# A TAXING ENDEAVOR: LOCAL GOVERNMENT PROTECTION OF OUR NATION'S COASTS IN THE "WAKE" OF CLIMATE CHANGE

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*"Climate change is a global problem with local solutions."*
- Kevin Murphy, Berks County Community Foundation, Pa.



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## I. INTRODUCTION

A storm is brewing, and not just in our nation's coastal waters. The effects of climate change are becoming alarmingly apparent: sea levels are rising[1], storm surges are intensifying and ocean temperatures are warming at increasing speeds. Higher storm surges have led to increased flooding in coastal zones and nearby low-lying regions.[2] The need for greater disaster preparedness in areas vulnerable to storm surges is evident, not just in the United States, but worldwide.[3] As a direct result, coastal towns and cities have been left with the daunting task, and cost, of implementing littoral adaptation measures such as beach renourishment of coastal erosion and sand dune restoration and preservation.

Naturally occurring sand dunes protect against inland flooding by absorbing storm surge impacts, and are known for providing shelter and resources to plants and animals that live on the shore.[4] Once naturally occurring sand dunes diminish, they are hard to replace and allow inland communities to become extremely vulnerable without a buffer sitting between them and the shore. Granted, sand dunes alone cannot be a panacea for all storm surge problems. Sand dune restoration works most effectively in conjunction with human development efforts and local land-use planning to best preserve our coasts.[5]

Local coastal communities must be developed to accommodate additional methods for coastal protection, utilizing a universal implementation system that avoids risk to "suckers" and "free-riders."[6] Specifically, local governments should implement a special

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1. In the last century, the Global Mean Sea Level (GMSL) has risen by four to eight inches (ten to twenty centimeters) and the annual rate of rise is about twice the average speed it used to be. *See Sea Level Rise,* NAT'L GEOGRAPHIC, http://ocean.nationalgeographic.com/ocean/critical-issues-sea-level-rise/ (last visited Jan. 29, 2016).

2. *See generally* Susmita Dasgupta, et al., *Climate Change and the Future Impacts of Storm-Surge Disasters in Developing Countries,* CTR. FOR GLOBAL DEV. (Sept. 2009), http://www.cgdev.org/files/1422836_file_Future_Storm_Surge_Disasters_FINAL.pdf

3. *Id.*

4. *See generally Dune Protection and Improvement*, DEL. DIV. OF WATERSHED STEWARDSHIP, http://www.dnrec.delaware.gov/swc/shoreline/pages/duneprotection.aspx [hereinafter *Dune Protection*]; *see also Building Back the Sand Dunes*, FLA. DEP'T OF ENVTL. PROT., http://www.dep.state.fl.us/beaches/publications/pdf/bldgbkvw.pdf [hereinafter *Building Back*].

5. *See* Rachel Nuwer, *Sand Dunes Alone Will Not Save the Day*, N.Y. TIMES: GREEN ENERGY, THE ENVIRONMENT, AND THE BOTTOM LINE (Dec. 4, 2012), http://green.blogs.nytimes.com/2012/12/04/sand-dunes-alone-will-not-save-the-day/?_php=true&_type=blogs&_php=true&_type=blogs&_r=1.

6. Coastal communities and beachfront property owners that pay for the addition of sand in an attempt to restore local beaches have been generally classified as "suckers." Suckers pay to build up the beaches, but their replenishment efforts benefit the coastlines of neighboring, "free-riding" communities, who do not contribute to the nourishment, yet benefit

assessment, similar to that of Portland, Oregon's proposed Transportation User Fee, in which homeowners and businesses pay a flat monthly fee to cover the costs of shoreline adaptation methods.[7] The fee will be a charge to users of the city or town's coastal infrastructure, based on estimates of use they generate.[8] Inland and shorefront property owners will uniformly benefit by municipalities evenly splitting coastal adaptation measures between them.

This paper focuses on the implementation and adaptation of a local government tax for the construction, planning and payment of sand dunes to protect the nation's coastlines against storm surges. Part I discusses the effects of climate change on storm surges, beach renourishment, and inland flooding and outlines why the need for action is imminent.

Part II begins by examining current mitigation efforts, such as sand dune formation, and growth, and the policy issues behind other local government adaptation efforts. Part II then addresses local government's current responses to coastal regulation, the issue of "free-riding" and prescribes a solution in the form of a legislative tax. This part will close by addressing why it is crucial for municipalities to implement a uniform solution to the high cost of coastline protection.

Finally, Part III will provide an in-depth analysis of implementing a special assessment fee, such as the Portland, Oregon Transportation User Fee, as a model solution for coastal renourishment efforts. Part III concludes with a projected analysis of how a user fee will help construct, plan, and pay for adequate coast line protection.

## II. STORM SURGES, SAND DUNES & THE CHANGING CLIMATE

To have an accurate understanding of the policy issues local governments are facing, it is helpful to first consider the effects of climate change on our coastal waters. This section will provide an overview of how storm surges have been affected by climate change and the direct impact they have on the nourishment and preventative effects of sand dunes.

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from its effects. *See Beachfront Nourishment Decisions: The "Sucker-Free Rider" Problem*, PHYS.ORG, http://phys.org/news/2013-04-beachfront-nourishment-decisions-sucker-free-rider.html (last visited Jan. 29, 2016).

7. *See* Max Barr, *City Leaders Announce Plans for Portland Street Fee*, KATU.COM (May 22, 2014), http://www.katu.com/news/local/City-leaders-announce-plans-for-Portland-street-fee-260290061.html.

8. *See Our Streets Transportation User Fee*, CITY OF PORTLAND, BUREAU OF TRANSP., https://www.portlandoregon.gov/transportation/article/491497(last visited Dec. 11, 2014).

