal with property loss are not well-suited for takings because sea level rise is not governmental action).

162. *See* Bill Blakemore, *Sea Levels Rising Toward Washington and Other Cities*, ABC News (Oct. 14, 2012, 3:37 PM), <http://abcnews.go.com/blogs/technology/2012/10/sea-level-rising-toward-washington-and-other-cities/> (explaining some sea level cities in places such as Russia and Holland have already built extensive sea walls to protect against threats from rising sea levels). For a further discussion of action taken by agencies to reduce the risks of rising sea levels, *see supra* notes 129-139 and accompanying text.

163. *See* Vergano, *supra* note 5 (quoting urban flooding expert Jeroen Aerts, who was shocked to discover there are not more comprehensive measures in place to protect New York City from dangers of surrounding waters).

164. *See* Gresham & Imwalle, *supra* note 8, at 11 (indicating responsive measures to sea level rise are enormously expensive and require coordinated approaches from all levels of government); *see also* Blakemore, *supra* note 162 (identifying options to deal with sea level rise, including protecting coastlines with hard structures, planning retreats from coastal areas as seas rise, and working to slow sea level rise by attempting to limit manmade global warming).

165. Weber, *supra* note 40 (addressing additional reason why implementing policies that limit threats from rising sea levels is difficult). The amount of mass capable of coming onshore increases with each inch of seawater added, and this creates additional problems that were not considered in initial implementation stages. *Id.*

reasonable solution.¹⁶⁶ Federal, state, and local governments must work together to create a comprehensive plan to respond to the ever rising and unstable sea levels.¹⁶⁷

A. Regulation of Emissions Levels

Examining at the relationship between rising sea levels and global warming, it appears that “in order to avoid the worst impacts, the United States must work to slow sea level rise by reducing emissions of heat-trapping gases.”¹⁶⁸ According to a 2012 study by the National Center on Atmospheric Research, “aggressive steps to cut emissions could reduce the amount of sea-level rise by somewhere between [six] and [twenty] inches” compared to current predictions for the year 2100.¹⁶⁹ The foremost issue is that for these regulations to be effective, the federal government must take leadership in mitigating global warming’s effects as soon as possible.¹⁷⁰ Judging by the federal government’s refusal to comply with the emissions standards set forth in the Kyoto Protocol, it appears unlikely it will act through the EPA to put more aggressive emissions standards in place.¹⁷¹ Additionally, like most plans that deal with rising sea levels, many methods of regulating and lowering greenhouse gases and conserving energy are costly and complex.¹⁷² This leads to hes-

166. See Poirier, *supra* note 102, at 93 (quoting account of law professor Oliver Houck, who stated that since 1960, people have dealt with devastating storms by rebuilding and then assuming these storms will not occur again). The idea that a storm is a once-in-a-lifetime event is an illusory response that leads to improper preparation and failure to consider the possibility of reoccurring weather events. *Id.*

167. See Gresham & Imwalle, *supra* note 8, at 11 (maintaining that to address problems of rising sea levels, all parts of government must work together to find environmental and economic solutions).

168. Strauss et al., *supra* note 4, at 3 (stating there is no way around regulating emissions if we want to curb effects of global warming, which includes rising sea levels).

169. Can We Stop the Seas from Rising, *supra* note 9 (discussing study on how reduced emissions may impact rise in sea level and indicating aggressive reductions are necessary).

170. See Glicksman, *supra* note 36, at 1157 (implying emission regulations must be implemented as federal standards to be effective). Over 700 U.S. cities made pledges to reduce emissions to Kyoto Protocol standards; however, the cities’ contribution does not reach the emission levels required to have a substantial impact. See Poirier, *supra* note 102, at 106 (discussing how some U.S. cities are attempting to change federal policy by seeding cultural and economic shifts).

171. See Glicksman, *supra* note 36, at 1157 (asserting it is unlikely that federal government will take action to mitigate effects of greenhouse gas emissions given government’s position on such emissions, as seen in its refusal to abide by Kyoto Protocol standards).