### *A. The Creation of Storm Surges and the Effects of Climate Change*

Storm surges are caused by unprecedented changes in water level due to the presence of a storm. They occur when rough waters, generated by hurricanes or tropical storm winds, "rise over and above the predicted astronomical tide."[9] Generally, the winds around the eye of a hurricane blow on the surface of the water, producing a vertical circulation under the water.[10] The vertical disruptions of storm surges are harder to detect in deep waters.[11] However, once a hurricane reaches shallow waters near coastlines, the vertical circulations start to strike the ocean floor.[12] The water's vertical momentum can no longer go down, so instead it is pushed up and inland, resulting in a storm surge.[13] Surges generally occur when winds are blowing onshore. The strongest hurricane winds are known to cause the highest surges.[14] All eastern and Gulf coasts of the United States are vulnerable to storm surge. These potentially affected coastal regions are home to more than 30 million Americans,[15] and include the entire peninsula of Florida.[16]

Because storm surges cause the most fatalities during hurricanes, they are a topic of grave concern for all coastal communities.[17] Entire neighborhoods have been leveled in their wake, with death tolls in the thousands. Two recent examples of storm surge include Hurricane Katrina in Louisiana, where surges reached twenty-eight feet[18], and Hurricane Sandy, in New York, which carried a record-breaking thirty-two-foot surge.[19] As storm surges continue to increase, they will also worsen flood damage in coastal zones and adjoining low-lying areas.[20] Stronger winds and

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9. *See* NAT'L WEATHER SERV., NAT'L OCEANIC & ATMOSPHERIC ADMIN., INTRODUCTION TO STORM SURGE 1, http://www.nws.noaa.gov/om/hurricane/resources/surge_intro.pdf [hereinafter *Introduction*].

10. *Id.*

11. *Id.* at 2.

12. *Id.*

13. *Id.*

14. *Id.*

15. *Id.* at 1; *see also* Doyle Rice, *Deadliest Hurricane Risk is Not Wind, But Water*, USA TODAY (July 12, 2011), http://usatoday30.usatoday.com/weather/hurricane/2011-07-11-hurricane-storm-surge-dangers_n.htm.

16. *See generally* NAT'L WEATHER SERV., NAT'L HURRICANE CTR., STORM SURGE OVERVIEW, http://www.nhc.noaa.gov/surge/ (last visited Jan. 29, 2016).

17. *See generally* Rice, *supra* note 15.

18. *Introduction*, *supra* note 9, at 2.

19. *See* Simon Worrall, *Two Years After Hurricane Sandy Hit the U.S., What Lessons Can We Learn From the Deadly Storm?,* NAT'L GEOGRAPHIC: BOOK TALK (Oct. 18, 2014), http://news.nationalgeographic.com/news/2014/10/141019-hurricane-sandy-katrina-coast-guard-hunters-ngbooktalk/.

20. Dasgupta, *supra* note 2, at 1.

larger onshore waves will similarly contribute towards a greater destructive impact.[21]

1. Factors Influencing Storm Surge

Various factors influence storm surge production, which contribute to the severity of surges. The National Weather Service, National Oceanic and Atmospheric Administration have listed the following characteristics as direct contributors to the amount of surge a given storm produces: (1) low central pressure, (2) intense storm winds, (3) fast forward speeds, (4) the width and slope of the ocean floor, (5) the angle by which a storm approaches a coastline, (6) the shape of the coastline, (7) the size of the storm approaching the coast, and local features, and (8) barriers that affect the flow of water.[22] Despite instruments being available to observe and measure storm surge such as tide stations, high water marks, and pressure sensors, these tools often fail during storms, and are difficult to rely on since recorded data has a high level of unknown error characteristics.[23]

2. The Effect of Climate Change on Storm Surges

Climate change has a direct influence on tropical cyclones.[24] The effects of such influence are becoming apparent via increased atmospheric moisture build-up, and post El Niño events, altering upper level winds.[25] However, sea level rise and warmer ocean temperatures will likely intensify storm surges the most.[26]

Sea level rise is caused by the thermal expansion of seawater and ice cap melting. Thermal expansion occurs when seawater becomes less dense and expands as it warms.[27] Ever since Hurricane Sandy, there has been a noticeable shift in climate change discussion from sea level rise to storm surge. Both sea level rise, as well as storm surge events, when compounded with global warming's increased temperatures, can cause weaker hurricanes to

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21. Dasgupta, *supra* note 2, at 1.
22. *Introduction*, *supra* note 9, at 4.
23. *Introduction*, *supra* note 9, at 5.
24. Tropical cyclones occur when rotating, organized cloud systems with low-pressure centers form over tropical waters. Depending on its location and strength, a tropical cyclone is generally classified as a tropical storm or hurricane. *See Tropical Cyclone Climatology*, NAT'L WEATHER SERV., NAT'L HURRICANE CTR., http://www.nhc.noaa.gov/climo/ (last visited Jan. 29, 2016).
25. *See generally Introduction*, *supra* note 9.
26. *See* Simon Donner, *Storm Surges, Sea Level and Climate Change*, MARIBO (Nov. 8, 2012), http://simondonner.blogspot.com/2012/11/storm-surges-sea-level-and-climate.html.
27. *Id.*

be more damaging, which alters the overall strength of storms.[28] In 2006, the World Meteorological Organization reported that there would be a direct relation between an increase in sea level rise and the vulnerability of tropical storm surge flooding.[29] Since then, the science behind cyclone activity is gradually becoming more conclusive.[30]

In addition to local sea level rise, warmer ocean temperatures are likely to cause more intense cyclones, which in turn will heighten storm surges.[31] Scientists Aslak Grimsted, John C. Moore, and Svetlana Jevrejeva conducted a 2013 study that projected the Atlantic hurricane surge threat from rising ocean temperatures.[32] The study estimated that for every 1.8 degree Fahrenheit increase in global average surface temperatures, there could be a two to seven-fold increase in the risk of Katrina-magnitude surge events.[33]

To reach this number, Grimsted used historical records of storm surge events from six tide gauges,[34] and compared the surge record changes with theorized influences, such as global temperature changes, regional sea surface temperatures changes, and sources of natural climate variability, such as El Niño or La Niña events.[35] Regional sea surface temperatures and global average surface temperatures were found to best match the tide gauge records, which in turn suggests that increases in warmer climates, even at a minimal scale, cause extreme increases in surge activity.[36] In an article discussing the study, Grimsted noted that the findings are relevant because they suggest

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28. *See* Andrew Freedman, *Storm Surge Risk Amplified by Climate Change, Study Finds*, HUFFINGTON POST (June 24, 2013, 4:17PM), http://www.huffingtonpost.com/2013/03/18/storm-surge-risk_n_2902823.html [hereinafter *Storm Surge Risk*]; *see also* Kerry Emanuel, *Increasing Destructiveness of Tropical Cyclones Over the Past 30 Years*, 436 NATURE 686, 688 (2005).

29. Dasgupta, *supra* note 2, at 2.

30. The Intergovernmental Panel on Climate Change, (IPCC) 2014 Synthesis report confirms there is very high confidence that impacts from recent climate-related extremes, such as floods and cyclones, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability. However, despite the existing connection between sea level rise and storm surge flooding, it has yet to become an established trend. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS REPORT 55 (2014), http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_LONGERREPORT.pdf; *see also* P.J. Webster, et al., *Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment*, 309 SCIENCE 1844 (2005).

31. Dasgupta, *supra* note 2, at 1.

32. *See* Aslak Grinsted, et al., *Projected Atlantic Hurricane Surge Threat From Rising Temperatures*, 110 PROC. NAT'L ACAD. SCI. 5369, 5371 (2013).

33. *Id.*

34. Tide gauges measure the variation in water level along the coast, and are traditionally the most reliable way of measuring surge. *See Introduction*, *supra* note 9, at 5.

35. *Storm Surge Risk*, *supra* note 28.

36. Grinsted, *supra* note 32.

that, "coastal adaptation measures should include changes in surge statistics in addition to local sea level rise."[37]

However, according to Geography professor Simon Donner[38] at the University of British Columbia, "there's a non-linear relationship between surge height and the 'run-up': how far the water runs up on to the land."[39] Donner believes that "increases in surge height can have a disproportionate effect on the distance water travels inland and the erosive power it yields."[40] Shoreline profiles and the types of ground or sediment lining the coasts should be taken into consideration as well.

### *B. Impending Coastal Doom*

The need for greater disaster preparedness in areas vulnerable to storm surge is apparent, not just in the United States, but worldwide.[41] Despite recent efforts, storm-surge losses continue to occur in many coastal areas.[42] About 2.6 million people worldwide have drowned during surge events over the past 200 years.[43]

#### 1. Surge Vulnerability

Not only is human life at risk, but also devastating property loss via coastal inundation, or the flooding of normally dry, low-lying coastal lands.[44] Coastal flooding can reach far distances inland, sometimes as much as ten or more miles from the shore.[45] As expected, varying levels of storm surges carry with them varying levels of effect on coastal flooding.[46]

Typically, surges fit into one of three classifications: peak, "fore-runner," and "post-runner" surges.[47] Peak surges occur at the landfall of a storm along an open coastline.[48] "Fore-runner" surges

37. *Storm Surge Risk*, *supra* note 28 (emphasis added).

38. Simon Donner studies why the climate matters to people and the environment and publishes a blog, where he discusses many of his findings. *See* SIMON DONNER, CLIMATE MATTERS, http://ibis.geog.ubc.ca/~sdonner/.

39. Donner, *supra* note 26.

40. *Id.*

41. Dasgupta, *supra* note 2.

42. *Id.*

43. *Id.* at 1.

44. Coastal inundation is caused by severe weather events, such as storm surges along coasts, estuaries, and adjoining rivers. *See Storm Surge and Coastal Inundation,* NAT'L OCEANIC & ATMOSPHERIC ADMIN., http://www.stormsurge.noaa.gov (last visited Jan. 29, 2014).

45. *See* HURRICANES: SCIENCE & SOC'Y, HURRICANE IMPACTS DUE TO STORM SURGE, WAVE, AND COASTAL FLOODING http://www.hurricanescience.org/society/impacts/stormsurge/ (last visited Jan. 29, 2016) [hereinafter *Hurricane Impacts*].

46. *Id.*

47. *Id.*

48. *Id.*

are larger, and have also been found to occur hours before hurricane landfall.[49] As the name may suggest, "post-runner" surges occur after hurricane landfall.[50] Because of their design and timing, fore-runner and post-runner surges that are known for causing unexpected flooding carry the most potential for damaging property and life located further inland.[51]

Population density and economic productivity in coastal zones also serve as factors susceptible to surge vulnerability.[52] Twenty-three of the twenty-five most densely populated counties in the United States are located on the coast, and much of these densely populated coastlines are less than ten feet above the mean sea level.[53] For example, Rhode Island, Delaware, and Hawaii are three states in which their entire population is located in coastline counties.[54] Population density has increased by 32% in Gulf coastal counties, 17% in Atlantic coastal counties, and 16% in Hawaii, between 1990 and 2008.[55] Now, over half of the nation's economic productivity is located within coastal zones.[56] In the Gulf Coast Region alone, 72% of ports, 27% of major roads, and 9% of rail lines are at or below a four-foot elevation.[57] This means that a storm surge of 23 feet could inundate 67% of interstates, 57% of arterials, and almost half of all rail miles, as well as twenty-nine airports.[58] Coastal civilizations must take precaution. If the rate of sea level rise increases in the next fifty years, the results can and will be catastrophic.[59]

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49. *Hurricane Impacts*, *supra* note 45.
50. *Id.*
51. *Id.*
52. Dasgupta, *supra* note 2.
53. *See* NAT'L WEATHER SERV., NAT'L HURRICANE CTR., SURGE VULNERABILITY FACTS, http://www.nhc.noaa.gov/surge/#FACTS (last visited Jan. 29,2016) [hereinafter *Vulnerability Facts*]; *see also* Wendy Koch, *Dunes, Reefs Protect U.S. Coasts from Climate Change*, USA TODAY (July 14, 2013, 5:19 PM) http://www.usatoday.com/story/news/nation/2013/07/14/dunes-reefs-protect-us-coastlines-from-climate-change-storms/2513299/.
54. *See* U.S. CENSUS BUREAU, COASTLINE POPULATION TRENDS IN THE U.S.: 1960 TO 2008 (May 2010), http://www.census.gov/prod/2010pubs/p25-1139.pdf.
55. *Id.*
56. *Vulnerability Facts*, *supra* note 53.
57. *Coastline Population Trends, supra* note 54.
58. *Id.*
59. *See* COASTAL CARE, SEA LEVEL RISE, http://coastalcare.org/sections/inform/sea-level-rise/ (last visited Jan. 29, 2016).