172. Poirier, *supra* note 102, at 112 (indicating difficulties of implementing emissions regulations to confront global warming and rising sea levels).

itance in implementing any kind of aggressive policies, as the effects of emissions reductions will not be realized for several years.¹⁷³

Despite these shortcomings, policymakers must take meaningful action that will reduce greenhouse gas emissions and thereby lessen the threat posed to low-lying areas from rising sea levels.¹⁷⁴ The longer it takes policymakers to implement more stringent emissions standards, the more difficult and expensive it will be to avoid the adverse consequences of higher sea levels.¹⁷⁵ As the majority opinion in *Massachusetts* noted, “[a] reduction in domestic emissions would slow the pace of global emissions increases, no matter what happens elsewhere.”¹⁷⁶ Even small changes, such as encouraging individuals and businesses to turn thermostats up in the summer and down in the winter, could mitigate global climate change and subsequently slow the process of sea level rise.¹⁷⁷ Cutting emissions now will make modest improvements, but these regulations’ real impact will be experienced in the year 2100 when the effects of rising sea levels could drastically threaten coastal cities.¹⁷⁸ Further, by implementing policies to reduce emissions levels, it is possible to reduce the rate of sea level rise and buy the government time to put other adaptive measures in place, such as hard structures and planned retreat strategies from coastal areas.¹⁷⁹

173. See *Can We Stop the Seas from Rising*, *supra* note 9 (explaining that emissions already released into atmosphere will continue to affect global warming for centuries no matter what actions are taken to reduce these emissions).

174. Glicksman, *supra* note 36, at 1158 (concluding policymakers have no choice but to regulate emissions and that not doing so would prove detrimental to low-lying coastal areas).

175. *Id.* at 1182 (explaining emission regulation strategies must be put in place now to avoid increased costs, global warming’s adverse consequences, and future sea level rise).

176. *Massachusetts v. EPA*, 549 U.S. 497, 500 (2007) (rebutting opposing position that present actions to limit emissions will be ineffective because developing countries are continually increasing their greenhouse gas emissions).

177. Glicksman, *supra* note 36, at 1157 (identifying certain seemingly small changes that could lessen global warming and thereby slow sea levels from rising at such unprecedented levels). The government could also enact necessary limitations on mobile and stationary source emissions; however, the federal government has yet to take this kind of action. *Id.* at 1164.

178. *Can We Stop the Seas from Rising*, *supra* note 9 (maintaining that cutting current emissions will modestly improve current sea levels and provide substantial benefits regarding future sea levels). For a further discussion of the impact that rising sea levels could have for coastal cities in the future, see *supra* notes 111-119 and accompanying text.

179. *Can We Stop the Seas from Rising*, *supra* note 9 (contending that even if regulating emissions does not presently impact sea levels, it allows affected areas to implement protective policies to deal with future, unavoidable changes).

B. Hard Structures: Seawalls and Beach Nourishment

Rather than implementing strong emissions policies to fight global warming and rising sea levels, the most popular measures used to respond to rising sea levels are “structural protection measures such as seawalls and beach nourishment.”¹⁸⁰ These hard structures and beach nourishment programs serve as a “line of defense” against coastal flooding and attempt to prevent rising sea levels from inundating coastal cities.¹⁸¹ Although these protective measures help cope with the current issues of rising sea levels, they are likely more expensive and less effective than other options with regard to the dangers of long-term sea level rise.¹⁸²

1. Seawalls

To deal with threats of flooding due to rising sea levels, many nations construct extensive seawalls to protect their coasts.¹⁸³ Seawalls serve as protective devices by “hold[ing] back the rising sea or storm wave action” through the use of wall-like structures.¹⁸⁴ Noting these barriers’ success in countries that are at or below sea level, city planners in the United States believe seawalls may be the best solution to deal with the current impacts of rising sea levels.¹⁸⁵ Experts acknowledge that these “barriers are very good at keeping out the high water during storms,” and, if they are constructed at a sufficient height, they could keep out water for several decades.¹⁸⁶

180. Gresham & Imwalle, *supra* note 8, at 11 (highlighting processes of sea walls and beach nourishment as most popular methods for dealing with sea level rise).

181. See *Coastal Barrier Resources Act*, U.S. FISH & WILDLIFE SERV., http://www.fws.gov/CBRA/Act/Coastal_Barriers.html (last updated Aug. 29, 2013) (setting forth purpose of hard structures such as coastal barriers and explaining how they protect coastal areas against rising sea levels and severe storms).

182. Gresham & Imwalle, *supra* note 8, at 11 (reiterating SLRTRF’s Dec. 31, 2010 report that building hard structures is not ideal method of defending against rising sea levels).

183. *Id.* (recognizing extensive seawalls are in place in both London and the Netherlands and detailing how these seawalls protect against threats of rising sea levels).

184. Sax, *supra* note 125, at 642 (describing seawalls and how they protect coastal lands from floods and rising sea levels).