## III. RESPONDING TO COASTAL CLIMATE CHANGE: MITIGATION AGAINST STORM SURGES

Because so many Americans reside within 50 miles of the coast, it is within the national interest to encourage mitigation of the potential dangers in our environment.[60] Local governments in coastal states must step in and address the national problem. At-risk state municipalities can create sustainable coastal communities by implementing a broad range of mitigation techniques.

### *A. "Armoring" the Coasts with Sand Dune Protections*

Thomas O. Herrington, writing on behalf of New Jersey's Sea Grant Coastal Processes Program, has published a Manual for Coastal Hazard Mitigation (MCHM), which "introduces the concept of coastal hazard mitigation through community and individual preparedness" and "provides information for implementing effective hazard reduction efforts."[61] Herrington's article provides detailed analysis and explanation of various mitigation strategies as well as their required levels of effort for New Jersey to follow.[62] However, Herrington's findings also serve as an excellent outline from which coastal communities everywhere can benefit from.

Herrington's data is broken down into three categories: hazard mitigation, risk assessment, and coastal hazards.[63] Specifically, he proposes nine broad categories of mitigation practices: beach nourishment, coastal regulation, building elevation, siting, shore protection structures, coastal resource management, natural resource restoration, building techniques and community maintenance and preparedness.[64]

Beach restoration and nourishment are listed first as mitigation for long and short-term erosion, flood hazards, and wave hazards.[65] Despite its high cost, beach nourishment is valuable to all aspects of coastal maintenance and serves as an integral building block for future coastal management.[66] An essential aspect of beach

60. *See* Thomas O. Herrington, *Manual for Coastal Hazard Mitigation*, N.J. SEA GRANT COLLEGE PROGRAM 9, www.state.nj.us/dep/cmp/coastal_hazard_manual.pdf.
61. *Id.* at 4.
62. *Id.*
63. *Id.*
64. *Id.*
65. *Id.* at 44.
66. *Id.*

nourishment is the maintenance of improved and naturally existing sand dunes.[67] As it stands, coastal dunes can be found along the shores of Maryland, Florida, Massachusetts, North Carolina, New York, Texas, and Michigan.[68] Some of these dunes are located within the National Park Service System, which affords them protection.[69] However, for the remaining majority of coastal dunes, it is up to the state municipalities to provide their own nourishment.[70]

1. Sand Dune Formations and Growth

Natural sand dunes are widely considered to be protective treasures.[71] Vegetated, healthy, natural dunes are most capable of blocking storm surge. [72] They are the first line of defense against hurricanes and beach erosion. Their roots hold sand in place, and absorb the impact of storm surge while fortifying the area around them. In doing so, sand dunes prevent or delay the flooding of inland structures.[73]

Additionally, sand dunes provide shelter and resources to plants and animals living on the shore that are otherwise exposed to the harsh environment of shifting, infertile sands, salt sprays, and direct sunlight and storms. [74] Various animals depend on sand dunes, such as burrow dwelling beach mice, coach-whip snakes, ghost crabs, nesting sea turtles, least terns[75], piping, and snowy plovers[76], ground doves, and migrating monarch butterflies.[77] Not only do sand dunes protect our homes, businesses, plants and animals, but they also enhance the quality of life in states like Florida whose economy depends on tourism, which in turn depends

67. *Id*. at 41.

68. *See* U.S. GEOLOGICAL SURVEY: COASTAL DUNES, http://geomaps.wr.usgs.gov/parks/dune/cdune.html (last visited Jan. 29, 2016) [hereinafter *Coastal Dunes*].

69. *Coastal Dunes*, *supra* note 68.

70. *Id*.

71. Samuel Brody, a professor in marine sciences and urban planning at Texas A&M University, is well known for his promotion of natural sand dunes and naturally occurring wetlands. *See* Samuel D. Brody, et al., *Examining the Influence of Development Patterns on Flood Damages Along the Gulf of Mexico*, 50 URBAN STUDIES 789-806 (2013), http://jpe.sagepub.com/content/31/4/438.abstract. *See also* Nuwer, *supra* note 5.

72. *See* Nuwer, *supra* note 5.

73. *Dune Protection, supra* note 4.

74. *Building Back*, *supra* note 4, at 2.

75. A Least Tern is the smallest species of American Terns, or seabirds found along the Southern coasts of the United States. *See Least Tern*, THE CORNELL LAB OF ORNITHOLOGY, ALL ABOUT BIRDS, http://www.allaboutbirds.org/guide/Least_Tern/lifehistory (last visited Jan. 19, 2015).

76. Piping and snowy plovers are among the rarest and most threatened beach nesting birds. Plovers are known to nest directly on the beach, by laying their eggs in shallow sand depressions. *See Beach Nesting Bird Project*, CONSERVE WILDLIFE FOUNDATION OF NEW JERSEY, http://www.conservewildlifenj.org/protecting/projects/beachnestingbird/ (last visited Jan. 19, 2015).

77. *Building Back*, *supra* note 4, at 2.

on healthy beaches.[78] Additionally, sand dunes are an integral component of a barrier island system.[79]

The only problem with sand dunes, as per Professor Samuel Brody of Texas A&M University, is that once naturally occurring dunes are taken away, they can't be easily recreated.[80] Because sand dunes are basically piles of wind-blown sand, their composition depends on many factors including the amount of sand available on any given beach, the size of the sand, and prevailing wind directions.[81] With these shifting variables, dunes can grow or shrink based on wind speeds alone.[82] Sand dunes can also be created and destroyed by either humans or nature; one giant storm can wash away an entire dune area. For purposes of this paper, it is important to distinguish between natural and man-made dune systems, as both have a large impact on coastal, beachfront property owners.

Natural sand dune systems form when sand starts to pile up around accumulations of beach debris, such as piles of seaweed, clumps of salt marsh straw, or human refuse.[83] The debris slows down shore winds, blocking it and causing sand to accumulate in the wind's "shadow" of the object.[84] Eventually, dune grass seeds, or sea oats, find their way over to the sand piles, germinate, sprout, and trap more sand.[85] The rotting vegetation underneath provides nutrients, which helps the seedlings survive.[86] As growth continues, more sand accumulates and new dunes are born.[87] Mentioned supra, natural shorelines are valuable because they are perfectly engineered to protect against erosion.[88] The deep-rooted plants provide structural integrity, which prevents the land from breaking apart.[89]

Man-made dune systems are generally constructed by bulldozing, which pushes piles of sand up and back onto beaches.[90] Because these dunes lack all characteristics of a natural dune, they

78. *Id.*

79. Barriers islands are naturally occurring, long accumulations of sand, separate from the mainland. *See generally* William Birkemeier, et al., *The Evolution of a Barrier Island: 1930-19080*, 52 J. OF THE AM. SHORE & BEACH PRES. ASS'N. 2, 2-12 (1984), http://www.frf.usace.army.mil/aerial1930/pdf/evolution_of_a_barrier_island.pdf.

80. *See* Nuwer, *supra* note 5.

81. *See* SEA SAND DUNES, COASTAL CARE, http://coastalcare.org/educate/sand-dunes/ (last visited Feb. 7, 2016).

82. *Id.*

83. *Id.*

84. *Id.*

85. *Id.*

86. *Id.*

87. *See* SEA SAND DUNES, COASTAL CARE, http://coastalcare.org/educate/sand-dunes/ (last visited Feb. 7, 2016).

88. *See* N.Y. STATE, DEP'T OF ENVTL CONSERVATION, SHORELINE STABILIZATION TECHNIQUES (July 2010), http://www.dec.ny.gov/permits/67096.html.

89. *Id.*

90. SEA SAND DUNES, *supra* note 81.

often contain a lot of shell material and finer, looser sands, which erode much quicker. There are no roots in place, and therefore man-made dunes are less stable. For these reasons among others, bulldozing sand to create artificial dune systems is not a healthy solution for stabilizing beaches.[91]

2. Rebuilding Sand Dunes

Natural sand dunes, though structurally instrumental on coastal fronts, are easily susceptible to change and destruction via tropical storms and winds. Coastal municipalities must be educated on how to rebuild them once they are destroyed. The Florida Department of Environmental Protection, Bureau of Beaches, and Coastal Systems has teamed up with the U.S. Fish and Wildlife Service in publishing an article titled Building Back the Sand Dunes.[92] According to their findings, there are two main ways municipalities can assist with the rebuilding of sand dunes: dune planting and sand fencing. Dune planting involves planting native coastal plants such as sea oats, so their roots and stems can help trap sand as the dunes build.[93] Other vegetation, such as bitter panicum, can be planted around the sea oats, and sand fences can be installed to help protect the seedlings as well.[94] Planting is most effective in the early fall or spring, so that minimal watering is required.[95] Depending on rainfall, planting during other times of year can be dangerous.[96]

Sand fences are generally made of wood, or biodegradable plastic materials and help build up sand dunes by trapping and collecting wind driven sand.[97] To encourage dune growth, fences must be raised before sand accumulates to a depth of eighteen inches. Once a fence becomes buried, it will no longer serve its purpose.[98] There are certain places sand fencing may be restricted: the Southeast coast, because of marine turtle nesting, as well as in the barrier islands, where the dry beach area may not be wide enough to supply the necessary amounts of wind driven sand.[99] In Florida, the Department of Environmental Protection as well as local governments require permits for installing sand fences,

91. *Id.*
92. *See Building Back, supra* note 4.
93. *Id.* at 1.
94. *Id.*
95. *Id.* at 2.
96. *Id.*
97. *Id.*
98. *Id.*
99. *Id.* at 3.

constructing dune walkovers, and dune plantings; but still encourage the building back of sand dunes.[100]

3. The Need for Adaptation, Not Alteration

The more our global temperature rises as a symptom of climate change, the higher the ocean waters climb and the more susceptible coastal communities become to storm surges and flooding. Beach restoration efforts must be undertaken, with specific emphasis on protective measures like sand dune fortification, not coastal armoring.[101] However, the sheer presence of dunes should not create a false sense of security for developers to continue building along the Gulf Coasts, or homeowners who do not invest in additional protective measures.[102] Dr. Orrin H. Pilkey, a James B. Duke Professor Emeritus of Earth and Sciences at Duke University, recommends starting with a more grim approach.[103] He believes municipalities should assume upfront that sand dunes will be breached, and that therefore, the proper combination for coastal protection lies in a combination of both beach restoration and human development and planning.[104] Currently, these efforts continue to rely on strong local ordinances.

### *B. Adaptation, Mitigation, & Climate Change Policy*

Generally, climate change responses have been categorized into three classifications: adaptation, mitigation, and geoengineering.[105] Of the three, adaptation is the most widely used response to coastal climate change because it involves simply responding to the negative impacts caused by climate change.[106] Mitigation comes in a close second, involving the construction and adoption of policies that would avoid climate change in the first place.[107]

Because adaption measures do not require collective decisions, and people can decide for themselves how they want to initiate a

100. *Id.* at 1.

101. The Netherlands is in the lead with preserving and restoring dunes: it has recently added 32-foot high dunes along a 13-mile stretch of beach in The Hague. Upon completion, the dunes will add an additional 65 feet to the beach. *See* Nuwer, *supra* note 5. Shoreline armoring is bad for the structural integrity of beaches, and has been outlawed in North Carolina. *See* SHORELINE ARMORING, COASTAL CARE, http://coastalcare.org/sections/inform/shoreline-armoring/ (last visited Feb. 7, 2016).