185. Gresham & Imwalle, *supra* note 8, at 11 (explaining how seawalls are successful at protecting the Netherlands, which is mostly at or below sea level); see also Blakemore, *supra* note 162 (highlighting three general ways for city planners to deal with rising sea levels).

186. Crean, *supra* note 127 (interviewing geophysicist Klaus Jacobs, who stated that if federal, state, and local governments work together in New York City to come up with thirty to forty billion dollars for seawalls, New York City could be protected from floodwaters for one hundred years).

Although experts recognize the short-term benefits of seawalls, they also realize seawalls are an “unlikely remedy for the entire East Coast.”¹⁸⁷ The main issue with seawalls is that they do not take into account long-term sea level rise, and eventually the sea will win.¹⁸⁸ Once sea levels rise five to ten feet and match the height of these seawalls, these barriers will be completely useless.¹⁸⁹ Even if rising sea levels do not reach heights to render seawalls ineffective, seawalls create a situation where an increasing number of people are living in coastal areas below sea level.¹⁹⁰ This is the situation in New Orleans, where the city is like a “giant bathtub[] that can fill up from one well-placed hurricane.”¹⁹¹ Because seawalls are so expensive and will ultimately be taken over by the rising sea, it seems inefficient to use “limited public fisc or limited private capital that might be more productively and helpfully spent elsewhere rather than to protect doomed private assets.”¹⁹² In addition to this financial limitation, seawalls eliminate natural protective barriers as the force of waves hitting against the seawall accelerates the loss of the foreshore and wetland areas and results in even greater destruction to coastal areas.¹⁹³

2. Beach Nourishment

Because natural barriers such as coastal wetlands and foreshore areas are so important in protecting against the impact of rising sea levels, certain federal agencies are taking action to restore natural

187. Vergano, *supra* note 5 (contending that seawalls are not very feasible to protect all U.S. coastal areas even though they work in smaller countries).

188. See Craig, *supra* note 18, at 435 (recognizing that seawalls only protect coastal areas from short-term, small rises, and determining that sea walls will eventually succumb to rising sea levels and prove completely ineffective).

189. See *id.* (explaining how rising sea levels will eventually make seawalls worthless and unable to protect against further sea level rise or storm surges).

190. Nash, *supra* note 77 (detailing how seawalls may prove dangerous by unintentionally creating areas below sea level that could become inundated during severe storms). As sea levels build up against seawalls, the area protected by these barriers transforms into land located below sea level. *Id.*

191. *Id.* (implying seawall system surrounding New Orleans creates situation where city can fill up with unmanageable amounts of water during storms). New Orleans is forced to rely on a twenty-four-hour-a-day pumping system to keep higher waters from inundating the city because it is below sea level. See Crean, *supra* note 127 (explaining how New Orleans operates its seawall and levee system and denoting why this would not be prudent in other U.S. cities such as New York).

192. Craig, *supra* note 18, at 435 (contending that seawall expense will limit their effectiveness).

193. See Sax, *supra* note 125, at 642-43 (detailing negative environmental effects of seawalls on natural coastal barriers).

protective areas.¹⁹⁴ Agencies such as the United States Army Corps of Engineers (Corps) work to combat encroaching seas by dredging sand offshore and spreading it along the coast to make beaches hundreds of feet wider.¹⁹⁵ This process creates an area that serves as “a sacrificial buffer” between the shoreline and the rising sea that absorbs the brunt of the energy of incoming waves.¹⁹⁶

Although environmentalists recognize the benefits of natural barriers, experts often question the long-term benefits of these beach nourishment projects.¹⁹⁷ Like seawalls, beach nourishment projects may be another ineffective and inefficient use of public tax dollars.¹⁹⁸ For example, the Corps is currently undertaking a beach nourishment project in Virginia Beach that is costing federal taxpayers about nine million dollars.¹⁹⁹ This is the forty-ninth time since 1951 that the government used public funds to build up this strip, which indicates that this nine million dollar cost will not have a substantial long-term impact.²⁰⁰ Because these beach nourishment projects only appear to have short-term effects, they do not provide adequate protections from sea level rise.²⁰¹ As a result, beach nourishment projects do not present an economical and effective long-term solution to deal with rising sea levels.²⁰²

194. Nash, *supra* note 77 (discussing benefits of natural barriers such as coastal wetlands, which serve as valuable habitats and reduce flooding impacts); see also Jennifer Ludden, *Debate Over Rebuilding Beaches Post-Sandy Creates Waves*, NPR (Jan. 30, 2013, 8:01 AM), <http://www.npr.org/2013/01/30/170301306/debate-over-rebuilding-beaches-post-sandy-creates-waves> (identifying action taken to reinvigorate natural barriers).