102. Nuwer, *supra* note 5.

103. *Id.*

104. *Id.*

105. ANDREW E. DESSLER, INTRODUCTION TO MODERN CLIMATE CHANGE 165 (2012).

106. *Id.* at 165-66.

107. *Id.* at 165.

response, local governments have relied heavily on adaptation.[108] But adaptation measures should not be confused with alteration or armoring methods.[109]

Armoring utilizes physical structures to protect shorelines from coastal erosion.[110] This technique differs from adaptation, because instead of adapting the actual environment to best protect against coastal erosion through fortification processes such as sand dunes, armoring simply builds objects on top of the environment to shield it against coastal erosion. Sometimes referred to as shoreline stabilization, armoring includes alteration techniques that adjust natural or human systems, and are therefore known for causing more problems than they solve. Common shoreline alternations include: building bulkheads, retaining walls, and permanent docks; the creation of artificial sand beaches; and planting lawns via the use of lawn chemicals.[111] Armoring has ultimately lead to "increased erosion, structural damage, and the destruction of the shoreline ecosystem."[112]

In the face of harsh, negative stabilization techniques, beach nourishment and the fortification of sand dunes are usually the favored, least abrasive alternative.[113] Adaptation measures benefit local communities and individuals because it allows them to take issues into their own hands, in the absence of federal government regulation.[114]

However, issues arise here because nourishment costs are usually paid by taxpayers, but often only benefit the private oceanfront buildings.[115] Because of this, the taxpaying public has been refused access to beaches they have paid to protect. [116] Additionally, pushing adaptation to the local level limits what adaptation measures can be undertaken because many strategies are too expensive for local governments to undertake without

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108. *Id.*

109. Shoreline armoring is "the construction of seawalls, jetties, offshore breakwaters and groins intended to hold shorelines in place." SHORELINE ARMORING, *supra* note 101.

110. *See* NAT'L OCEAN SERVICE, NAT'L OCEANIC & ATMOSPHERIC ADMIN., WHAT IS SHORELINE ARMORING?, http://oceanservice.noaa.gov/facts/shoreline-armoring.html (last visited Oct. 5, 2015).

111. *See Shoreline Stabilization Techniques*, *supra* note 79; *see also* VT. NW. REG'L PLANNING COMM'N, THE SHORELINE STABILIZATION HANDBOOK 13-14, http://www.uvm.edu/seagrant/sites/default/files/uploads/publication/shorelinestabiliationhandbook.pdf.

112. *See Shoreline Stabilization Techniques*, *supra* note 88.

113. *See* Howard Marlowe, *Beach Nourishment: A Guide for Local Government Officials*, http://coast.noaa.gov/archived/beachnourishment/html/human/dialog/series2a.htm (last visited Feb. 7, 2016).

114. DESSLER, *supra* note 105, at 167.

115. Marlowe, *supra* note 113.

116. *See* SHORELINE STRUCTURES, http://www.beachapedia.org/Shoreline_Structures (last visited Feb. 7, 2016).

help.[117] Critics, such as author Andrew E. Dessler, believe the level of impact of climate change has on an area is a direct reflection on how wealthy the area is to begin with.[118] The rest of this paper will focus on prescribing a way to disprove this policy theory at the local government level.

### *C. Local Government's Responses & The Issue of Free Riding*

For years, environmental legal advisors have argued for greater state commitment to environmental protection. As Lynda L. Butler recommends in her article titled State Environmental Programs: A Study in Political Influence and Regulatory Failure, states should "adopt standards and restrictions to govern the use of natural resources and the development of comprehensive plans for certain critical resources."[119] While some states like Hawaii, Massachusetts, Maine, Delaware, South Carolina, and California have implemented aggressive environmental programs, some states, such as Louisiana and Florida, have not.[120] This inaction directly conflicts with scientific knowledge and understanding of climate change today.[121] Local government action is therefore often restricted due to the state and its delegation structure. For example, local governments in Dillon's Rule states can only exercise powers expressly conferred or implicated.[122] In state's run by Dillon's rule, the "state legislature controls the local government structure, which often includes managing its procedures, activity financing, and individual authority to undertake functions."[123] Dillon's Rule states generally have stricter state control of local governments via judicial supervision to avoid local government risks. These states are wary of local government regulation, and often view municipal structures as too fragmented to allow effective guidance.[124] Despite varying views, improvements on the local level need to occur. Critic Lynda Butler notes in her 1990 article, mentioned above, a more uniform

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117. DESSLER, *supra* note 105, at 167.

118. DESSLER, *supra* note 105, at 167.

119. Lynda L. Butler, *State Environmental Programs: A Study in Political Influence and Regulatory Failure*, 31 WM. & MARY L. REV. 823, 824 (1990).

120. *See* Lauren Campbell, *Climate Change Adaptation*, http://www.beachapedia.org/Climate_Change_Adaptation (last visited Feb. 7, 2016).

121. *See generally* IPCC, *supra* note 30.

122. Butler, *supra* note 119, at 875.

123. *See* NAT'L LEAGUE OF CITIES, LOCAL GOVERNMENT AUTHORITY, http://www.nlc.org/build-skills-and-networks/resources/cities-101/city-powers/local-government-authority (last visited Feb. 7, 2016).

124. Butler, *supra* note 119, at 923.

system of local regulatory powers is abundantly necessary to "permit regional cooperation and achieve desired results."[125]

1. Local Government Regulation (CZMA)

Coastal regulation started with the Coastal Zone Management Act (CZMA) in 1972, which created incentives for states and local governments:

> [T]o encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of . . . the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development . . . programs . . .[126]

The Act has been helpful in organizing comprehensive planning and "establish[ing] coastal protection laws and state coastal zone management programs."[127] Coastal management programs, such as the California Coastal Commission and the North Carolina Division of Coastal management, allow local communities to develop local coastal plans that reduce hazards resulting from erosion.[128] However, many of these plans were established long before climate change became prevalent, and consequently do not address relevant adaptation or mitigation efforts. As a result, Beachapedia, an online coastal knowledge resource, notes "coastal zone management programs tend to lack the necessary resources to properly defend coastal zones from the developmental pressures placed on them today."[129]

2. "Suckers" & "Free Riders"

In the void of success behind coastal management program implementation, local governments have been facing additional issues between "suckers" and "free riding" communities.

As per scientists at the University of North Carolina at Wilmington, "suckers" are the coastal towns that are currently

125. *Id.* at 928.

126. 16 U.S.C. § 1452 (2015); *see* OFFICE FOR COASTAL MGMT., NAT'L OCEANIC & ATMOSPHERIC ADMIN., COASTAL ZONE MANAGEMENT ACT, http://coast.noaa.gov/czm/act/?redirect=301ocm (last visited Feb. 7, 2016).

127. *See* COASTAL ZONE MANAGEMENT ACT, http://www.beachapedia.org/Coastal_Zone_Management_Act (last visited Feb. 7, 2016).

128. *Id.*

129. *Id.*

spending millions of dollars toward the re-nourishment of eroded beaches.[130] Nearby towns that spend minimal to no money on re-nourishment are known as "free-riders."[131] Free-riding towns are receiving nourished sand from the "suckers" who are supplying them, and treating them as crutches in the process.[132] Typically, towns paying for the new sand and nourishment begin to see improvements on their beaches and therefore continue to bring in more sand. As a consequence, neighboring free-riding towns start to see their erosion mitigated and become less inclined to spend their own money on additional efforts, because they are already receiving the benefits of the process for free.[133] A computer model created by Zach Williams of UNC-Wilmington, along with scientists from Duke and Ohio State Universities, shows that suckers will eventually pass a point of lessened return where they are spending more money and creating less improvement, which eventually leads to lowered property values in coastal communities.[134]

Once again, the issue circles back to politics and money. Not all communities are equal; some towns have more money to pay toward nourishment than others. Unfortunately, politics such as these become the deciding factor behind which beaches become re-nourished and which do not.[135]

3. Managed Retreat

A third prescribed method for local governments to combat coastal erosion and disappearing coastlines is managed or planned retreat. This option recommends moving homes and businesses away from the shore to allow natural ocean processes to run their course.[136] Under managed retreat programs, municipalities focus on business and homeowner relocation, which in turn relies on buyout

130. *See* Zachary C. Williams, et al., *Coupled Economic-Coastline Modeling with Suckers and Free Riders*, 118 J. OF GEOPHYSICAL RES.: EARTH SURFACE 887 (2013), http://www.readcube.com/articles/10.1002%2Fjgrf.20066?r3_referer=wol&show_checkout=1. *See also* Joel N. Shurkin, *When 'Suckers' Rebuild Eroding Beaches, 'Free Riders' Benefit*, INSIDE SCIENCE (May 8, 2013), http://www.insidescience.org/content/when-suckers-rebuild-eroding-beaches-free-riders-benefit/1002.

131. *Id.* at 893.

132. *See generally* Shurkin, *supra* note 130.

133. *Id.*

134. *Id. See also* Williams, *supra* note 130.

135. *See Beachfront Nourishment Decisions, supra* note 6. *See also* Jared Anderson, *Energy Quote of the Day: On Climate Change Mitigation vs. Adaptation and Tragedy of the Commons*, BREAKING ENERGY (July 10, 2014) http://breakingenergy.com/2014/07/10/energy-quote-of-the-day-on-climate-change-mitigation-vs-adaptation-and-tragedy-of-the-commons/ (for free riding on a global scale).

136. *See* MANAGED RETREAT, http://beachapedia.org/Managed_Retreat (last visited Feb. 7, 2016).

programs.[137] Buyout programs are run by municipalities and provide incentives for relocation, assistance for down payments among low-income residents, and identify new areas of safe growth.[138] These programs typically start in repetitive loss areas and tend to be most effective if initiated immediately after a natural disaster.[139]

There are many cons associated with managed retreat, since it is often viewed as "giving up." Most communities resort to managed retreat in highly erosive areas because it is thought to be less expensive than structural stabilization projects.[140] Unfortunately, it is a daunting task to implement both politically and financially, and can cause shorefront property values to decrease immensely.[141]

Attempting to stop coastal erosion is not a losing battle. Shoreline protection efforts and repeated maintenance must be implemented in a cost-effective manner to ultimately prevent further erosion.

## IV. "SPECIALLY ASSESSING" A USER FEE SOLUTION

Local coastal communities must be developed to accommodate additional methods for coastal protection, utilizing a universal implementation system that avoids risk to suckers, free riders, and the prospect of managed retreat. Specifically, local governments should implement a special assessment, similar to that of Portland, Oregon's proposed Transportation User Fee.[142] The coastal fee will require all coastal users such as homeowners and businesses to contribute a monthly payment to cover the costs of shoreline adaptation methods.[143] The fee will essentially be a charge to users of the city or town's coastal infrastructure, based on estimates of use they generate.[144] Properties within a 100-mile radius of the shore will be charged, in varying degrees dependent on season.[145] Because

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137. *See generally* Anne Siders, *Managed Coastal Retreat, A Legal Handbook on Shifting Dev. Away from Vulnerable Areas*, COLUMB. CENTER FOR CLIMATE CHANGE L. at v (2013), *available at* https://web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Publications/Fellows/ManagedCoastalRetreat_FINAL_Oct%2030.

138. Anne Siders, *supra* note 137.

139. *Id.*

140. *See* MANAGED RETREAT, *supra* note 136.

141. *Id.*

142. The City of Portland decided to seek more public input on ways to reduce charges for low-income residents and businesses, and provide discount for non-profits, altering and adapting the Transportation User Fee on November 10, 2014, into what is now known as the Portland Street Fund. *See News Release: Mayor Hales, Commissioner Novick Propose $46 Million Portland Street Fund*, CITY OF PORTLAND, BUREAU OF TRANSP. https://www.portlandoregon.gov/transportation/article/508979 (last viewed Dec. 12, 2014).

143. Barr, *supra* note 7.

144. *See Our Streets Transportation User Fee*, *supra* note 8.