195. See Ludden, *supra* note 194 (explaining process of beach nourishment along coastal areas).

196. *Id.* (recognizing beach nourishment programs' purpose).

197. See Craig, *supra* note 18, at 432 (questioning overall effectiveness of hard structures such as beach nourishment projects).

198. See Ludden, *supra* note 194 (presenting well-debated question of whether beach nourishment projects are effective use of tax dollars). Although beach nourishment projects can be largely beneficial to local areas, the federal government currently pays sixty-five percent of the bill while local communities only finance thirty-five percent. *Id.* For a further discussion on why investment in seawalls is an inefficient use of federal funds, see *supra* note 192 and accompanying text.

199. Ludden, *supra* note 194 (setting forth current Corps beach nourishment project at Virginia Beach).

200. See *id.* (noting temporary nature of beach nourishment projects and how they incur substantial costs for short-term benefits).

201. *Id.* (explaining unreasonableness of creating beach nourishment projects while planning for sea level changes more than twenty years ahead).

202. See Craig, *supra* note 18, at 432 (stating beach nourishment projects are not reasonable when looking at their long-term impacts).

C. Strategic Retreat

The final and most drastic method of dealing with sea level rise involves a “planned retreat from the coastline as sea level rises.”²⁰³ While this method presents the best way to protect people from inevitable sea level rise, it poses an extremely difficult task, as “moving an entire huge city would take an [sic] great deal of time, planning, long range financial commitment, and overall political agreement.”²⁰⁴ Strategic retreat would also be tremendously expensive.²⁰⁵ Therefore, rather than mandating the relocation of entire cities away from the coast, the government should develop policies to make coastal retreat more appealing.²⁰⁶ These policies could include requiring coastal development projects to internalize the risks of sea level rise in planning and decision-making, as well as compelling coastal real estate developers to disclose the risks of rising sea levels to potential buyers.²⁰⁷ By making proprietors of newly developed coastal areas responsible for the costs of sea level rise and coastal flooding, the government will inevitably cause the value of coastal properties to decrease.²⁰⁸ Ultimately, these properties will become less attractive, and the government will achieve its goal of encouraging retreat away from coastal areas.²⁰⁹

Overall, it does not appear that there is any ideal way to respond to rising sea levels, and whatever defenses coastal cities have in place are most likely inadequate to ensure their long-term survival.²¹⁰ The federal government must support the development of

203. Blakemore, *supra* note 162 (internal quotation marks omitted) (concluding most extreme method of dealing with sea level rise entails moving cities and activities away from shorelines).

204. *Id.* (outlining issues presented by strategic retreat, which are extremely difficult to overcome); *see also* Nash, *supra* note 77 (presenting strategic retreat as ideal option to deal with rising sea levels).

205. *See* Nash, *supra* note 77 (identifying why strategic retreat strategy is not very feasible).

206. *See* Craig, *supra* note 18, at 433 (recognizing that coastal retreat for major cities does not present viable option without something more).

207. *Id.* (setting forth potential options to encourage strategic retreat without going through expensive and excessive process of attempting to move entire cities).

208. *Id.* (implying that if property owners are responsible for damages from rising sea levels and coastal flooding, they will be less willing to purchase coastal property and will be forced to migrate landward). To further increase the effect of this policy, the government could work with insurance companies to institute reforms “that would reduce the availability or increase the cost of insurance for coastal real estate.” *Id.*

209. *Id.* (explaining that certain governmental requirements may result in ultimate retreat from coastal property).

210. *See* Goldenberg, *supra* note 3 (contending city measures to deal with rising sea levels are likely inadequate).

local and regional long-term programs, consider the environmental impact of emissions, and identify and implement the most cost-effective solutions to deal with sea level rise.²¹¹ If the government is willing to compromise the ease of dealing with rising sea levels on a short-term basis for long-term improvements benefits, it will truly begin to confront the problem of rising sea levels.²¹²

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211. See Craig, *supra* note 18, at 433-34 (indicating that ideal way to deal with rising sea levels is only possible using comprehensive approach involving several different environmental policy aspects).

212. See generally Gresham & Imwalle, *supra* note 8, at 11 (explaining certain agencies' actions are evidence that regulators are beginning to confront problem of rising sea levels).

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