145. *Id.*

these properties and users rely on the coast for business, and pleasure, they must all pay to keep that system safe and well maintained. [146] Inland and shorefront property owners will uniformly benefit by municipalities evenly splitting coastal adaptation measures between them.

### *A. Special Assessments and User Fees*

Special assessments and user fees are commonly given the same general classification, though they differ slightly. Special assessments are unique charges that local governments can assess against real estate parcels for certain public projects.[147] User fees are paid for a service provided, based directly on the value of the individual use or benefit.[148] Both are dues that a city or county can charge businesses and homeowners for utilities, road maintenance, and other services such as street lighting and fire protection.[149]

Despite their topical similarity, special assessments are not to be confused with taxes. [150] Taxes produce a general benefit to a community and no specific benefit to a person or particular area of land.[151] In contrast, special assessments can only be levied on land, and can only be imposed to pay the cost of improvement or service that the land will specially benefit.[152] Special assessments and user fees are therefore an important funding tool available to local governments.[153]

### *B. Portland, Oregon's Proposed Transportation User Fee Analogy & Comparison*

In recent years, special assessments have been used to fund solid waste management services, as well as transit investments. [154] Special assessments are surprisingly elastic; they can be applied to

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146. *Id.*

147. *See* SPECIAL ASSESSMENT TAX, http://en.wikipedia.org/wiki/Special_assessment_tax (last visited Feb. 7, 2016).

148. *Id.*

149. *See* Roy F. Weston, *Local Government Guide to the Establishment of Solid Waste Special Assessments*, CARL VINSON INST. OF GOV'T, THE UNIV. OF GA., 1-2 (1995), http://infohouse.p2ric.org/ref/26/25021.pdf.

150. *See* Mich. Mun. League, *Chapter 22: Special Assessments and User Charges*, HANDBOOK FOR GENERAL LAW VILL. OFFICIALS 105 (2006), https://www.mml.org/pdf/glv/chapter22.pdf

151. *Id.*

152. *Id.*

153. Weston, *supra* note 149 at 2-1.

154. *See* Rachel MacCleery & Casey Peterson, *Using Special Assessments to Fund Transit Investments*, URBANLAND, (Oct. 24, 2012), http://urbanland.uli.org/infrastructure-transit/using-special-assessments-to-fund-transit-investments/.

commercial or industrial properties, or stretched to include residential land uses as well. The fees charged can also change over time. [155] As Rachel MacCleery and Casey Peterson explain in their 2012 article, Using Special Assessments to Fund Transit Investments, "[s]pecial assessments for transit can be used to channel revenues from property tax rate increases to fund transit construction, operations, or related infrastructure improvements."[156]

Earlier this year, Portland, Oregon proposed its own special assessment Transportation User Fee in an effort to pay for street maintenance and safety improvements.[157] As per Portland Mayor Charlie Hales, the city's streets are in declining condition, and the User Fee is Portland's way of attempting to do something about it.[158] Portland will be the 29th city in Oregon to adopt a similar transportation fee, which is why the Mayor feels as if the cost is not a radical imposition on city residents. [159] The City has acknowledged that street maintenance could not be addressed with the existing gas tax revenues alone.[160]

The pay structure was originally set up so that homeowners would pay a flat monthly fee of about $11.56 per month, or $140 per year.[161] A higher fee would be charged to businesses, depending on the amount of trips the particular property generates.[162] As per Max Barr, of KATU.com News, "churches, schools, and non-profit organizations would also need to pay."[163] The fee is estimated to go into effect in July 2015 and will appear on all water and sewer bills. Portland Comissioner Steve Novick, estimates the new tax will raise about $50 million per year.[164] The funds will go directly towards transportation and will focus on maintenance and safety with specific projects such as sidewalk and crosswalk creation and restoration.[165]

On November 10, 2014, the City of Portland adapted the proposed Transportation User Fee into what is now known as the Portland Street Fund. Because the city received backlash from citizens concerned about payments, the City Council decided to seek more public input on ways to reduce charges for low-income

155. *Id.*
156. MacCleery & Peterson, *supra* note 154.
157. Barr, *supra* note 7.
158. *Id.*
159. *Id.*
160. *Id.*
161. *Id.*
162. *Id.*
163. Barr, *supra* note 7.
164. *Id.*
165. *Id.*

residents and businesses, and provide discount for non-profits.[166] Individuals will now pay rates related to their ability to pay.[167] Businesses will now pay between $3 and $144 a month, and will include a 50 percent discount for non-profits.[168]

The Portland Transportation User Fee example is analogous to a beach re-nourishment and fortification solution. Special assessments or user fees can provide local communities with a viable adaptation measure. Fees will only be imposed to pay the cost of improvement or services by which the assessed coastal land is specially benefitted. With the benefitting individuals and businesses each paying a fraction of the cost, more money can ultimately be collected and spent on U.S. coasts. Most importantly, local communities will be able to take the matter into their own hands, in the absence of federal government regulation.

## V. CONCLUSION

As the effects of climate change continue to manifest, the issues surrounding storm surge will only intensify. Low-lying regions in coastal zones will remain at risk to flooding and disaster unless coastal communities adapt. Local governments on the United States' coasts must act quickly to implement a new method of funding for fortification of our beaches. Special assessments and user fees are a feasible solution that rest well within the delegated local government powers. With special assessments in place, fees for beach re-nourishment and maintenance will be charged directly to users of a city or town's coastal infrastructure, based on estimates of the use they generate. Special assessment fees will eliminate the prospect of free riders benefitting from suckers, and prevent wealthier towns from having stronger coasts simply because they can afford it. Special assessment fees will allow for heightened promotion of the growth and maintenance of sand dunes, and will encourage more access to beaches by all who wish to benefit from them. Ultimately, local government special assessment coastal fees will provide communities with the resources to effectively combat the dangers of coastal climate change.

166. *See* PORTLAND BUREAU OF TRANSP, BETTER STREETS, SAFER CITY: STREET REPAIR AND SAFETY PROGRAM, https://www.portlandoregon.gov/transportation/64188 (last visited Feb. 7, 2016) [hereinafter BETTER STREETS].

167. *Id.*

168. *Id.*